

AN APPLICATION OF HIERARCHICAL BAYES MODELS TO ESTIMATED
PREVALENCE OF MENTAL DISORDER AND MENTAL HEALTH SERVICE USE
AMONG COOK ISLANDERS IN NEW ZEALAND

JESSE KOKAUA

A THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
AT THE UNIVERSITY OF OTAGO, DUNEDIN,
NEW ZEALAND

May 2014

ABSTRACT

The aims of this thesis are twofold. First is the epidemiological goal of reporting patterns and determinants of mental disorder among people of Cook Island ethnic group descent (Cook Islanders) compared to people from other ethnic groups living in New Zealand. In addition to prevalence of disorder, patterns and factors associated with use of treatment services for disorder are identified. The second goal is to develop hierarchical Bayes models based estimates of prevalence that show improved precision for a small sub-population such as Cook Islanders.

Two sources of data are used. The New Zealand Mental Health survey (NZMHS), and the Mental Health Information National Collection (MHINC). Hierarchical Bayes models were developed to predict 12-month and lifetime prevalence as well as cumulative lifetime prevalence of mental disorders and service use from both data sets. These models are specified to adapt to complex survey design and question pathways of the NZMHS. The analysis of the NZMHS data, where a subset of people has been excluded from some questions, are analysed as if missing at random. The same principle is further applied to the analysis of MHINC data where the models are adapted to cope with missing ethnic group codes under missing at random assumptions. Bayesian survival models have been used to estimate the cumulative probability of onset of mental disorder and, in addition, that a person will seek treatment or recover without treatment with competing risks.

The prevalence of any 12-month mental disorder is 31%, around 50% higher than those from non-Māori, non-Pacific (NMNP) ethnic groups. They have comparatively high prevalence of service use for mental health problems compared with people from other Pacific nations, but less than NMNP. Much of the increased risk of any mental disorder is explained by age and sex differences and further mediated by age at migration. However, the increased risk for some disorders such as mood, alcohol or serious disorders, remain, even after accounting for other factors.

Evidence suggests that migrant Cook Islanders were less likely to have disorder while subsequent generation are at greater risk. Rather than reflecting a population with severe risk as a result of their ethnicity, descendants of Cook Islands appear to be a population that is more acculturated to New Zealand society than other Pacific peoples,

inheriting not only its benefits but also the levels of mental disorders that accompany a comparative young population with low incomes and higher unemployment.

Implications for public health research might involve investigating the potential for this group to return to their original native levels of mental disorder. Further, there is a resistance of those living in areas of high Pacific population density to use mental health services. This may represent an increased burden of care on other parts of the Cook Islands and wider Pacific community with disproportionately high use of mental health services as a result of an acute episode or an enforced intervention. The challenge for New Zealand's government policy makers is to ensure the needs of those requiring treatment are appropriately met.

PREFACE

This is an original piece of work, the culmination of my own conception and development over the duration of my study for this degree. It involves the analysis of two separate sets of data: Te Rau Hinengaro - the New Zealand Mental Health Survey (NZMHS), and an extract from the New Zealand government's Mental Health Information National Collection (MHINC) from July 2001 to June 2008. Between 1998 and 2011, as an employee of the Health Funding Authority and then New Zealand Ministry of Health, I participated in the implementation of these two datasets and many subsequent resulting analyses. Its novelty lies in its content which describes the mental health state of Cook Islanders in New Zealand as well as some of its more uncommon methodological applications set up to overcome some of the analytical challenges that have resulted from the complex or sometimes restricted data gathering.

My involvement with the NZMHS began when I worked for the Health Funding Authority. That authority funded a pilot for the survey in jointly with the Ministry of Health under new Mental Health Research funding fund. I participated alongside Dr Siale Foliaki as part of a team led by Professor Mark Oakley-Browne, Professor Mason Durie and Dr Elisabeth Wells (Oakley Browne, Durie, & Wells, 2000). After which, as a member of the Pacific team, I participated in the development from the pilot questionnaire and methodology to the full survey. The NZMHS was funded by the Ministry of Health, the Alcohol Liquor Advisory Council and the Health Research Council of New Zealand. Additionally, the NZMHS was carried out in conjunction with the World Health Organization World Mental Health Survey Initiative.

I took part in the many teleconferences and face-to-face administrative meetings with a growing team that included Dr Te Kani Kingi, Dr Kate Scott, representatives from Statistics New Zealand and other contract and administrative organisations. These meetings led to decisions about the questionnaire's content, the survey design and the organisation that would finally take the survey into the field.

By early 2003, Professor Oakley-Browne and Dr Wells had organised a number of researchers to contribute to the administration of the survey as well as the ensuing analyses and reports that follow any piece of research of this kind. The groups included a

small but capable Māori research team led by Professor Mason Durie and supported by a Kaitiaki group. Dr Foliaki and I had become part of a larger Pacific research team led by Dr Colin Tukuitonga, and joined by Dr David Schaaf. This team contributed to the administration of the survey alongside the overall research team, all of whom are listed in the main report (Oakley Browne et.al., 2006a). This team wrote the Pacific chapter of the main report and participated in writing subsequent papers related to, or including, analyses of Pacific peoples.

The Pacific research team was also well supported by an advisory group led by Karl Fuimaono Puluotu-Endemann and comprised of Dr Francis Agnew, Vito Nonumalo, Rev Feilonga Taule-aleausamai, Lina-Jodi Vaine Samu, Sefita Hao'uli and Hemi Lesatele. These people's contributions were invaluable in supporting the outcomes of the survey and ensuring that Pacifika gleaned the maximum possible value from the subsequent information that was reported from the NZMHS survey results.

Other members of the NZMHS Research Team were K. M. Scott, M. McGee, J. Baxter, T. K. Kingi, R. Tapsell, A Beutrais, and C. Gale.

My involvement with the MHINC has also been through my work; initially with the Health Funding Authority to develop the output from the emerging MHINC to reduce the contractual reporting burden of participating District Health Boards. As part of their contracts with the Health Funding Authority, DHBs were obliged to contribute to MHINC. But, as a consequence, they were able to move to a schedule of reduced contract reporting. The intent was that much of the utilization reporting in the contract monitoring system would be better reported in the unit record reporting of the MHINC. To that end, many of the outputs from the MHINC were mapped to the Health Funding Authority's purchase framework. It is that purchase framework mapping that provides the broad service category definitions used in Chapter 9.

Further to that work, as part of the New Zealand Ministry of Health, a summary report for each DHB was produced with my colleague Barry Welsh. The aim was to produce an early MSEXcel based tool to provide summary information about the mental health services in each DHB. Several of the outcomes definitions from that project have also been

used in Chapter 9. However, apart from the use of those definitions, the work in this thesis is not related to that earlier piece of work.

This thesis, about levels of mental disorders and resulting service use by Cook Islanders in New Zealand, is divided into ten chapters. Excluding Chapter 1, the introduction, and Chapter 10, the concluding chapter, the middle eight chapters comprise two sections; one focused on analysis of the NZMHS, and the other on analysis of the MHINC. Each section begins with background detail about each dataset followed by a statistical chapter about the Bayesian models developed for the analysis of each section. The remaining chapters present results.

Part one of this research begins with the relevant background to the NZMHS presented in Chapter 2. It also includes the design structure and the definitions of diagnoses and other variables included in analyses. Section 2.2 gives an overview of how ethnicity is recorded in NZMHS and subsequently reported in analyses of NZMHS data.

Chapter 3 introduces the Hierarchical Bayesian methodology and the models from which all subsequent NZMHS analyses results are produced. The language of Chapter 3 is necessarily statistical in order to succinctly describe the methodology around the models used in subsequent chapters. The models are developed to analyse data from a survey with a complex design like the NZMHS. Section 3.6 provides two examples of Hierarchical Bayes analyses of NZMHS data with a comparison to results using SUDAAN. The latter replicates the methodology used to compare ethnic groups in Te Rau Hinengaro: the New Zealand Mental Health Survey.

Chapter 4 presents the prevalence and some determinants of twelve month mental disorders using Bayesian logistic regression models. Chapter 5 initially presents lifetime prevalence of mental disorders in a similar fashion to Chapter 4. However, Chapter 5 concludes with lifetime-cumulated incidence of mental disorders. The latter sections use a Bayesian Cox regression survival methodology introduced in Chapter 3.

The 12 month prevalence of service use resulting from mental health problems in the NZMHS are presented in Chapter 6 using similar methods to those used in Chapter 4 and the first part of Chapter 5. Chapter 6 also looks at the ages that first service use occurs

or when someone recovers without receiving treatment. A Bayesian Cox regression model is applied in this case, as in Chapter 5, with the added complexity that it is extended to include competing risks: treatment for a mental health problem or recovering without receiving treatment.

Part two begins with Chapter 7 which gives an overview of the MHINC data extract provided by the New Zealand Ministry of Health that is used in the analyses of government-funded specialist mental health service use. In particular, section 7.2 gives an overview of how ethnicity is recorded in the MHINC, and subsequently in analyses of MHINC data, and introduces the issue of missing ethnicity codes.

Chapter 8 begins with a review of the background to, and nature of, missing data and analyzing data with missing values. It covers the various models and approaches to analyzing data with imputed values. Section 8.3 introduces a Hierarchical Bayes model as an alternative to multiple imputation. This model is different from the usual approach of imputed models in that it is applied to aggregate tables as opposed to unit record data itself. Like Chapter 3, Chapter 8 is also written in a statistical style.

The key findings from the analyses of the MHINC using the Hierarchical Bayes model developed in Chapter 8 are reported in Chapter 9. It shows patterns of use of government-funded specialist mental health treatment system among ethnic communities in New Zealand.

It should be reiterated that this is my own work from the suggestion of the topic, the broad analytical approach, to the development of the more novel applications of the Hierarchical Bayes models to overcome the complex survey design or missing data in aggregate table form. Results from Chapters 4 and 5 were published in a paper about Migration and Pacific peoples while preliminary results from Chapters 4, 5, 6, and 8 were published on a paper about mental health of Cook Islanders (Kokaua et al., 2009; Kokaua & Wells, 2009)

Acknowledgements

This piece of work would not have been possible without the valued input from many people that I have had the pleasure to encounter during this journey. Firstly, I would like to express my appreciation and admiration to my supervisors, Professor Elisabeth Wells, Dr Patrick Graham and Professor Richie Poulton for their generous support, patience, and sound advice.

I would also like to thank my colleagues within the department who have provided day-to-day contact and acted as a soundboard (Dr Moana Theodore, Fiona Parker, Dr Sandhya Ramrakha, Michelle McCann, Sean Hogan and Associate Professor David Craig). At the beginning of this study, I was working for the Ministry of Health who generously allowed me time to dedicate to this piece of work. I was given permission to use the data and a support from a team that provided more than a little input into my work (Dr Janice Wilson, Dr Barry Welsh, Heidi Browne, Bevan Sloan, Anna Long, Lisa Clyde, Deborah Baird and Chris Windsor to name just a few). I would like to thank also the entire research team of the NZMHS for their invaluable input into my development as a researcher. By the end of my study I was employed part time by the Pacific Islands Research and Student Support Unit (PIRSSU) whose support in the last year has been very much appreciated (Faumuina Associate Professor Fa’afetai Sopoaga, Malia Lameta and Barbara Weastell). In addition, I would like to thank Anna Paris who so generously has helped with formatting and proof-reading earlier drafts of this thesis.

It is with the deepest gratitude that I to acknowledge my parents, Te Rangitira O Ngati Arera Roinga Taiti Kokaua, and Jane (Marsters) Kokaua, my brothers and sisters (Maureen Hilyard, Evelyn Kenneally, Tuaivi Kokaua, Roy Marsters, Jane MacPherson, and Bob Kokaua) and their partners for their support for my family and myself through this process. Finally, it is dedicated to: my wife, Anne; my children, Stacey, Rebekah, Sarah, Hamish; and my grandchildren, Roinga, Penny, Joseph and Gabriella each of whom, at some time, had the “pleasure” of sharing a bit too intimately in this journey.

TABLE OF CONTENTS

Abstract	ii
Preface	iv
Acknowledgements	viii
1. Introduction	1
1.1 Background	1
1.2 Background to the effects of immigration on mental health	7
1.3 Aims and Objectives	21
2. Background to the New Zealand Mental Health Survey data	24
2.0. Introduction	24
2.1. Background	24
2.2. Sample design in NZMHS	25
2.3. Definitions	28
3. Bayesian models for analysing New Zealand Mental Health Survey data	40
3.0 Abstract	40
3.1 Introduction	41
3.2. A hierarchical Bayes model applied to NZMHS data	47
3.3. Bayesian Cox proportional hazards models	59
3.4. Hierarchical Bayes model diagnostics	66
3.5. An example of SAS code for a model prevalence in WinBUGS	73
3.6 Comparison to previously published results	76
3.7 Discussion	78
4 Twelve-month prevalence and correlates of mental disorder among Cook Islanders in NZMHS	81
4.0. Abstract	81
4.1. Method	82
4.2. Results	94
4.3. Discussion	111
5 Lifetime prevalence and risk of mental disorder among Cook Islanders in NZMHS	115
5.0. Abstract	115
5.1. Method	116
5.2. Results	122
5.3. Onset of disorder among Cook Islanders	126
5.4. Discussion	131
6 Treatment for mental health problems among Cook Islanders in NZMHS	135
6.0 Abstract	135
6.1 Method	136
6.2 Results	140
6.3 The effect of correlates on ethnic differences in twelve-month service use for those with any mental disorder	143
6.4. Cumulative incidence of mental disorder, treatment and recovery	146
6.5 Discussion	151
7 Background to National Mental Health service use data in the MHINC	155
7.0. Abstract	155

7.1. Introduction to the MHINC	155
7.2. Ethnicity in the MHINC	159
7.3. Discussion	162
8 A hierarchical Bayes model for analysing aggregate ethnic group data with missing entries in the MHINC	163
8.0. Abstract	163
8.1. Background to analyses of missing data	164
8.2. Models for addressing missingness	167
8.3. Missing data methods applied to ethnicity in MHINC	173
8.4. Comparison of several different models	179
8.5. Discussion	185
9 Use of New Zealand government funded mental health services between 2000 and 2008 by Cook Islanders	189
9.0. Abstract	189
9.1. Method	190
9.2. Results	193
9.3. Discussion	202
10 General Discussion	206
10.0 Abstract	206
10.2 Methodology	207
10.3. Limitations of the study	208
10.4. Strengths of the study	210
10.5. Summary of findings	212
10.6. Implications from findings	222
10.7. Conclusions	227
References	229
Appendix A Published Papers	243
Appendix B Programmes for Bayes Models	263

LIST OF TABLES

Table 2.1	The ethnicity question used in the NZMHS.....	31
Table 3.1	Model diagnostic summary for 12 month prevalence of mood disorder; Geweke and Gelman-Rubin statistics.	69
Table 3.2	Summary posterior predictive distribution for the proportion of total sample observed with a disorder (10,000 draws), the observed proportion and proportion of predictive draws greater than or equal to the observed proportion.	74
Table 3.3	Comparisons of estimated 12-month prevalence of mental disorder by diagnosis and ethnicity.	78
Table 4.1	Predictive diagnostic summary for models of 12-month prevalence of disorders: predictive proportion and observed proportion.	86
Table 4.2a	Model diagnostic summary for models of 12-month prevalence by disorders; Gelman Rubin and Geweke statistics.	87
Table 4.3	Predictive diagnostic summary for single fixed effect models with single covariate of 12-month prevalence of any mental disorder: predictive proportion and observed proportion.....	89
Table 4.4a	Individual covariate model diagnostic summaries for models of 12-month prevalence of any mental disorder; Gelman Rubin and Geweke statistics, multivariate R and predictive analysis.	90
Table 4.5	Predictive diagnostic summary for joint covariate models of 12-month prevalence of disorders: predictive proportion and observed proportion.	92
Table 4.6	Joint covariate model diagnostic summaries by disorder; Gelman Rubin and Geweke statistics, multivariate R and predictive analysis.	93
Table 4.7	Twelve-month prevalence Cook Islanders for disorder groups.	94
Table 4.8	Twelve-month prevalence* and rate ratios (RR) for any mental disorder among Cook Islanders by age and sex.	96
Table 4.9	Cook Islands twelve-month prevalence of any mental disorder. Rate ratios relative to Cook Island s prevalence for each age group or sex.....	99
Table 4.10	Twelve-month prevalence among and ethnic relative risks by disorder group.	100
Table 4.11	Unadjusted twelve-month prevalence of any mental disorder among Cook Islanders by covariate with rate ratios.....	103
Table 4.12	Odds ratios among Cook Islanders for covariates by twelve-month disorder adjusted for all covariates.	105
Table 4.13	Twelve-month prevalence and ethnic relative risks of any mental disorder adjusted for each individual and all covariates.	106
Table 4.14	The percent of ethnic difference in twelve-month prevalence of mental disorder between Cook Islanders and NMNP that is explained by covariates.	109
Table 4.15	Twelve-month prevalence and relative risk for other ethnic groups by disorder: unadjusted, adjusted for age and sex and adjusted for all covariates.	110
Table 4.16	The percent of ethnic difference in twelve-month prevalence of mental disorder between Cook Islanders and NMNP that is explained by covariates.	111
Table 5.1	Predictive diagnostic summary for models of lifetime prevalence of disorders; predictive proportion and observed proportion.	117
Table 5.2a	Visual diagnostic summary for models of lifetime prevalence by disorders; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.	118
Table 5.3	Predictive diagnostic summary for models of lifetime prevalence of disorders; predictive proportion and observed proportion.	120
Table 5.4	Visual diagnostic summary for models of lifetime prevalence by disorders; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.	121

Table 5.5 Lifetime prevalence of mental disorder among Cook Islanders with comparisons to other ethnic groups.	122
Table 5.6 Prevalence of lifetime disorder among Cook Islanders by age and sex.....	124
Table 5.7 Lifetime prevalence of mental disorder among Cook Islanders with comparisons to other ethnic groups.	107
Table 6.1 Model diagnostic summaries for 12-month service use by disorder.....	120
Table 6.2 Diagnostic summary for models of cumulative lifetime incidence of disorder; treatment and recovery from disorder.	121
Table 6.3 Twelve-month service use, among Cook Islanders with a diagnosed disorder, by service type	123
Table 6.4 Twelve month prevalence of service use by service type with ethnic comparisons ...	124
Table 6.5 Prevalence of any 12-month service use adjusted by covariate, by itself and in addition to age and sex, with ethnic group comparisons.....	126
Table 6.6 Prevalence of 12-month mental health specialist service use adjusted by covariate, by itself and in addition to age and sex, with ethnic group comparisons.....	127
Table 6.7 The cumulative proportion at time since onset of any mental disorder by place of birth among Cook Islanders.....	132
Table 7.1 Total number of agencies and clients reporting to MHINC 2000/01 to 2005/06.....	138
Table 7.2 Client numbers by ethnicity recorded in the Users and Access tables.	142
Table 7.3 Client numbers by combined ethnicity (either NHI- or access- reported).....	143
Table 8.1 Data layout for aggregate MHINC data for 12 age groups over T years.	157
Table 8.2 Comparisons of estimated mean annual client number; by imputation method and ethnicity.	181
Table 8.3 Comparisons of estimated rates per 10,000 that a person will be a mental health service client by imputation method and ethnicity.....	183
Table 8.4 Comparison of run times for each model.	184
Table 8.5 Comparison of run times for each method	186
Table 10.1 Potential burden of increased risk of mental disorder on numbers of government-funded specialist mental health service users in 2008.....	193

LIST OF FIGURES

Figure 2.1 Stratum and cluster design for NZMHS.....	26
Figure 2.2 A flowchart for Part I and Part II sample selection	27
Figure 2.3 Flow chart for classifying treatment and recovery.	32
Figure 3.1 Prior location and standard deviation (whiskers) for survey design variables for any mental disorder, substance specifically, service use, and covariates.	53
Figure 3.2a Twelve-month prevalence of mood disorder WinBugs model diagnostic plots: distribution, trace and Gelman-Rubin plot. (5 chains of 40,000 runs)	70
Figure 3.3 Left: Multivariate R diagnostic graphs for mood (3 chains 20,000 draws). Right: Posterior predictive distribution for the unweighted proportion of total sample observed with a mood disorder (10,000 draws) the actual observed proportion indicated by a solid line.	73
Figure 4.1 Rate ratios across Cook Islands age groups; anxiety, eating, substance, serious and mild disorder groups.....	95
Figure 4.2 Probability distribution of estimates for twelve-month prevalence of any mental disorders by ethnicity.	98
Figure 5.1 Cumulative incidence of disorder among Cook Islanders by age.	127
Figure 5.2 Cumulative probability for any mental disorder amongst Cook Islanders by place of birth and sex (vertical bars* represent 95% CRs).....	127
Figure 5.3 Cumulative probability for any alcohol disorder amongst Cook Islanders by place of birth and sex.	128
Figure 5.4 Cumulative incidence of any mental disorder by ethnicity and age.....	130
Figure 5.5 Cumulative incidence of alcohol disorder by ethnicity and age.	130
Figure 6.1 Age of onset of any mental disorder, recovery and treatment (any and mental health specialist) by ethnic group	147
Figure 6.2 Time to treatment and recovery from onset of any mental disorder by ethnic group (N= 4910)	148
Figure 7.1 MHINC tables extracted annually from 00/01 to 07/08.	140
Figure 8.1 Model layout for hierarchical Bayes models.	176
Figure 9.1 Visual diagnostic summary for models for total service use; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.	192
Figure 9.2 Cumulative onset of mental health service use with age.	193
Figure 9.3 Any specialist mental health service use by ethnic group	193
Figure 9.4 Onset of specialist mental health service use by ethnic group	193
Figure 9.5 Rate ratios of mental health service use by NZDEP06 quintiles.	193

1. Introduction

<i>1.1 Background</i>	<i>1</i>
1.1.1 Pacific people and mental health	1
1.1.2. People from the Cook Islands and mental health	5
<i>1.2 Background to the effects of immigration on mental health</i>	<i>7</i>
1.2.1. The immigrant paradox	9
1.2.2. The healthy migrant hypothesis	11
1.2.3. The salmon bias	12
1.2.4. Acculturation	13
1.2.5. Native influences	16
1.2.6. Other factors that influence an immigrant paradox	17
1.2.7. Implications for mental healthcare services	18
1.2.8. Findings for New Zealand's Pacific immigrant communities	19
<i>1.3 Aims and Objectives</i>	<i>21</i>
1.3.1. Aim 1: Methodology	22
1.3.2. Aim 2: The Prevalence, determinants and onset of mental disorder	23
1.3.3. Aim 3: Recovery, treatment and service use	23

1.1 Background

1.1.1 Pacific people and mental health

The social and cultural fabric of Pacific peoples in New Zealand society is diverse, complex and heterogeneous. There are differences both between and within cultural groups in terms of norms, customs, language, cultural values and behaviours. Pacific peoples have come to New Zealand from picturesque, seeming idyllic, island nations with supportive, structured, village-based communities. Compared with western nations, the existence of mental disorder appeared low or almost non-existent in more traditional based communities (Allen & Laycock, 1997). However, a study of substance use in Papua New Guinea pointed to ceremonial practices that involved traditional substance use (in the form of a drink made from the root of the Kava plant), giving way to contemporary use of alcohol that has resulted in growing alcohol related problems (Posanau, 1997). Another study, this time of native Hawaiians compared with other Hawaiians, showed they had higher prevalence of many physical disorders and increased levels of moderate to severe depression (Aczon-Armstrong & Reyes-Savai, 2013).

Since the early 1950s, demand for workers in the manufacturing and service industries has culminated in increasing numbers of Pacific peoples emigrating to urban centres of New Zealand. This accelerated dramatically with the economic boom of the 1960s and early 1970s (Spoonley, 2001; Krishnan, Schoeffel, & Warren, 1994). The establishment of South Pacific Work Schemes recruited labourers from Fiji, Samoa, Tonga, Tuvalu and Kiribati throughout the 1970s. However, an economic downturn that started in the 1970s and characterised New Zealand's economy in the 1980s and 1990s, led many Pacific peoples in the manufacturing industries to be laid off or in less than full-time employment. This created adverse consequences in general living conditions for many Pacific migrants and their families and, alongside pressures of adjustment and acculturation, has been speculated to have negatively impacted on the mental health of Pacific peoples living in New Zealand.

In one study of the consequences of growing up as a second generation Pacific Islander in New Zealand, Mila-Schaaf (2011) introduced a negotiated space, a conceptualisation of a rethinking of the intersection of two knowledge systems. This is a contemporary cultural metaphor representing the Va; a watering hole, a debating chamber or a Kava circle. The study provides an example of how the negotiated spaces applies to Pacific and Palagi (European) worldviews and its relevance to second generation Pacific migrants (Mila-Schaaf & Hudson, 2009). Mila-Schaaf (2011) focused specifically on the way second generational Pacific peoples have developed, as well as the struggles of maintaining their Pacific culture and identity in New Zealand. Mila-Schaaf provides a detailed investigation into the difficulty of descendants of recent migrants of maintaining their identity while being brought up with multiple cultural influences. While that study attempts to focus solely upon second generation Pacific New Zealanders, this study is unable to capture generational status and so allows analyses by place of birth only.

Prior to the New Zealand Mental Health Survey (NZMHS), estimates about the prevalence of mental disorders among Pacific peoples in New Zealand had been drawn from the few prevalence studies performed in the Island nations (Allen & Laycock, 1997), or from Pacific people's use of mental health services in New Zealand (Bridgeman, 1996; Ministry of Health, 2005). In 2006, using NZMHS data, Foliaki et al.

reported the 12 month prevalence of mental disorder among Pacific peoples by age at migration and showed that among New Zealand-born Pacific people, 31.4% had a mental disorder which was twice as that of people who migrated at age 18 and over (15.1%) (Foliaki, Kokaua, Schaaf, & Tukuitonga, 2006a; Foliaki, Kokaua, Tukuitonga, & Schaaf, 2006b). That observation supported international studies that pointed towards migrants having a lower lifetime prevalence of mental disorders (Breslau et al., 2005; Escobar et al., 2000; Vega et al., 1998).

Subsequent studies have shown that Pacific peoples living in New Zealand still exhibit higher levels of mental distress compared to others (Ministry of Health, 2012), and in spite of lower prevalence of alcohol use, evidence among those who do drink shows increased risk of problem drinking and related morbidity and other harm (Huakau et al., 2005; Wells, Baxter, & Schaaf, 2007). A study of Pacific families also showed overall drinking appeared lower than the general population and mothers had extremely low levels of use during pregnancy. However, 2 years after childbirth, problem drinking had occurred in around 20% of Pacific mothers and fathers were twice as likely to consume alcohol to levels that may be harmful to themselves or those around them (Schluter et al., 2013). In another publication, the same study also showed that while fathers' mental health was good 12 months after childbirth, their odds of poorer mental health had increased 70% by 2 years after childbirth and 3 fold by 6 years. Smoking, employment and marital status were all strong contributors to their mental health status. Though not statistically significant, cultural integrators and marginalists appeared to also have increased odds of poorer mental health (Tautolo, Schluter, & Sundborn, 2009).

Several studies have found that a strong national identity promotes psychological wellbeing (Flores & Brotanek 2005; Haasen, Sinaa, & Reimer, 2008). Alongside a strong ethnic identity, together they promote the best integration and adaptation into a new culture (Eitle et al., 2009). Becoming a part of the host society was found to be important, but not at the cost of ethnic identity which can be thwarted by host societal attitudes (Phiney et al., 2001). Using an interesting factor analytic approach to understand key components of identity and wellbeing among Pacific peoples, a key factor that emerged as a link to both traits was the importance of religion

in terms of "centrality" and "embeddedness". Societal and familial wellbeing also appeared central to overall wellbeing while cultural connectedness was a key factor associated with identity (Manuela & Sibley, 2013a, 2013b). Another study of Pacific families also showed that increased retention of Pacific cultural identity was aligned with decreased health risk among Pacific Mothers. Those who were marginalised and even those who had fully adopted their non-Pacific cultures appeared to have poorer health outcomes (Borrows et al., 2010).

In spite of many of these findings, Pacific communities are moving positively to overcome the apparent inequity in levels of mental illness, accompanied by an underutilization of support or treatment services. Te Whare Tapa Wha and Fono Fale models (Crawley, Pulotu-Endemann, & Stanley-Findlay, 1995; Durie, 1994) are two popular models of Maori and Pacific conceptualisations of health and wellbeing that have served as a foundation for many mental health care services in New Zealand. Those models were based upon attributes of health and wellbeing in the context of a cultural setting. Several studies have further investigated concepts around ethnicity, traditional and contemporary culture, mental health and mental health service delivery for Pacific peoples (Bush et al., 2009). Pacific models identified were: an understanding of spiritual and cultural values of the collective group; their use of language and hospitality and taking time to build a rapport; and a balance of mind, body and soul as important factors. Each of those values, while not uniquely Pacific, were not typically descriptive of conventional medical models of treatment (Suaalii-Sauni et al., 2009).

These in turn have led to service development changes for providers and workers in the mental health sector that work with and alongside Pacific clients and their families (Parsonage et al., 2009), as well as for other sectors that interact with Pacific peoples with mental illness. The implications for primary MH care are to: address a range of barriers, work closer with Pacific communities, improved treatment with understanding of Pacific models of care, provide choice, and undertake research that will improve Pacific responsiveness to treatment (Collings et al., 2010).

Mental health has been identified as one of the health issues where Pacific peoples are of greatest increased risk. Four factors have also been identified as of

greatest impact for Pacific mental health: demography, socioeconomic status, ethnic diversity and health literacy (Ryan et al., 2011).

1.1.2. People from the Cook Islands and mental health

The Cook Islands are a group of 15 islands in the South Pacific well known as a relaxed holiday destination with a colourful, appealing and varied culture. The peoples from these islands have a varied mix of cultural practices and languages. The past century has seen much interaction between the people of the Cook Islands and New Zealand since the Islands were annexed in 1900. People of the Cook Islands have both Cook Islands and New Zealand citizenship.

As previously reported for people from all over the Pacific, increased demand for workers in New Zealand manufacturing and service industries during the 1950s and 1960s led to greater numbers of people from the Cook Islands emigrating to urban centres (Spoonley, 2001). International migration has become a feature of Cook Islands society to the extent that it is estimated that 85% of Cook Islands descendants live outside of the Cook Islands themselves (Tongia, 2003). In 2006, while 11,800 residents lived in the Cook Islands there were 52,600 Cook Islanders who lived in New Zealand (Cook Island Statistics Office, 2008).

As a result, there are many thriving Cook Islands communities throughout New Zealand. Although largely established in Auckland, there are strongly identified Cook Islands communities around the rest of New Zealand. Wellington, Hamilton, Hastings, Tokoroa, Christchurch, and even as far south as Dunedin and Invercargill, each have small but distinct Cook Islands communities. People of the Cook Islands who have settled in New Zealand and their descendants, have quietly become a part of that society. Cook Islanders can be found at all levels of New Zealand society.

The economic downturn that began in the 1970s affected Cook Islanders employed in primary industries, as it did to other migrant groups from throughout the Pacific who had settled in New Zealand. Likewise, the accompanying adverse consequences in general living conditions experienced by many Pacific migrants and their families, represented by adverse socio-economic status, poor living conditions,

acculturation and adjustment pressures were felt strongly in this community. Prior to the economic downturn in recent years, Cook Islanders had seen some improvement in their social and economic conditions. However, there is some evidence to suggest Pacific communities are still more vulnerable to the negative impacts of economic shifts and remain more likely to be found below the poverty line (Expert Advisory Group on Solutions to Child Poverty, 2012).

Like those who descended from other Pacific nations, issues exist for Cook Islanders born or raised in New Zealand from an early age that differ from Island-born Cook Islanders (Tiatia & Coggan, 2001). Issues of identity for young Pacific peoples are significant in a bicultural and multicultural environment. Transition from Island culture to an urban, largely papa'a (the Cook Islands word for pakeha or palagi usually referring to European) dominated culture of New Zealand has had some negative consequences. Some evidence suggesting that the burden of this transition has been felt more keenly among the New Zealand-born descendants of those who migrated than the migrants themselves (Flores & Brotanek, 2005).

Few publications exist about Cook Islands history, culture, health and traditional healing practices (Baddeley, 1985; Hecht, 1985). Even fewer documents have dealt with mental illness among Cook Islanders in New Zealand (Kokaua & Wells, 2009). An observation of traditional healing practices was that physical manifestations possibly attributed to mental illness would be interpreted and treated as "maki tupapaku" or spiritual illness. Waitemata District Health Board (DHB) produced a workbook for a report on Cook Islands cultural competency for mental health services in New Zealand (Worth, 2004). That report also proposed a Cook Islands model for mental health care as well a glossary of Cook Islands' translations for many concepts related to mental illness.

Very little has been reported on the prevalence of mental disorder among Cook Islanders or even the use of mental health services by Cook Islanders in New Zealand. In an analysis of Pacific fathers' health, Cook Islands fathers stood out as ethnic groups with poorer mental health (Tautolo et al., 2009). Foliaki and colleagues (2006a)

reported that Cook Islanders had a 12 month prevalence rate of mental disorder 50% higher than that of New Zealand as a whole.

1.2 Background to the effects of immigration on mental health

One research focus for this study is the mental health of a transnational migrant worker population, and as such a choice has been made to refer to international studies that focused upon the transnational migrant experiences of non-refugee immigrants. In addition, this study is also focused upon the prevalence of common mental disorders and mental health service use. Consequently, a lower priority has been placed upon studies of physical conditions, schizophrenia or psychoses.

There has been much international evidence showing an association between migration and psychiatric disorder or mental wellbeing. Studies of mental disorder and/or service use emanating from Europe were more likely to conclude that migration had a negative effect upon the mental health of migrants (Oppedal & Roysamb, 2004; Rundberg et al., 2006). A study of Swedish immigrants, found that other external factors were also considered determinants of the increased risk of psychoses (Zolkowska, Cantor-Graae, & McNeil, 2003).

However, one study of immigrants in England concluded that migration was not associated with the increased risk of depression (Livingston et al., 2001). Whilst another UK study showed that Afro-Caribbean children had an increased risk of psychotic symptoms while the same risk among Asian children was lower (Laurens, West, Murray, & Hodgins, 2008). Subsequent European studies have also concluded that nativity, region of origin, mediated any differences in immigrants' mental health (Amad et al., 2013; Jurado et al., 2014).

While migration, with gender, was also associated with increased mental disorder, it was also linked to lower mental health service use (Gaber et al., 2013; Straiton, Reneflot, & Diaz, 2014; Schouler-Ocak et al., 2008).

Most studies of migration to America originating from Canada and the USA were more likely to report positive mental health of immigrants compared with studies from Europe. A study of immigrants to the United States displayed a gradient with age

at migration and concluded that a low risk of mood and anxiety disorders was associated with having spent their pre-adolescent years outside of the USA. However, that phenomena applied to groups with a low risk of disorders in the country of origin (Breslau, Borges, Hagar, Tancredi, & Gilman, 2009). Many studies have found that Mexican and other Latin American migrant to the United States had lower prevalences of mental disorder and better overall mental health than existing residents or subsequent generations of migrant descendants born in the United States (Karno et al., 1989; Orozco, Borges, Medina-Mora, Aguilar-Gaxiola, & Breslau, 2013; Vega, Kolody, & Warheit, 1985).

However, some studies found that Mexican and other Latin American immigrants reported increased levels of mental disorder. While many of these findings were found a link with levels of disorder that had previous existed in their populations of origin, others found this increased also consistent with adverse effect of migration (Breslau et al., 2011; Pole, Best, Metzler, & Marmar, 2005)

Seemingly conflicting results from studies of immigrants to Canada found that migrants had reduced odds of common mental disorders (Aglipay, Colman, & Chen, 2013), while another Canadian study found that young migrants had higher risk of mood and anxiety compared to older migrants (Patterson, Kyu, & Georgiades, 2013).

In a comparative study of Australian immigrants, low rates of anxiety and depression were found in Vietnamese migrants (Liddell et al., 2013). Australian immigrants, overall, were also less likely to be seen by psychiatric services (Klimidis, McKenzie, Lewis, & Minas, 2000).

In a study of Pacific peoples in New Zealand, a positive gradient with age at migration was associated with increased prevalence of mental disorder (Kokaua, Schaaf, Wells, & Foliaki, 2009). This finding was consistent with other studies that showed migrants who migrated at older ages had less mental disorders than those who migrated as children. Also consistent with other international findings, older migrants were also healthier, in terms of less mental disorder, than New Zealand born descendants of immigrants.

1.2.1 The immigrant paradox

The “healthy immigrant” phenomena is where an immigrant group is comparatively healthier than others in the local population of their host country. If, in addition, the same population appear to have increased exposure to risk factors usually associated with poorer mental health in the host country, then an *immigrant paradox* is said to be evident. Another part of the “paradox” is that the protective effect of the healthy immigrant is not extended to subsequent generations of migrant descendants who are born in the host country.

An immigrant paradox has been observed in many studies of Latin American immigrants to the USA and has been referred to as the “*Mexican*” or “*Latina(o)*” *paradox*. A study of Mexican migrant farm workers observed lower lifetime prevalence of overall mental disorder among Mexicans and immigrants, whether in their native homeland or recently migrated (Alderete, Vega, Kolody, & Aguilar-Gaxiola, 2000b). This low prevalence, however, was not found in subsequent generations of migrant descendants who shared similar levels of mood and substance use disorders to the overall host population. Karno et al. (1989) observed significant migrant differences in several anxiety disorders. While immigrants appeared healthiest, the group with the highest rates alternated between US born and non-migrants depending upon the type of anxiety disorder. Several other studies have also concluded that immigrants have better mental health than subsequent generations (Bostean, 2013; Eitle, Wahl, & Aranda, 2009; Orozco et al., 2013).

Also consistent with an immigrant paradox are findings that showed little or no difference between early age migrants and host country locals or children of immigrants (Alegria et al., 2008; Breslau et al., 2007; Breslau et al., 2009). Their findings suggested that a strong effect of environmental factors on young immigrants, and either early socialisation in their host country or resilience in immigrants who arrive as adults explained much of the effect of migration. However, the paradox did not appear to exist among Puerto Ricans and Cubans but did for Mexicans, yet, risk of mental

disorder appeared to worsen for subsequent generations of Mexicans but not for Puerto Ricans (Eitle, Wahl & Aranda, 2009).

Other studies of US immigrants from non-Latin American nations also confirmed a wider immigrant mental health paradox among older Chinese immigrants (Wu, Chi, Plassman, & Guo, 2010), migrants from the wider Asian continent (Leong, Park, & Kalibatseva, 2013), and Caribbean migrants (Williams et al., 2007).

Unlike non-mental health related studies, comparatively few recent European studies appeared to support a wider immigrant paradox. Findings from a Belgian study of Moroccan immigrants confirmed the immigrant paradox but concluded that employment was a contributing factor to risk of psychosis in migrant groups (Fossion et al., 2002).

Several studies of immigrants to Canada had findings consistent with the immigrant paradox. Kwak & Rudmin (2014) reported that immigrant adolescent experience better health in spite of lower household income and adapted as well as native peers. Conversely, Patterson, Kyu & Georgiades (2013) noted an association between age at migration and mood or anxiety. They found that young migrants had higher risk of disorder than migrants. Aglipay et al. (2013) observed an association between anxiety and elapsed time since migration finding that recent migrants had less chance of disorder.

Counter to those studies that confirmed evidence of any immigrant paradox, many predominantly European studies found that either: there was no evidence to support a “healthy immigrant” (Oppedal & Roysamb, 2004; Pole et al., 2005; Ponizovsky, Radomislensky, & Grinshpoon, 2009; Schouler-Ocak et al., 2008; Zolkowska, Cantor-Graae, & McNeil, 2001), or there were no differences across subsequent generations of immigrants (Schwartz et al., 2011). Cantor-Graae & Pedersen (2005) concluded that while there were generational differences in prevalence of schizophrenia, their overall findings were not consistent with an immigrant paradox.

Several established theories have been posed to explain the immigrant paradox if it exists in a population. Several common hypotheses have been proposed. The first two are variations of a selective migrant hypothesis that asserts that migrants are healthier to endure the process of migration.

- A “*healthy migrant*” hypothesis: This hypothesis asserts that immigrants are healthier by selection from their home communities. Thus, their mental health, prior to leaving their native country, was better than either others in their native home country or that of their host population, enabling them to endure the physical and psychological stresses associated with migration.

- A “Salmon bias”: This hypothesis asserts that less healthy immigrants, or those who become unwell, are more likely to return to their home of origin. Thus, confounding the healthy immigrant perception since remaining immigrants appear even more likely to have better mental health outcomes.

- Native, country of origin, effects: These are the influence upon the mental health of immigrants exerted by the prevalence of disorder in their home country of origin.

- Acculturation effects: these are the effects associated with the process of a migrant group or individual blending with the culture of their host country, often to the detriment of their native culture and values, which may have a detrimental effect upon immigrant’s mental health. It has been suggested to have a negative influence the mental health second generation immigrants thereby contributing to the immigrant paradox.

- Other post-migration influences: Other than acculturation several other external factors have been proposed that may explain any healthy immigrant effect.

1.2.2 The healthy migrant hypothesis

The evidence presented for a “healthy migrant”, who is healthier by selection prior to migration, is a popular hypothesis for physical conditions (Flores & Brotanek, 2005). However, the evidence supporting a healthy migrant hypothesis for mental disorders is less conclusive.

While some evidence may be consistent with such a conclusion, the evidence is rarely consistent for all migrant groups, and few studies have tested that migrants were actually healthier than non-migrants in their host country. Breslau et al. (2009), in a study of common mental disorders, observed the healthy migrant effect was not seen consistently across all countries or even all Latin American countries. They observed high rates of common mental disorders among Puerto Rican and eastern European migrants and low rates for migrants from Mexico. They concluded that low risk of mood and anxiety was associated with preadolescent upbringing outside of USA, but only if their native country had low prevalence of mental disorder. A study of Spanish immigrants found region of origin mediated many differences in migrant mental health (Jurado et al., 2014).

One study of rural-urban migrants found that young migrants are healthier as they move for work while older migrants may move for better healthcare (Lu, 2008). Another urban-rural migrant study found healthier migrants were more likely to move further away from home while those with poorer health are more likely to move closer to their original communities (Lu & Qin, 2014).

1.2.3 The Salmon bias

This theory, where migrants with poorer health are more likely to return home, has found support in several migrant studies of physical health outcomes. Bostean (2013), found that for activity limitation, returned Mexican migrants to the USA were less healthy than migrants who remained in the USA, evidence that supported both healthy migrant and Salmon effect. Lu & Qin (2014) found that, among urban-rural migrants in China, healthier migrants are more likely to move further away from home, while those with poorer health are more likely to move closer to their original communities, a finding consistent with the Salmon bias.

Do psychologically unhealthy migrants return to their home of origin? Comparatively few studies sought to actually test the hypotheses for mental illness. Most studies concluded that there was little evidence to support a Salmon bias hypothesis. Riosmena, Wong, & Palloni (2013) found that although their evidence was consistent with the immigrant paradox being mediated by return migrants (Salmon

bias) ethnic differences were not fully explained. Cantor-Graae & Pedersen (2005) in a review of publications about schizophrenia found that inconsistent international findings that could not support the Salmon hypothesis. Few of these were found to confirm the hypothesis that less psychologically healthy migrants were any more likely to return to their home of origin, but this was not sufficient to explain the immigrant paradox (Flores & Brotanek, 2005). Karno et al. (1989) suggested that a difficulty in analysing a selective migration hypothesis is that less healthy illegal migrants may be excluded from such studies.

1.2.4 Acculturation

Host acculturation

Host acculturation is the process of a migrant group or individual blending with the culture of their host country, often to the detriment of their native culture and values. Bhugra (2003), in a systematic review of literature around depression, identified four levels of acculturation (total assimilation, mutual integration, cultural rejection, and deculturation), and concluded that the consequences of acculturation - culture shock and cultural distance, leading to cultural and social conflict - may lead to isolation and alienation. Migration, cultural identity and mental distress have been shown to be linked. It has been suggested that to improve mental health care to immigrant populations, clinicians must take into account cultural background to enable a stronger therapeutic alliance (Bhugra, 2003 2005). The long term effects of acculturation are variable and depend upon native and resident social and individual factors (Berry, Kim, Minde, & Mok, 1987).

Many papers have been published about both the positive and negative effects of acculturation on the mental health of immigrants and most significantly upon the subsequent generations of host country born immigrant descendants. However, some studies have pointed out that acculturation is too ill defined to be useful, and is a proxy for what appears to be a multitude of underlying causes and can serve to reinforce existing stereotypes (Hunt, Schneider, & Comer, 2004). Yet, Escobar, Hoyos Nervi, & Gara (2000) reported that in spite of a poor operational definition for the term

“acculturation”, many studies point to it as a cause for increased risk among descendants. Many factors appear linked to the process of acculturation.

A study of anxiety in immigrants to Germany found anxiety manifests itself differently across cultures as each has different expressions or experiences resulting from varied psychopathology. Migration adds an additional stressor, but in spite of some migrants with higher levels of anxiety, access to services is often low. They suggest a migrant specific treatment with multimodal and culture sensitive treatment options (Agorastos, Haasen, & Huber, 2012).

A study of Caribbean immigrants to the United States describe their acculturation experience similar to the increased societal stress and downward social mobility associated with Black Americans (Williams et al., 2007). Among Latin American immigrants in the USA, lifetime prevalence of mental disorder increased with high acculturation (Alderete, Vega, Kolody, & Aguilar-Gaxiola, 2000a). Depleted resources, discrimination and family cultural differences play a significant role in the negative effects of acculturation on the mental health of immigrants (Cook, Alegria, Lin, & Guo, 2009; Pole et al., 2005). Other factors such as a lack of social support, self-esteem, choice of occupation, religious attendance and higher education were also associated with increased risk of mental disorder (Hovey & Magana, 2002a). Environmental factors in the host country also had a strong effect on the mental health of young immigrants (Breslau et al., 2007).

Hajat, Blakely, Dayal, & Jatrana (2010), in a study of mortality and immigration, observed that acculturation was related to improved health as much as decline; if the environment is high risk then acculturation is likely to be negative influence and if low risk then the other way round. Also a gene-environment interaction is discounted if the paradox is evident.

Native acculturation

Healthier immigrants have found that borrowing attributes of their hosts culture and language, while retaining their own native culture can result in better mental health outcomes for immigrants as well as second generation migrants. Flores

& Brotanek (2005) suggested that understanding the influence of acculturation would be key to the solution of poorer mental health in our time.

Segmented assimilation theory suggests that some native cultural retention may help mediate some of the increased risk of problem alcohol use encountered by subsequent immigrant generations with the seemingly inevitable host country acculturation (Eitle et al., 2009). The experience of Mexican and Cuban adolescents supported the immigrant paradox. Academic performance (grade point average), family social capital and having other Latino students at school were protective for problem alcohol use. However, the experience of Puerto Rican immigrants differed from that of others in that their migration experience was not consistent with the immigrant paradox.

Flores & Brotanek (2005) reported that less host acculturation is consistently associated with better health outcomes even in the face of apparent increased risk factors. In addition, less acculturated children also share healthy outcomes. Further, easing the process of integration into a host society will reduce the incidence of mental health problems (Haasen, Sinaa, & Reimer, 2008). Thus, adopting the host culture was not unhealthy but that discarding one's native heritage and culture was (Schwartz et al., 2011).

A study of Latin American families suggested that parents could improve the risk of anxiety and depression associated with their children's migration by involving them in the migration decision. However, it was not seen as the complete solution, but time in the host country and support can also help reduce the risk (Potochnick & Perreira, 2010). Furthermore, it was suggested that children not involved in the decision to migrate can find themselves with higher risk of depression or anxiety, especially if there is a traumatic event that occurs in their host country.

One study of Mexican immigrants found adopting American culture can be protective and negative acculturation effects were moderated by education and income (Gonzalez, Haan, & Hinton, 2001). Another study of Latin American migrants showed the migrant culture such as family cohesion, native language proficiency and social networking was protective for common mental disorder. Acculturative stress,

discrimination and family conflict were associated with increased risk (Leong et al., 2013).

A study of Korean immigrants to the United States identified two groups: culturally "integrated" (low cultural distance) and "separated" (high cultural distance); the former group identified with better mental health (Jang, Kim, Chiriboga, & Kallimanis, 2007). Acculturation factors and social networking were also associated with lower depressive symptoms Korean immigrants (Kim, Sangalang, & Kihl, 2012). Low social support was associated with poorer depression and increased acculturation. Kim, Sangalang, & Kihl (2012), concluded that the negative effects associated with acculturation could be mediated by strong social support.

1.2.5 Native influences

Some studies suggest that the immigrant paradox, or lack thereof, is reflective of the health in their native country of origin. Bhugra (2003, 2004, 2005) observed that prevalence of mental disorder was associated with migration, but these differences were dependent upon the predisposition of the individual to stress, as well as the cultural and social factors which they came from and arrived to. The European experience tends to highlight the heterogeneity of the migrant groups (Lindert, Schouler-Ocak, Heinz, & Priebe, 2008). Alegria et al. (2008) highlighted differences in prevalence of mental disorder between Latin American countries and cautioned readers about generalising the immigrant paradox to all Latino migrant groups.

In the United Kingdom, immigrant children from Afro-Caribbean nations reported increased risks while Asian children had decreased risk of psychotic symptoms (Laurens et al., 2008). Berry et al. (1987) pointed out that the long term effects of acculturation on immigrants are variable and depend upon native as well as resident social and individual factors.

In a study of common mental disorders, Breslau et al. (2009) observed the healthy immigrant effect was not consistent across all countries or even all Latin American countries. They observed high rates among Puerto Rican and eastern European migrants and low rates for migrants from Mexico.

Region of origin may mediate differences in migrant mental health (Jurado et al., 2014). It would appear that the low risk of mental disorders is associated with preadolescent upbringing outside of USA but only if their native country had low prevalence of mental disorder (Breslau et al., 2009). Conversely, higher prevalence rates among migrants have been suggested may be due to higher prevalence in native country of origin (Amad et al., 2013).

1.2.6 Other External factors that influence an immigrant paradox

Ethnic density within host country

Ethnic density occurs where immigrants move to areas within host countries that have a high proportion of other migrants from their own country, or countries with similar cultures. Boydell, Van Os, Mckenzie, & Al. (2001) reported that ethnic density is protective for non-white immigrants in London. Among immigrants to the USA, it was found ethnic identity, family cohesion and native language proficiency were protective for rates of common mental disorders. While, for immigrants and their descendants, social networking was protective for common mental disorders (Leong et al., 2013).

In a study of immigrants from Asia, Pacific and Britain to NZ, it was found that discrimination, unemployment, lack of friends and limited time spent with others from within their own ethnic group was correlated with the prevalence of anxiety and depression. Close friends and spending time with their own ethnic group had a positive influence upon mental health. Both Pacific and Asians immigrants reported discrimination by mental health services including mis- or over- diagnosis and mistreatment (Pernice, & Brook, 1996). An international study of migrants from Samoa found that Samoans have a clear desire to stay connected to their villages and culture (McGarvey & Seiden, 2010).

Social, economic and other external factors

Some studies have shown that while increased risk of psychoses was observed among some immigrant groups, other factors were considered to be the determinants (Zolkowska et al., 2001). Some ethno-cultural differences were explained by socio-economic differences. Higher socio-economic status, along with social support, was

found to be protective for immigrants' mental health (Ladin & Reinhold, 2013). However, the mediating effects of higher socio-economic status on mental health were found to vary across different immigrant groups (Dohrenwend, 2000; Kobayashi, Prus, & Lin, 2008). Higher post-traumatic stress disorder in Hispanic individuals appear to be related to a number of culture and social factors accompanied by depleted social resources and racial discrimination (Pole et al., 2005).

1.2.7 Implications for the provision of mental healthcare services.

Less acculturated immigrants were found to be less likely to use mental health services. Women and those who are less acculturated were more likely to use complimentary alternative medical services (Fang & Schinke, 2007; Schaffer et al., 2009). Additionally, studies of European immigrants found that mental health differs among migrant groups and that service use is affected by legal and/or financial access to care, language, lack of knowledge and communication (Lindert et al., 2008; Vega, Kolody, & Aguilar-Gaxiola, 2001). Transportation, employment, patient-provider issues and immigrant documentation were identified as barriers (Alegria et al., 2007; Wells, Lagomasino, Palinkas, Green, & Gonzalez, 2013).

High diagnosis of schizophrenia has become associated with immigrant populations with language difficulties and mis-diagnosis of mentally unwell immigrants was seen to be caused by culturally inappropriate diagnostic tools and language differences (Schouler-Ocak et al., 2008). In spite of improvements in many areas of treatment for the severely mentally disordered in the general population, these improvements were not shown extend to the care for immigrants with severe mental illness (Arvidsson & Hultsjo, 2009; Orozco et al., 2013). In Australasia, in the past, it has been found that immigrant patients had experienced discrimination by mental health services with mis- or over- diagnosis and mistreatment (Pernice, & Brook 1996). Poor clinicians' understanding of cultural issues and language have long been considered likely to lead to miscommunication of disorder (Minas, Stuart, & Klimidis, 1994).

Relative ethnic differences in diagnosis of psychotic disorders were reduced or removed using a culturally sensitive instrument (Zandi et al., 2010). Mental health

treatment and care services need to address self-esteem, emotional support and coping skills for immigrants requiring treatment (Hovey & Magana, 2002b).

A challenge remains to bring cultural competence and ethnic diversity as an everyday clinical practice in mental health care (Machleidt & Sieberer, 2013) but need not overlook common ground for service delivery (Kamperman, Komproe, & de Jong, 2007). Migration, cultural identity and mental distress are linked. Clinicians must take into account cultural background to enable a stronger therapeutic alliance (Bhugra, 2005). Long term migrant specific treatment recommended with multimodal and culture sensitive treatment options (Agorastos et al., 2012). Transcultural psychiatry involves careful and ongoing reflection of the culture and social background of patients. Differences in disease concepts can lead to communication problems and inappropriate care leading to cultural competent diagnosis and treatment (Schouler-Ocak et al., 2008). Also understanding the influence of acculturation on the health of all children will perhaps lead to the single most effective solution to poorer mental health in our time (Flores & Brotanek, 2005). An example of a culturally adapted family intervention has been piloted and evaluated for Mexican American immigrant mothers with depression with some success (Valdez, Padilla, Moore, & Magana, 2013).

1.2.8 Findings for New Zealand's Pacific immigrant communities

Over the last 20 years there has been a growing body of information and research on Pacific peoples' immigration experiences and mental health, although there has been some social and historical analysis (Macpherson, 1996, 2004). Most international research has been undertaken on the immigration experiences of refugees. This differs to the experiences of Pacific peoples who migrated to New Zealand for economic or family reasons.

Only a few Australian or New Zealand-based studies on the impact of migration have been undertaken to estimate the prevalence of mental disorders among migrants. The Australian experience is different to that of New Zealand Pacific peoples as many publications deal with early European (Morrell et al., 1999), recent Middle Eastern immigrants (Khavarpour & Rissel, 1997; McGrath et al., 2001) or recent issues among those detained under Australian migration regulations (Abhary & Koopowitz, 2004).

Within New Zealand, one study focused upon Chinese immigrants (Abbott et al., 1999), and another on a general population comparison which included a small Pacific sample (Pernice & Brook, 1996). These focused on general mental disorder or feelings of anxiety or depression with a non-clinical rating and seemed to point to aspects of migration as the main influences on increased disorder, more so than ethnic differences as pointed out in the latter piece.

Very few international studies have compared people who have moved to another country with those who had remained at home. One study of Tongan migrants to New Zealand compared with those left at home, showed improved mental health for Tongan migrants, especially women, compared with comparatively poor levels of mental health at home (Stillman, McKenzie, & Gibson, 2006). However, an earlier commentary on the mental health of Tongan migrants pointed to growing concerns about increasing mental illness and substance issues compared with those resident in the Kingdom of Tonga (Foliaki, 1999; Foliaki, 1997). Further analyses of Samoan emigrants suggest poor health outcomes for Samoans living outside of Samoa (McGarvey & Seiden, 2010).

A study of Pacific immigrants in New Zealand found that Pacific people arrive with no apparent Healthy Migrant effect in mortality (Hajat et al., 2010). They found that European and other migrants have some mortality advantage that reduces as length of residence increased. However, that advantage was not observed for Pacific peoples. Furthermore, as identified earlier, that study concluded that acculturation may be a positive influence in an environment of low risk, and negative in an environment of high risk. Particularly, the nature and nurture interaction is diminished if an immigrant paradox is evident. In a study of migrants from Tokelau, it was found incidence of gout in Tokelau immigrants was similar to that of NZ Maori and 8 times that of Tokelau natives (Prior, Welby, Ostbye, Salmond, & Stokes, 1987). Both of those results would seem to dispute the presence of an immigrant health paradox for Pacific migrants.

Two Australasian study findings were consistent with an Immigrant Paradox for mental health (Liddell et al., 2013; Kokaua, Schaaf, Wells, Foliaki 2009). Both studies

confirm a healthy immigrant effect, but also found increased risk of mental disorders with age at migration and generations born in their host country.

As a consequence of settling in New Zealand, two distinctive subcultures have emerged: a younger New Zealand-born and raised population and an older Island-born and raised (Tiatia & Coggan, 2001). This has fostered issues such as shifts and tensions in traditional customs, norms, beliefs and values, which affects individuals' sense of belonging, identity, and social cohesion. Issues of identity for young Pacific peoples are significant in a bicultural and multicultural environment; in which balancing the desires to retain a cultural heritage are tempered by living in a contemporary non-traditional society.

1.3 Aims and Objectives

Why study Cook Islanders? There are many very successful New Zealanders at all levels of society who are of Cook Islands descent. People of the Cook Islands have been given open access to New Zealand through shared citizenship, and as such have a long tradition of migration and settling in New Zealand. To this end, they represent a part of the Pacific community that has had the best opportunity to integrate into New Zealand society. Initial investigations appear to show that this may have disproportionately negative mental health effects on a comparatively youthful population, who, as part of the wider Pacific community, have inherited a vulnerability to the ongoing effects of poverty, but also have the highest proportion of New Zealand born generations (Kokaua & Wells, 2009). This is in the face of evidence that points to apparent low utilization of, and inappropriate entry into, specialist mental health treatment services. The question is: are Cook Islanders living in New Zealand really worse off than other populations in terms of mental disorder and is mental disorder being treated by the appropriate services?

This thesis seeks to expand on the latter analysis of Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS) and combine this with patterns of use of mental health services in New Zealand from the Mental Health Information National Collection (MHINC), New Zealand's national database of mental health services, to provide a broader picture of the mental health of Cook Islanders living in New Zealand.

There are three separate aims of this thesis related to: mental illness and related service use, ethnicity and analytical methodology. The first methodological aim is to apply an alternative methodology that will enable the analysis of a small sub-population. The second is to investigate the prevalence and burden of mental illness among Cook Islanders living in New Zealand. A third is to look at the use of mental health and other health services as a result of their mental health problems. Although the main focus of the thesis is to look at mental health of Cook Islanders in New Zealand, some of the analyses show comparisons to three other ethnic groups; Other Pacific Peoples, Maori who are not also Pacific, and non-Maori, non-Pacific (NMNP).

1.3.1. Aim 1: Methodology

Bayesian models will be developed and applied to do all analyses in this thesis to improve the precision of statistical estimates for Cook Islanders. This is an alternative to classical small area estimation techniques developed to provide analyses for areas with small populations that may be sparsely reported in data collections.

The method makes use of its ability to self-impute missing values to analyse survey data with complex design. In another separate application, a method is developed to analyse aggregate tabulated data with a missing or non-response category. Finally, survival models will be adapted to complex survey design to analyse the cumulated incidence to events with competing risks.

1.3.2. Aim 2: The Prevalence, determinants and onset of mental disorder

Hierarchical Bayesian logistic models will be used to estimate the 12 month and lifetime burden of mental disorders on Cook Islands peoples in New Zealand and investigate factors that lead to increased or decreased levels of mental disorder.

To estimate the stage of life that mental disorder may occur, the onset of mental disorders is reported as the cumulated lifetime incidence of mental disorders. These will be analysed using Bayesian Cox regression survival methodology.

1.3.3. Aim 3: Recovery, treatment and service use

Treatment for mental health problems

Bayesian Poisson models will be used to describe the 12 month prevalence of health service use by Cook Islanders with and without mental health problems as well as any factors that may contribute to increased treatment.

Onset of treatment or recovery

Bayesian Cox regression models will once again be used to investigate the age that first service use occurs or the age that someone has recovered without receiving any treatment. These two outcomes represent competing risks. Consequently, those with a mental disorder who have neither recovered nor received treatment for their disorder represent a group who has an unresolved need that is yet to be addressed.

Use of government-funded specialist mental health services

Another set of Bayesian Poisson and logistic models will be used to show patterns of use from government-funded specialist mental health treatment systems among ethnic communities in New Zealand.

2. Background to the New Zealand Mental Health Survey data

<i>2.0. Introduction</i>	24
<i>2.1. Background</i>	24
<i>2.2. Sample design in NZMHS</i>	25
2.2.1 Stratification and Cluster design	25
2.2.2. Part I and Part II questionnaires	27
<i>2.3. Definitions</i>	28
2.3.1 Disorder groups	28
2.3.2. Age sex and ethnicity	30
2.3.3. Onset of disorder and time to treatment.....	32
2.3.4. Covariates of 12-month prevalence of mental disorder or service use	32

2.0. Introduction

The overall objective of this chapter is to describe the background to the New Zealand Mental Health Survey (NZMHS) and the definitions for selected variables from the data used in subsequent analyses.

Section 2.1 provides a brief background to the NZMHS. Section 2.2 describes the sample design and the question pathway that further complicates the analyses for selected diagnoses beyond that of adjusting for design alone.

Section 2.3 provides the definitions of variables used in this thesis. Importantly, it describes how ethnicity is defined and recorded in NZMHS and subsequent choices about the ethnic groups reported in these analyses of NZMHS data. It also includes definitions of diagnoses and covariates that have been used in 12 month disorder and service models and are reported in Chapters 4 and 6.

2.1. Background

The NZMHS was a nationally representative household survey of 12,992 adults aged 16 years and over, with a complex sample design. Face-to-face interviews were carried out between October 2003 and December 2004 by specially trained interviewers, in English. Although translation services were made available in the most common Pacific languages, very few of these were taken up. Most people opted to use a family member to provide translation in times of language difficulty.

The stated objectives of the NSMHS were to:

1. Report the prevalence of common mental disorders.
2. Report on the levels of disability from mental disorders.
3. Report results for Māori and Pacifica.
4. Investigate a brief measure of mental disorder prevalence for use in subsequent population surveys.

Pacific peoples and Maori were oversampled. In total, there were 2374 Pacific people, of whom 138 reported both Pacific and Māori ethnicity. This thesis includes all 2374 Pacific participants

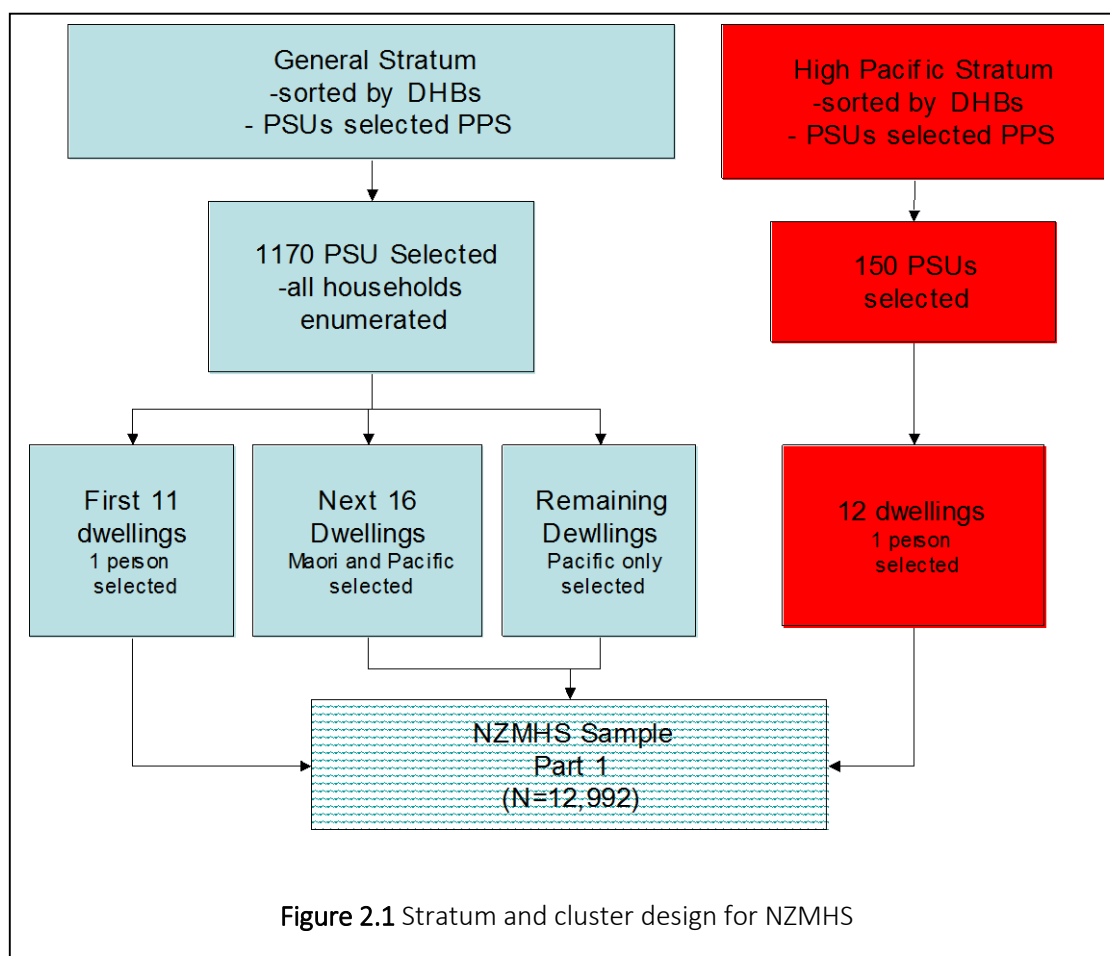
The overall response rate achieved was 73.3%. More detail regarding survey method and background is provided in the main initial report of results from the survey, *Te Rau Hinengaro: the New Zealand Mental Health Survey* (Wells, McGee, & Oakley Browne, 2006; Wells et al., 2006).

2.2. Sample design in NZMHS

2.2.1 Stratification and Cluster design

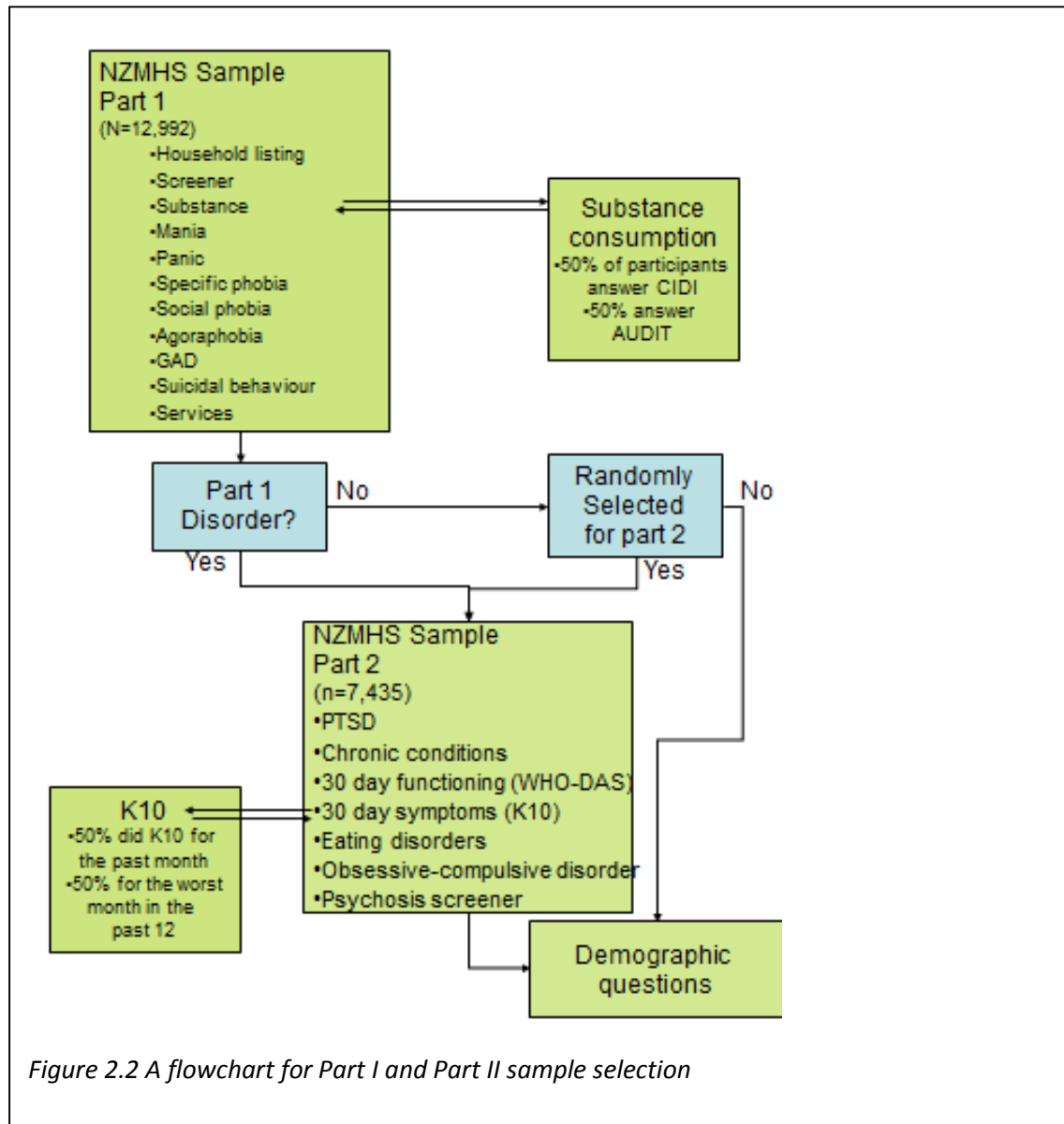
As previously stated, the survey employed a stratified multilevel clustered design, the full details of which are presented in the main report, *Te Rau Hinengaro* (Wells et al., 2006). The layout for the strata and cluster design is shown in figure 2.1. The first level of clusters required selecting a Primary Sampling Unit (PSU) from which eligible individuals were interviewed from a selected number of households. A PSU was equivalent to a meshblock, a geographic area unit defined by Statistics New Zealand. It is the smallest geographic subdivision of New Zealand that is used to comprise larger electoral and local authority boundaries.

At the first level two strata were used. A “High Pacific” stratum indicated that selected PSUs, from which individuals were chosen, came from areas of high density of Pacific peoples. All other PSUs were categorised as from the “General” stratum.



The probability of selecting a person from the high Pacific strata was, on average, much higher than from the general strata. Sampling of PSUs within each stratum was with a probability proportional to the PSU size, and the probability of selecting a household within high Pacific strata was equal for all households in that stratum. Within each high Pacific stratum, anyone aged 16 or older was eligible.

In the general, strata three sub-strata was formed from which individuals were selected, if numbers allowed (see figure 2.1). If the PSU contained the number of households found at the last census, then 11 households were selected for the “main” sub-stratum for which everyone aged 16 or older was eligible. A further “Māori-Pacific” sub-stratum was created from a further 16 households from which only Māori or Pacific people were eligible. In the remaining households, if any, only Pacific individuals were eligible.



2.2.2. Part I and Part II questionnaires

All participants answered Part I questions relating to service use as well as mood, substance and some anxiety disorders. A subset of participants went on to answer questions about other anxiety disorders in Part II of the survey, a long form of the interview. Figure 2.2 shows the how respondents were selected from Part I to either complete Part II followed by the demographic section or straight to the latter before finishing. Of the 12992 individuals surveyed, all of whom were asked Part I questions, 7435 respondents were asked questions from Part II. This has been described in detail in Te Rau Hinengaro (Wells et al., 2006b; Wells et al., 2006).

2.3. Definitions

2.3.1 Disorder groups

Mental disorders were defined using the Composite International Diagnostic Interview (CIDI) version 3.0, a widely used computer assisted structured interview that produces valid and reliable psychiatric diagnoses. The CIDI generates DSM-IV (APA, 1994) diagnoses by determining whether the respondent has ever in their lifetime met the criteria for the disorder, then determines the last time the person had an episode or key symptoms of the disorder (irrespective of treatment). If this was within 12 months of interview, this is classified as a '12 month disorder'. Prevalence of rare conditions such as schizophrenia and other psychotic disorders could not be reliably estimated from this household survey. Organic brain syndromes such as dementia were also excluded from data collection (Wells et al., 2006).

Anxiety disorders

The anxiety disorders included in the NZMHS were panic attack, agoraphobia (excluding panic disorder), panic disorder, specific phobia, social phobia, obsessive compulsive disorder, post-traumatic stress disorder, and generalised anxiety disorder (GAD). Other DSM-IV anxiety disorders that were not included were acute stress disorder, substance induced anxiety disorder and anxiety disorder due to a general medical condition.

Mood disorders

Mood disorders are a group of disorders focused on a disturbance in mood and comprise major depressive disorder, dysthymic disorder and bipolar disorder. Other categories not included in the NZMHS are cyclothymic, other bipolar and mood disorders due to a medical condition or induced by substance use, and non-specified mood disorders.

Eating disorders

Eating disorders are comprised of anorexia nervosa, characterised by an unwillingness to maintain acceptable weight levels, and bulimia nervosa, which usually

involves periods of binge eating followed by the taking of extreme measures to counter over-eating.

Substance use disorders

“Substance use” is a term that describes the use of drugs, medications or toxins. There are 11 categories described by the DSM-IV, of which three have been used in the NZMHS. They are alcohol, marijuana and other drugs, a composite category of other drugs. The NZMHS looked into substance dependence, which involves unusual patterns of use that would lead to clinically significant distress or impairment in at least 3 factors. The factors include characteristics such as tolerance, withdrawal symptoms, excessive use and others.

In addition, NZMHS asked questions that identify “substance abuse” as patterns of substance use that lead to clinically significant distress or display some indications of impairment. Impairment is understood in terms of failure, as a result of substance use, to either:

- fulfil major role obligations;

- suffer legal problems; or:

- display continued use; in hazardous situations, or in spite of resulting social or interpersonal problems.

Following the practice within the World Mental Health Consortium (WHO International Consortium of Psychiatric Epidemiology, 2000) substance abuse is described in this report whether or not there was dependence. This is a departure from the usual DSM-IV definition where substance abuse does not include dependence.

Severity of disorder

Following the method developed for the WMH Survey Initiative (Demyttenaere et al., 2004), ‘Serious’ mental disorder was assigned if in the past 12 months there was either: an episode of bipolar I disorder; substance dependence with serious role impairment; a suicide attempt and any mental disorder; at least two areas of severe role impairment due to a mental disorder in the Sheehan Disability Scale domains; or overall functional impairment found in the National Comorbidity Study Replication (

Kessler et al., 2005) to be associated with a Global Assessment of Functioning (Endicott et al., 1976) score of 50 or less in conjunction with a mental disorder (Wells, McGee, & Oakley Browne, 2006).

‘Moderate’ mental disorder was assigned to non-serious disorders with substance dependence, without serious role impairment or with moderate role impairment in the Sheehan Disability Scale domains from any other mental disorder.

‘Mild’ mental disorders were assigned to the remaining diagnosed disorders that are considered neither serious nor moderate.

2.3.2. Age, Sex and Ethnicity

Age and sex

Socio-demographic correlates included age at interview, sex and ethnicity and were assessed using 2001 Census of Population and Dwellings questions when possible. The NZMHS was restricted to people aged 16 years and older. Both age and sex were recorded at the screening stage of the questionnaire.

While individual age has been reported, the analyses applied in this thesis used age grouped into 6 different age cohorts. They are as follows: 16 to 19 years, youth; 20 to 24 years, young adults; 25 to 34, young family-working aged; 35 to 44, older family-working aged; 45 to 64, older but still working; and 65 and older.

Ethnicity

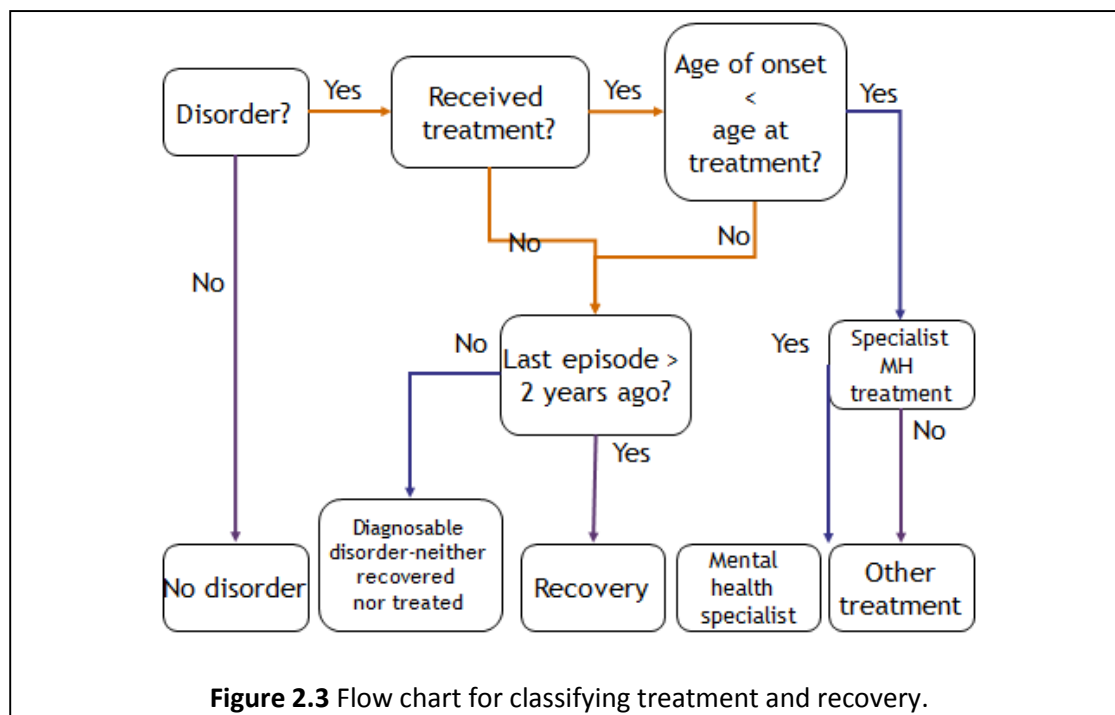
Ethnicity reported in the NZMHS was determined by self-identification and according to the ethnicity question in the 2001 Census of Population and Dwellings. Therefore, at the point of collection, all ethnic groups stated by the respondents were recorded. This enabled a breakdown to individual Island group for people of Pacific ethnicity.

Table 2.1 The ethnicity question used in the NZMHS

NZRDA2	Looking at showcard 1, which ethnic group or groups do you belong to?	
	NZ EUROPEAN	1
	MĀORI	2
	SAMOAN	3
	COOK ISLAND MĀORI	4
	TONGAN	5
	NIUEAN	6
	CHINESE	7
	INDIAN	8
	OTHER (SUCH AS DUTCH, JAPANESE, ETC.)	9
	SPECIFY OTHER	
	OTHER PACIFIC	10
	DON'T KNOW	98
	REFUSED	99

The question used by NZMHS to establish an individual's ethnic group (Wells et al., 2006), as shown in Table 2.1, asked individuals to identify as many ethnic groups to which they felt they belonged. Although ethnic group is a multiple reporting from individual national ethnic groups, the ethnic groups have been categorised into four mutually exclusive groups. "Cook Islands" were assigned to those people who responded to the ethnicity question (NZRDA2) as "Cook Islands Māori" or specified one of the 15 Islands in the Cook Islands. "Other Pacific" was assigned to those who reported themselves as from a Pacific ethnic group (including Fiji Indian) but not one of the Cook Islands. "Māori" indicated they were Māori in question NZRDA2 and had not indicated a Pacific ethnicity. Those who remained were assigned to "Non-Māori, Non-Pacific" (NMNP) ethnicities.

The breakdown for the 12992 NZMHS sample was: 500 "Cook Islanders", 1874 people from other non-Cook Islands Pacific ethnic groups (other Pacific), 2319 non-Pacific New Zealand Māori (Māori), and 7299 people from other ethnicities (NMNP). This grouping was introduced in Kokaua and Wells (2009), which presented a 12 month prevalence of mental disorder and treatment contact by ethnicity.



2.3.3. Onset of disorder and time to treatment

The age of onset was reported for each of the sub-group disorders recorded by the NZMHS: GAD, PTSD, Social, Specific, etc. The age of onset for any grouped disorder, for example any anxiety disorder, is taken as the earliest age of onset reported by any contributing subgroup disorder. Onset of treatment was reported for each service seen and was analysed if the age at first treatment met the following criteria: first, if the person had a disorder; secondly, if their onset of disorder was prior to the age at first treatment.

Figure 2.3 show the rules that were employed to define the treatment and recovery events in the data. An individual was considered “recovered” if they had a disorder and had not received treatment AND if that individual’s most recent event was more than two years ago. In subsequent text “recovery” will be used as shorthand for “recovery without treatment”.

2.3.4. Covariates of 12-month prevalence of mental disorder or service use

Socio-demographic correlates included age at interview, sex and ethnicity and were assessed using 2001 Census of Population and Dwellings questions when possible. The analyses that follow include variables that are defined below. Many of the variables included in this thesis have been predefined and used in previous analyses, but not

specifically for the ethnic groups identified here. Most of these variables were defined in the publicly available CURF, a confidentialised unit record file available to researchers from the New Zealand Ministry of Health, and can be accessed from their website; <http://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/surveys/access-survey-microdata>.

Age at migration and place of birth

Those who were born outside New Zealand were asked questions about their age at arrival and years since migrating to New Zealand. In earlier analyses age at migration was grouped into four categories: those who migrated to New Zealand at less than 12 years of age; between 12 and 18 years of age; 18 years and older; and those who did not migrate to New Zealand (NZ born) (Foliaki et al., 2006a). In this thesis, three groups have been used by combining those who migrated at 12-18 years with those who migrated at 18 years and older, thus forming one group who migrated at age 12 or more (older migrants). This was to increase the number of respondents under 45 years of age who migrated when older. The other migrant group were those also born in their Island home and migrated to New Zealand when under 12 years of age (young migrants).

Individual country of birth was also recorded and categorised into a dichotomous “New Zealand born”, for those born in New Zealand, and “Overseas born” for those born elsewhere. For those not born in New Zealand, their age at migration was recorded. This was further categorised into those who migrated before they were 12 years of age and those who migrated when they were older.

Marital status

International literature has shown that marital status, along with sex, socio-economic status and race was identified as a risk factor for psychological distress. Many studies prior to 2000 examined the relationship between marital status and depression. Their findings pointed to marriage as protective (Kessler, Walters, & Forthofer, 1982; Perlin & Johnson, 1977). This is in contrast to another study which reported that being married, female, young and poor increased symptoms of depression (Cotton, 1999). The increased risk for women was reduced, but not entirely removed, by the inclusion

of other support factors. The increased risk resulting from those factors were explained by the types of relationships within the marriage (Umberson et al., 1996). If previously married, the risk of mental illness or psychiatric distress was higher, particularly if separated or divorced (Aseltine & Kessler, 1993). The reasons were thought to be the impact of sudden relationship change impacting on emotional support, finances, childcare and home.

However, if widowed, it seems that many of those stressors were not as evident as many of their existing support structures were still in place (Cotton, 1999). Thus, in terms of increased risk of mental distress, widowed respondents were considered more like those who were married than separated or divorced (Cotton, 1999). However, in terms of risk factors, the results seemed to point to the risk of psychological distress for those who had been widowed was more like the risk for those who had been separated or divorced than married. If not previously married, there appeared to be higher levels of depression. This last group tended to be younger whose concepts of social identity appeared to be more based around friendships (Cockrum & White, 1985).

Other factors that seemed to influence levels of mental health were “self-esteem” and feelings of having control over one’s future direction (Cotton, 1999; House et al., 1995), and social support (Tobias et al., 2009). Marital dissatisfaction was also shown to contribute to increased risk of major depressive episodes (Whisman & Bruce, 1999).

A longitudinal analysis found no gender differences in levels of overall mental distress for married versus unmarried groups, except in depression and alcohol abuse (Simon, 2002). Generally, most previous studies had shown that marriage was protective of mental disorder but not for men and women alike. There also seemed little difference in the marital status of people whether or not they exhibited mental distress. A more recent paper looked at marriage and previously married, as time-dependent variables in a survival analysis of time to onset of mental disorder, using international mental health survey data (Scott et al., 2009). Their results found that, like the earlier findings of Simon (2002), there were gender differences across marital

status for depression and substance use disorders. However, they showed that marriage, in particular those in a long term stable marriage, was associated with reduced onset of any mental disorder for both men and women.

Question SC3 asked if an individual was married, separated, divorced, widowed or never married. A subsequent question also asked respondents who did not indicate they were married if they were currently living in a marriage-like relationship. If they answered “yes” to the latter question, they were reassigned to the “married” category. Those who were separated and divorced were combined into a single category. “Widowed” and “never married” made up the remaining two categories.

Parental status

Only two New Zealand studies have estimated the mental health risks experienced by sole compared with partnered parents. Sarfati and Scott (2001), looked at an overall self-reported rating for the state of mental wellbeing from the New Zealand Health Survey, while Tobias and colleagues used results from the NZMHS to report the prevalence and increased risk of 12 month mental disorder by sole parents (Tobias et al., 2009). Both studies found worse ‘mental health’ among sole parents, which persisted after adjustment for other socio-demographic factors.

Three Australian studies analysed cross-sectional data from the Australian National Survey of Mental Health, the Australian Longitudinal Study of Women’s Health and the Household Income and Labour Dynamics in Australia Survey (Butterworth, 2004; Butterworth et al., 2006; Crozier, Butterworth, & Rogers, 2007). These studies collectively supported the New Zealand study’s conclusions that financial hardship and a perceived lack of social support were the major measurable factors associated with sole parents’ excess risk of mental illness (Tobias et al., 2009).

Other international studies have also pointed to poorer mental health of sole parents. Baker and North analysed cross-sectional data from the Avon Longitudinal Study of Pregnancy and Childhood (UK) and showed links between sole parents and major depressive disorder (Baker, North, & team, 1999). Cairney and colleagues analysed cross-sectional data from the Canadian National Population Health Survey with similar findings, again restricted to major depressive disorder (Cairney et al.,

2003). The latter study estimated that 40% of sole parents' excess risk could be attributed to the joint effect of stress and perceived lack of social support. Also, most of the studies showed no link, or at best, a weak association, between employment and depression among sole parents.

Question NZHH1 asked whom the respondent lived with. The analysis of parental status was restricted to people who were under 65 years of age. If the respondent lived with their children and with a partner they were categorised as a "couple", otherwise they were categorised as "sole-parents". If no children were in the household they were assigned "non-parent" status. These were categories used by Tobias and colleagues in their analysis of 12 month prevalence of mental illness for sole parents (Tobias et al., 2009).

Number of adults in the household

Household size is a variable that is often included as a factor when calculating weights for surveys, where one person per household has been chosen to account for the number of different people excluded from larger, compared with smaller, households. While this was true in part of the sample from the high Pacific strata, in the general strata, the number of eligible adults was not the same as the number of household adults. This was because in some selected households only Māori or Pacific respondents were eligible. Nonetheless, from the household listing and the relationship questions about household members, the total number of adults in the household was known (an adult being someone aged 16 or more).

Very few studies have looked at mental illness by household size specifically. However, the number of adults has been used as a proxy for social support (Tobias et al., 2009). The "number of adults" was treated as individual groups of up to four adults and the remaining household was called "five and more adults".

Factors that reflect wealth or poverty

A World Health report on mental illness (WHO, 2001) summarised the evidence of poverty and the associated conditions of unemployment, low educational level deprivation and homelessness as impacting negatively on levels of mental disorder in communities (see also Patel et al., 1999; WHO International Consortium of Psychiatric

Epidemiology, 2000; Kessler et al., 1994; Saraceno & Barbui, 1997). Australian findings also showed that poorer groups in society experience higher prevalence of mental illness (Butterworth et al., 2006).

Early reports showed that prevalence of mental health service by Pacific peoples were not consistent in terms of geographic deprivation, with a decrease in service use in areas of higher deprivation (Ministry of Health, 2005). There has been some discussion about the theory that while Pacific communities were more likely to live in areas of high deprivation, cultural support was also more abundant in those areas. Those thoughts were derived from observed service use that seemed to be confirmed by results from the NZMHS, which showed mental health service use among Pacific peoples with disorders was much lower than those of other groups (Oakley Browne et al., 2006a). The latter was also inconclusive about any differences in the impact of deprivation on 12 month prevalence of disorder among Pacific peoples. Education and income were also looked at, but no trend was found in 12 month prevalence of any severe mental disorder or in service use.

Education, employment and income all play an important role in Pacific community participation as they influence not only an ability to contribute to their New Zealand communities as well as Island communities, but also hierarchical status and ensuing responsibilities within those communities. Many Cook Islanders maintain homes in the islands, and live in New Zealand to help maintain and support those homes while also supporting a career that has developed in New Zealand.

Education

Educational achievement is important to most Pacific communities, particularly among those recently migrated families who strive to improve their lifestyles from the ones they left behind. Yet for many, particularly those who are second or third generation New Zealand-born Pacific peoples, achievement in education has been elusive and has resulted in improved Pacific educational achievement to be a high priority in recent years (Ministry of Education, 2011; NZQA, 2012).

Te Rau Hinengaro introduced the three educational status categories: no qualification; qualifications obtained at school or since leaving school with no school

qualifications; and qualifications obtained since leaving school having obtained a qualification at school (Oakley Browne et al., 2006a). It showed for the New Zealand population as a whole, those with the highest level of education had the lowest 12 month prevalence of mental disorder. Yet for Pacific respondents, the difference between the three education levels was not so clearly defined.

Employment

The NZMHS questionnaire included a section of questions dedicated to employment from which a trichotomous “employment” status variable was defined. The levels included: those who were employed; not employed; and those who were not a part of the labour force.

Household income

The “equivalised” household indicator used in this section varies from the crude household income reported by the NZMHS. Equivalised household incomes were adjusted in two ways. Firstly, missing responses were imputed and secondly, income was modified (“equivalised”) by a factor to account for the number of adults and the number of children in the household. The method is outlined in Te Rau Hinengaro (Wells et al., 2006a) and is a modified version of the Jensen equivalence scale (Jensen, 1988).

Four categories were created for those whose household incomes were: from no income to half the median income; incomes between half the median and median; between median to halfway between the median and maximum income; and the remainder.

Local area deprivation

The 2001 New Zealand Deprivation Index (NZDEP01) was included to classify deprivation for the local area of respondents domicile (Salmond & Crampton, 2002). The index has been widely used since the introduction of the original NZDEP96 Index in 1998 (Crampton & Davis, 1998; Salmond, Crampton, & Sutton, 1998). This measure has proved useful as it describes the relative socio-economic status of a given domiciliary area. In this thesis, areas where respondents lived were categorised into quintiles,

based upon the NZDEP01, from the lowest quintile, representing areas of relative wealth, to the highest quintile, representing relative deprivation.

3. Bayesian models for analysing New Zealand Mental Health Survey data

<i>3.0 Abstract</i>	40
<i>3.1 Introduction</i>	41
3.1.1. Model-based inference for surveys.....	41
3.1.2. Bayesian analysis	44
3.1.3. Bayesian models for sample surveys.....	45
<i>3.2 Bayesian models for sample surveys</i>	47
3.2.1. The general model description.....	47
3.2.2. The design component of the model	48
3.2.3. Adjusting for analyses of part II questions	49
3.2.4. Analyses including age and sex	50
3.2.5. Analyses with other covariates	51
3.2.6. Prior estimates for model parameters	51
3.2.7. Ethnicity specific estimates	54
3.2.8. Posterior predictive marginal	57
3.2.9. Marginal group comparisons in prevalence	58
<i>3.3 Bayesian Cox proportional hazards models</i>	59
3.3.1 Background.....	59
3.3.2. Cox proportional hazard regression model for a single event, using WinBugs	62
3.3.3 Bayesian survival models with competing risks in NZMHS	65
<i>3.4 Hierarchical Bayes model diagnostics</i>	66
<i>3.5. An example of SAS code for a model prevalence in WinBUGS</i>	73
<i>3.6 Comparison to previously published results</i>	76
<i>3.7 Discussion</i>	78

3.0 Abstract

Aims and objectives

The objective of this chapter is to describe the methodology of the Bayesian models used for the analyses of the New Zealand Mental Health Survey (NZMHS) data and reported in Chapters 4, 5 and 6.

Overview

Section 3.1 provides a brief overview of Bayesian and hierarchical Bayes methodology. Section 3.2 describes that method applied to analyses of prevalence data from a survey with a complex design. Section 3.3 describes how it will be applied to prevalence estimates using NZMHS. Section 3.4 describes several Bayesian Cox

regression models to analyse onset data from the NZMHS. This model is extended to include the analysis of outcomes that exist under competing risks.

Section 3.5 introduces the statistics used to diagnose the performance of the models used. Sections 3.6 and 7 provide an example of the hierarchical Bayes models code and analysis results using NZMHS data with a comparison to previously published results. The latter replicates the methodology used to compare ethnic groups in Te Rau Hinengaro: the New Zealand Mental Health Survey (Oakley Browne et al., 2006a). Section 3.8 discusses the use of Bayesian methods to analyse NZMHS data.

Little (2004) summarized the benefits of a Bayesian model approach to survey data compared to a design-based approach to be: similar if the sample is large and non-informative priors are used; easily incorporating complex survey design; able to yield better inferences for small sample problems; and along with other model-based approaches, has improved efficiency with large samples. Another advantage of the hierarchical model, using WinBugs (Spiegelhalter et al., 2003), is that it avoids the necessity to re-weight the part II sample to address secondary sub-selection. As it will be shown, the model self-imputes data for non-selected individuals. As long as the appropriate model specification is made the results can be analysed as if from Part I and using the entire sample.

Chapter 3 is a technical chapter and as such is written in a predominantly statistical style.

3.1 Introduction

3.1.1 Model-based inference for surveys

In this study, an approach to analyse survey data has been adopted that is both model-based and Bayesian. A *model-based* approach is where results for survey outcomes are assumed to come from a statistical model and the model is the basis for the inference. Inference for model parameters follows from a predictive distribution, given the data and an assumed model structure. A well-defined model will address complexities that arise while undertaking a survey, such as complex sample design or questionnaire design, by including these features in the model.

Alternatively, a *design-based* approach assumes that the population values are regarded as fixed, and inference from the sample is based on the sampling distribution induced by the population sampling mechanism. Consistent point-estimation of finite population quantities are emphasized, with the variance of these estimators obtained with respect to the probability sampling scheme. Selection weights are usually included in the estimation to address the imbalance between the sample design and the population of interest.

Gregoire (1998) presents a plain language discussion of the differences between the two methods. In particular, the principal philosophical difference between the two is that the model-based approach to inference are that the sample values form the finite population are “realisations” of random variables (a superpopulation). Alternatively, the design-based approach asserts that the population is fixed and the sample is a randomized selection of observations from within it. Neither excludes nor is solely reliant upon statistical models for parametric estimation. The terms, model- and design- based, distinguish between inference from which the sample design is influential, as opposed to an inference based upon modelled data which the sample design becomes less of a condition (Gregoire, 1998).

The design-based approach has been extended to fit multi-level models for statistical inference (Pfeffermann, 2011). Pfeffermann et al. (1998) introduced an iterative generalised least squares method of scaled weighted likelihood to produce a pseudo maximum likelihood least squares estimates of parameters of a two-level linear mixed model of descriptive parameters for the inference with two level sample design strategies. That method was also generalized to Generalized Linear Mixed Models (GLMM) and multiple level design sample strategies (Rabe-Hesketh & Skondal, 2006). Using inverse selection probability weights for each stage of selection pseudo-maximum likelihood parameter estimates are derived and asymptotic normal theory is used to obtain the variance estimates. These approach to design-based fitting of multi-level models are not without their difficulties. The authors note sensitivity to the scaling of weights and simulations suggest reliance on asymptotic theory may not be justified for some parameters when cluster sizes (e.g. PSUs) are small. In contrast, fully Bayesian methods are not dependent on asymptotic results.

One publication also applied two iterative GLMM approaches and compared those results to two separate Hierarchical Bayesian methods to cope with heteroscedasticity in the first level of a complex survey design (Browne, Draper, Goldstein, & Rabash, 2002). Several Bayesian publications have also introduced weighted estimates for analysis of complex surveys (Chen, Wakefield, & Lumely, 2014; Little, 1993).

Over the past three decades, with the growing appeal of model-based over the more traditional design-based approaches to inference, there has been many discussions of the advantages of design- and model-based approaches to statistical inference (Little, 2004). The advantages of a model-based approach are that: it produces comparable or more efficient results if the sample is large and non-informative priors are used; it will easily accommodate a complex survey design; it is able to yield better inferences for small sample problems; and, if specified, has improved efficiency with large samples (Little, 2004; Larsen, 2003). Its main disadvantages are that: it can introduce bias, if the model is not well specified; and the models must rely upon their inherent assumptions. However procedures are available for checking the performance and long run accuracy of models (Gelman et al, 2004).

The advantages of a design-based approach are that: it is directly reflective of the observed data; it produces unbiased estimates for parameters of interest and is “tangibly” linked to the observed data (Stehman, 2000). Its disadvantages are that: it is prone to small number distortions; and it relies heavily on asymptotic results which are not well justified with small samples. Design-based methods usually report lower precision than model-based methods for small subsets of sampled data, and can be computationally problematic to fully address problems with complex sampling design requiring weight calculations and ambiguous distribution assumptions (Little, 2004).

Comparisons of methods for complex survey applications show similar results for the two approaches applied to moderate sample size examples (Farver 2002; Lehtonen, Djerf, Harkanen, & Laiho, 2002).

A further predominantly model-based approach that has been applied to inference for small sub-populations within a larger survey is small area (domain)

estimation (Ghosh & Rao 1994; Rao, 2008). Pfeffermann (2013), gives an overview of recent developments as well as a description of design-based and model-based approaches to small area estimation methodology. Hudson & Abbott (2013), provides a New Zealand example of small area estimation using NZMHS data to estimate prevalence of mental disorders in small geographic areas. They also provide a design-based example of small area estimation methodology.

Another model-based method used for this approach are Empirical Bayesian methods (Butar & Lahiri, 2003; Rao, 2008; Pfeffermann, 2013). As will be discussed in subsequent sections of this chapter, a core component to performing analyses using Bayes theorem is a requirement to make some prior assertions about the model. The Empirical Bayes approach uses the data itself to derive a prior. This reliance on the observed data make it appealing to many non-Bayesian analysts. However, it does add unwanted complexity to the model and subsequent inference (Datta, Rao & Torabi, 2010; Butar & Lahiri, 2003). Another often applied Bayesian alternative is to apply a Hierarchical Bayes model (Rao, 2008; Pfeffermann, 2013). Hierarchical Bayesian models easily incorporates complex sampling design as long as the variables associated with the design are included in the analysis (Nandram & Sedansk, 1993; Nandram & Sayit, 2011). It is this approach that will be described below for inference at a small ethnic domain level.

3.1.2 Bayesian Analysis

Bayesian models, assume the advantages of the non-Bayesian model-based approach, but differ in that they use Bayes theorem to introduce prior knowledge about the model (Little 2004). This approach is most useful if there is either much prior information available about the model or there are few observed data about small subsets of data within a sample. The added information from prior information can add to the precision of parameter estimates through variance shrinkage (Young, Graham, & Blakely, 2005). Little (2004) summarized the advantages of using a Bayesian model approach to analyse data from surveys with a complex sample design. In addition to those listed above, for model-based approaches generally, alongside the advantage of

incorporating prior knowledge, there is also an unambiguous specification of distributional assumptions, as will be shown in the model development below.

Lindley-Smith (1972) introduced a Bayesian regression model for normally distributed continuous data and obtained tractable solutions to the integrals required for Bayesian estimation of linear regression coefficients and predicted means. The development of Markov Chain Monte Carlo methods facilitated the extension of Bayesian modeling beyond Normally distributed continuous data to other types of data and to models with a variety of distributions and more complex hierarchies (Gelfand & Smith, 1990; Gilks, Richardson, & Spiegelhalter, 1996). The Gibbs sampler and Metropolis-Hastings algorithm are two common applications of this method to modelling problems (Geman & Geman, 1984; Hastings, 1970). The principle of the Gibbs Sampler is to iterate through a sequence of unknown parameters generating a new estimate for each parameter given, not only the data but previous estimates for all the other parameters in the assumed distribution. The Metropolis algorithms iteratively accept or reject proposed values using a probabilistic acceptance criteria which guarantee that the posterior sample converges to the desired posterior distribution to maintain the overall shape of that assumed distribution.

For this application of hierarchical models, since we are dealing principally with count data, our models will be of the form:

$$y_i \sim \text{ind Binomial}(\pi_i, N_i) \quad i=1 \dots K \quad (1)$$

$$\text{logit}(\pi_i) = \mathbf{x}_i^T \boldsymbol{\beta}$$

$$\boldsymbol{\beta} = \boldsymbol{\beta}_0 + \boldsymbol{\varepsilon}_\beta, \quad \boldsymbol{\varepsilon}_\beta \sim \text{MVN}(\mathbf{0}, \tau_\beta^{-2})$$

The hierarchical or multi-level model refers to the hierarchy of parameters in the model structure, with the implication that other parameters, called hyperparameters, are not of interest but contribute to the model for those parameters that are of interest. In the model given by equation (1), we are interested in estimating a value for π_i , then $\boldsymbol{\beta}$ represents a parameter vector stated in the model but are not the parameters of interest. Gelman and Hill (2007), provided an extensive text on the

theory and application of regression and both multilevel and hierarchical models (see also Congdon, 2002).

Belin et.al. (1993) presented an application of hierarchical logistic regression models for imputation of unresolved enumeration status in undercount estimation. The logistic model is used with count data that is not replaced or individuals are only counted once and π_i is bound by 0 and 1. The Poisson or Negative Binomial models are also common for count data that represent multiple frequencies where an individual may experience an event more than once. The model expressions remain structurally the same except that the Binomial distribution is replaced by Poisson or Negative Binomial distribution depending upon the model of choice, and the link function, $\text{logit}(\pi_i)$, is replaced with $\text{Log}(\pi_i)$.

3.1.3 Bayesian models for sample surveys

There have been only a handful of published studies that deal with Bayesian analysis of data from sample surveys. Chapter 7 of Gelman et al. (2004) described modeling accounting for different data collection methods. As mentioned earlier, this thesis does not include longitudinal or designed experimental methods. However, in terms of general sample surveys, only if a simple random sample were drawn from the entire population with no non-response, would the models apply as written above in equation (1). In that case, where each individual is assigned an equal probability of selection, the observations are considered independent and identically distributed or at least exchangeable.

In many other sample survey studies, as with this one, the sample design is stratified and clustered with individuals having different probabilities of selection, not to mention a need to overcome any non-response from respondents. Gelman et al. (2004) stated that Bayesian models should include any available information about how the data are collected. Also, if only incomplete data are available then a probability model should be used to relate the missing data to observed data.

Several studies have applied hierarchical Bayesian models to complex survey problems. Comparisons between Bayesian with non-Bayesian model- and design-

based estimates showed that the Bayesian models provided comparable estimates with non-Bayesian models that allowed for design effects (Browne, Draper, Goldstein, & Rabash, 2002; Lehtonen et al., 2002). Additionally, Lehtonen et al. (2002) found that the Bayesian model was able to impute for missing values of variables included in the model. This latter attribute will be used in a novel alternative application to address further complex survey design in section 3.2.3.

Rubin (1987) proposed multiple imputation as a general framework for addressing non-response to surveys. Gelman et al.'s (2004) approach to the problem was more model-based, but it was ultimately the same:

$$p(\theta|D_{obs}) = \int p(\theta|D_{obs}, D_{non-resp})p(D_{non-resp}|D_{obs})dD_{non-resp} \quad (2)$$

A posterior distribution, shown in equation (2), was created for the distribution of the parameter of interest, say θ , conditioned upon both observed and non-response data as well as other information multiplied by a prior distribution for non-response data given the observed data. The product was then integrated across the realm of all possible values for the non-response data, yielding a posterior distribution for the parameter of interest conditioned only upon observed data.

3.2. A hierarchical Bayes model applied to NZMHS data

3.2.1. The general model description

The description given in this chapter will be used to describe a number of different models that have been used in this thesis. Though the general structure of the model is the same, components of the linear expression used differ according to different situations. The components common to all models are those associated with the design of the survey. Other components, included as required by the model specification, were associated with; part II selection, adjustment for age and sex, or the inclusion of other covariates.

For the i th, of N , individuals, the distribution for an indicator for an observed discrete event, y_i , would take the form of one of the two following:

$y_i | \pi_i \sim \text{Bernouli}(\pi_i)$ for prevalence

$y_i | \pi_i \sim \text{Poisson}(\pi_i)$ for frequency of events

The usual hierarchical prior structure for either distributions is as follows:

$$\text{logit}(\pi_i | x_i, \beta) \text{ (or } \log(\pi_i | x_i, \beta)) = x_i \beta \quad (3)$$

where the parameter vector β , contains many elements in order to accommodate the survey design and covariates of substantive interest. The structure of the parameter vector and the hierarchical prior specification are described below.

Individual models result from different applications of the generic model. These vary only by the components included in x_i and consequently the coefficient vector β . The observed covariate vector for each individual, x_i , in the study is comprised of component vectors that, as mentioned earlier, are determined according to the models application. Thus, x_i will be comprised of $x_i(\text{design})$ and possible inclusions of indicator vectors; $x_i(\text{part II})$, $x_i(\text{age and sex})$, and/or $x_i(\text{other covariates})$. Likewise, the coefficient vector is comprised of a coefficient for every component of x_i and is a composite vector of β_{design} and corresponding $\beta_{\text{part II}}$, $\beta_{\text{age and sex}}$, and $\beta_{\text{other covariates}}$.

3.2.2. The design component of the model

Figure 2.1 shows four separate sub-stratum which have been identified in the sample design: High Pacific, Main Sample, Māori and Pacific sub-sample and Pacific only sub-sample (Wells et al., 2006). In this study these have used the two high level strata; the high Pacific stratum and Main stratum. The latter is comprised of the Main Sample, Māori and Pacific sub-sample and Pacific only sub-sample.

Small area sample units have been used as clusters in the model. It has been shown that clusters in the design are ignorable as long as the model includes an indicator variable for the clusters (Gelman et al., 2004; Nandram & Sedransk, 1993). To account for clustered sampling within each strata the general model applied for the analysis of the NZMHS recognised variation within each strata that is also conditional upon the within stratum clusters.

Thus the design component that is included in all analyses contains indicators for ethnicity and stratum clusters.

$$x_i(\text{design}) = \{ \text{ethnicity}(i,1:4); \text{cluster}(i); \text{strata}(i) \}.$$

Comprising indicators for four ethnic groups, and an indicator for small area sampling unit (clusters) as described in Chapter 2. The design coefficient vector β_{design} includes coefficients for each level of each design variable. So for part I:

$$\begin{aligned} \beta_{\text{design}} &= \{ \beta_{\text{CI}} : \beta_{\text{OPac}} : \beta_{\text{NZM}} : \beta_{\text{Othr}} : \beta_{\text{clust}}, \beta_{\text{stara}} \} \\ &= \{ \beta_{\text{eth}}, \beta_{\text{clust}}, \beta_{\text{stara}} \} \end{aligned}$$

A second level hierarchy is stated with prior distributions given by:

$$\beta_{\text{eth}} \sim \text{MVN}(\beta_{\text{eth}}^0, \sigma_{\text{eth}}^{-2} \times I(4))$$

$$\beta_{\text{clust}} = 1/k \times \mathbf{1}^T \times \beta_{\text{cluster}}$$

$$\beta_{\text{cluster}} \sim \text{MVN}(\mathbf{0}, \sigma_{\text{cluster}}^{-2} \times I(k))$$

Where β_{cluster} is a k-dimensional vector of parameters for each of k clusters, small area sample units and $\mathbf{1}$ is a k-dimensional unit vector. Thus, β_{clust} is defined as the overall mean the k elements of β_{cluster} .

The prior for β_{strata} , the for parameter associated with the indicator for a high Pacific strata (STRATA), is given by:

$$\mu_{\text{strata}} = \beta_{\text{strata}} * \text{STRATA} + e, e \sim N(0, \sigma_{\text{strata}}^{-2})$$

$$\text{where } \beta_{\text{strata}} \sim N(0, \sigma_{\text{strata}}^{-2})$$

3.2.3. Adjusting for analyses of Part II questions

One of the advantages of using Bayesian modelling for this type of analysis was that in order to produce prevalence estimates for Part II questions, the full sample of 12,992 could be included, with Part II responses for those not selected into Part II treated as item non-response. The responses for those respondents not included in the Part II sample were estimated conditional upon observed data. In addition, the

parameter was estimated conditioned upon the observed data and the imputed unobserved data.

The model structure for estimating parameters for variables in Part II of the survey was essentially the same as for Part I. The only exception was to include in the model indicators for the occurrence of having a disorder in Part I and the number of eligible adults in the household. In this case $x_i(\text{design})$ becomes:

$$x_i(\text{design}) = \{ \text{ethnicity}(i, 1:4); \text{cluster}(i); \text{strata}(i); \text{partII}(1, 1:11) \}.$$

So for Part II, $x_i(\text{part II})$ an (11×1) vector of observations and $\beta_{\text{part II}}$, and a (1×11) vector of coefficients. The 11 components fall into one of three groups. The first group were those meeting criteria for any Part I disorder who were selected with probability 100%. A second, a sub-threshold group with symptoms of disorder for which there were five subgroups with different probabilities of continuing to Part II depending on the number of eligible adults in the respondents household. Finally, a third group, apparently without disorder, who were also divided into five subgroups with probabilities of continuing depending on the number of eligible adults in the household. The prior distributions for β_{design} in part II are expressed in a similar way to those for other design variables with additional prior statements:

$$\beta_{ii} = \{ \beta_{II}(0), \beta_{II}(1, 1), \dots, \beta_{II}(1, 5), \beta_{II}(2, 1), \dots, \beta_{II}(2, 5) \}$$

where:

$$\beta_{II}(0) \sim N(\mu_{II}(\text{part I disorder}), \sigma_{II}(0)^{-2})$$

$$\beta_{II}(\text{sub-threshold}, n_{\text{eligible}}) \sim N(\mu_{II}(\text{sub-threshold}), \sigma_{II}(\text{sub-threshold})^{-2} \times I)$$

$$\beta_{II}(\text{no disorder}, n_{\text{eligible}}) \sim N(\mu_{II}(\text{no disorder}), \sigma_{II}(\text{no disorder})^{-2} \times I)$$

$n_{\text{eligible}} = \text{The number of eligible adults.}$

3.2.4. Analyses including age and sex

Analyses by or adjusted for age and or sex requires adding indicators for those two variables in this case, for the i th individual, as a vector given by:

$$x_i(\text{age and sex}) = \{\text{age}(i, 1:6), \text{female}(i)\}.$$

Comprising indicators for six age groups and an indicator where biological sex equal to female. In this study these have been included in all analyses and therefore the results need to be adjusted back to an unadjusted prevalence or even an estimate adjusted proportionally to a single population, e.g. New Zealand's total population.

The associated coefficient vector $\beta_{\text{age and sex}}$ includes coefficients for each level of each design variable. So for part I:

$$\begin{aligned}\beta_{\text{age and sex}} &= \{\beta_{16-19}, \dots, \beta_{65+}, \beta_{\text{sex}}\} \\ &= \{\beta_{\text{age}}, \beta_{\text{sex}}\}\end{aligned}$$

with priors:

$$\begin{aligned}\beta_{\text{age}} &\sim \text{MVN}(\beta_{\text{age}}^0, \sigma_{\text{age}}^{-2} \times I) \\ \beta_{\text{sex}} &\sim N(\beta_{\text{sex}}^0, \sigma_{\text{sex}}^{-2})\end{aligned}$$

3.2.5. Analyses with other covariates

The vector, $x_i(\text{other covariates})$, includes indicators for other covariates of interest and any interaction terms that are deemed necessary:

$$\beta_{\text{other covariates}} \sim \text{MVN}(\gamma_0, \sigma_{\gamma}^{-2} \times I)$$

3.2.6. Prior estimates for model parameters

The means of the normal prior distributions have been estimated using a graphical method beginning with approximations of asserted rate ratios within each variable category. For example, to derive a prior for the coefficient vector for ethnicity, β_{eth} , for a model of prevalence of any mental disorder, a rate ratio for Cook Islanders, other Pacific and Māori relative to NMNP is said to be equal to {1.5, 0.8, 2.0, 1.0}. These represent a Māori rate that is two times that of NMNP while Other Pacific are estimated to have 20% lower rates. Cook Islanders are estimated to be higher than NMNP but not as high as Māori. These were derived from pre-2005 analyses of rate ratios for acute inpatient use (Ministry of Health, 2005).

This result is then transformed to a vector of the log transform of the odds ratio values given by the following formula: $OR(i) = p_0/(1-p_0) \div (RR(i) \times p_0)/(1 - RR(i) \times p_0)$.

Where $RR(i)$ is the value of the rate ratio in the vector specified above. To estimate the odds ratio a baseline estimated prevalence was assumed to be $p_0 = 16\%$, taken from the best estimate of community prevalence in use by New Zealand mental health policy analysts prior to 2006, the Tolkein Report (Andrews, 1991). The resulting vector represents the location for the coefficients for vector of four ethnicity, {0.2, -0.1, 0.4, 1}.

Figure 3.1 shows the prior values, rate ratios and their respective log odds ratio transformations, calculated for the remaining variables and plotted in MSEXcel. Several versions of MSEXcel allow one to manipulate the graph manually, providing the ability to consider and reconsider the values of one's prior locations visually. While the rate ratios in figure 3.1 are in some respects arbitrarily stated, they are loosely based upon results from analyses of MHINC, administrative mental health service use data, as well as relevant international prevalence studies available in 2006, i.e. prior to the NZMHS.

There are four sets of priors: one for disorders generally applied, another for substance use disorders specifically, a set for service use models and a final set for rate ratios of any mental disorder by covariates.

Most of the priors have been stated based upon evidence gathered prior to 2005. The variances, standard deviations, for the prior distributions have been stated to represent any uncertainty about the prior expectation. The covariate priors, for example, loosely represent patterns reported in papers published at the time but the large standard deviations for each prior represent uncertainty about those values.

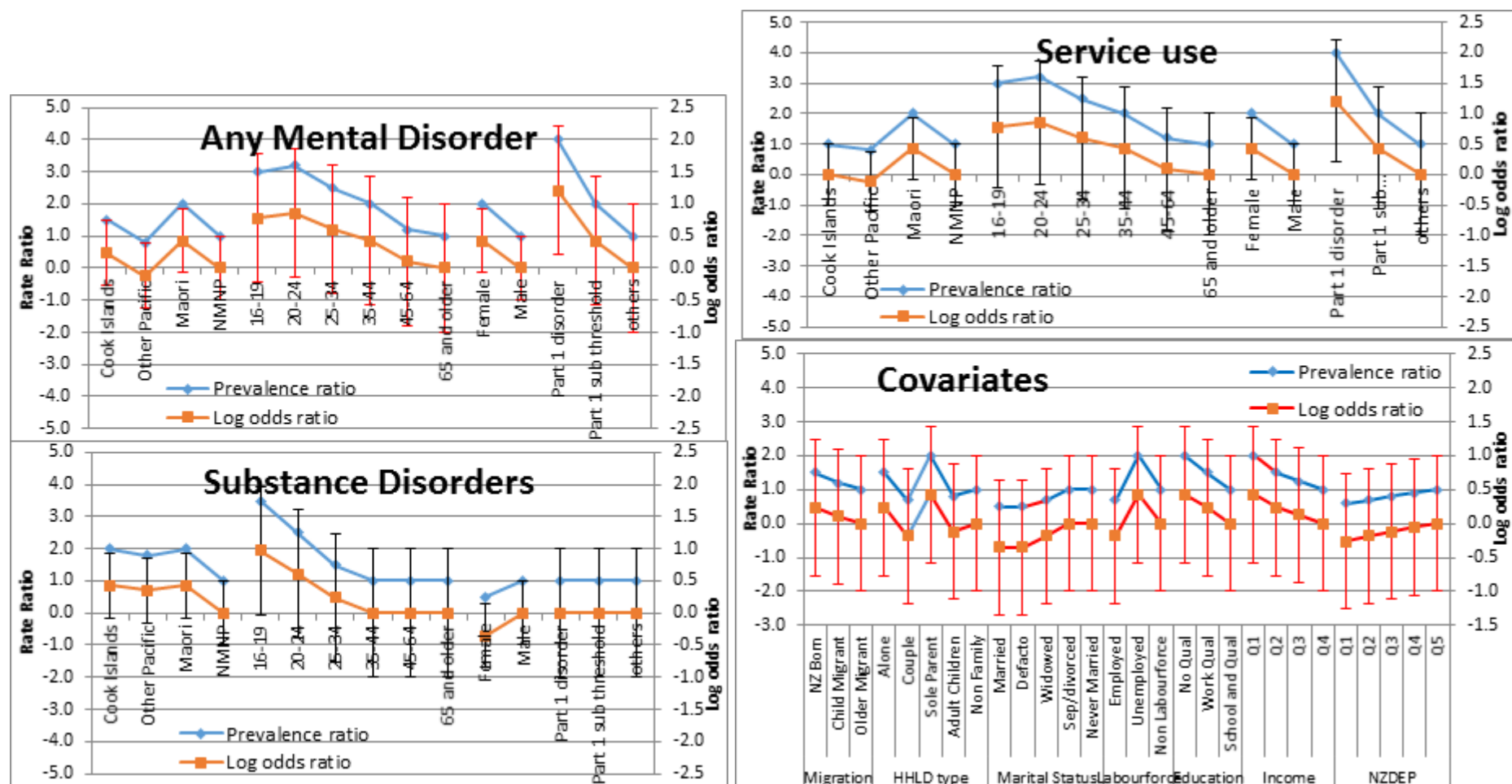


Figure 3.1 Prior location and standard deviation (whiskers) for survey design variables for any mental disorder, substance specifically, service use, and covariates

Each parameter prior is shown with extended whiskers which is a representation of ± 1 standard deviation. The prior distributions for the standard deviations are:

$$\sigma_{\beta}(j) \sim \text{Uniform}(0, \tau_{\beta}), \text{ the } j\text{th element of the } \sigma_{\beta} \text{ vector}$$

$$\sigma_{\gamma}(j) \sim \text{Uniform}(0, \tau_{\gamma}), \text{ the } j\text{th element of the } \sigma_{\gamma} \text{ vector}$$

The τ for each uniform distribution are set so the distribution has a location of the value for the standard deviation shown in figure 3.1. Note that, in each case, the expected standard deviation is such that the value of zero, lies within one standard deviation of central log odds ratio. Therefore although centered at non-zero values the priors are, in fact, quite open-minded. The Normal distribution statements in WinBugs use a precision parameter which is calculated directly as the square of the inverse standard deviation.

3.2.7. Ethnicity specific estimates

Analyses by ethnicity are commonplace in New Zealand and official statistics are often reported by ethnic group, especially comparing people from the Māori ethnic group with others. Not so common are analyses that look at Cook Islanders or use hierarchical Bayes models. Blakely et al. (2009) used hierarchical Bayes models to compare mortality rates between Pacific ethnic groups, including the Cook Islands, in New Zealand.

The model used by Blakely et al. (2009) was specifically a Poisson model, analysing events in person years. In this study a model is more general but has been developed specifically for analyses of survey results. Although not applied to survey data, Blakely et al. used a direct standardisation method to weight the posterior rates to a standard population. In the same way, a post-stratifying weight is applied to posterior estimates to weight the NZMHS survey results to the same proportions as in the original population (Young, Graham, & Blakely, 2005).

Posterior computations

Since the target parameters π are defined in terms of the regression parameters, β , posterior inference follows from the posterior distribution of β . Letting

Ω denote model hyper-parameters posterior distribution for a posterior distribution for β can be written as:

$$p(\beta|y) \propto \int p(y | X, \beta) p(\beta|\Omega) p(\Omega) d\Omega$$

$$\text{and, } \pi_i(X, \beta) = \exp(x_i\beta) / (1 + \exp(x_i\beta)) \quad (4)$$

$\pi_i(X, \beta)$ denotes π as a function of X and β . The distribution for π is derived from the distribution for β . In practice, values for the latter are generated from the posterior distribution above and π is calculated for each of those values. Thus, generating a distribution for π .

Post stratification

A problem faced by many model-based estimators is that, as in the case with this study, the models are fitted conditionally on a finely stratified and/or a large set of covariates to accommodate the survey design and covariates of interest. However, prevalence estimates are required for large groups, e.g. for an ethnic group which has been adjusted for age-groups (as opposed to ages in single years). Post stratification allows the estimates to be adjusted to reflect a distribution observed for a desired “standard” population. Gelman (2006) and Little (1993b), suggested using a regression-based estimator that include all variables associated with selection and non-response as well as post stratification. Furthermore, because age and sex are treated as if they are design variables, a version of post adjustment has to be performed to yield an unadjusted estimate also.

The posterior prevalence for the total population π , using the notation of Little (1993b), and conditioned the set of observed y , covariates X , including design, age and sex covariates, and integrated over the parameter space, Ω as given in equation (4). Let $\pi_i(X, \beta)$ be as stated in equation (4) with X representing x_i for all individuals sampled. Furthermore, let $\hat{\pi}(\beta)$ be the marginal prevalence for the entire sample. Ideally this would be computed as:

$$\hat{\pi}(\beta) = \sum_X \pi_i(X = x_i, \beta) \times p(X = x_i)$$

However, in some situations $p(\mathbf{X})$ is not be available for all values of x_i , although the population proportions are available for categorized values of (\mathbf{X}) . We refer to the cells of the coarsened version of (\mathbf{X}) as post-stratification cells, with $PSC=j$ denoting the j th post-stratification cell and $s(\mathbf{x})$ the cell to which an individual with covariate values $(\mathbf{X}=\mathbf{x})$ belong. We assume the population proportions for the post-stratification cells are known; for the j th post-stratification cell, $p(PSC=j)=N_j/N$. Since the post-stratification cells are a coarsened version of (\mathbf{X}) , we can rewrite the value for $\hat{\pi}$ as follows:

$$\begin{aligned}\hat{\pi}(\beta) &= \sum_i p(Y = 1 | PSC, \beta) \times p(PSC = j) \\ &= \sum_j \sum_{x: s(x)=j} \pi_i(X = x_i, \beta) \times p(X = x_i | PSC = j) \times p(PSC = j)\end{aligned}$$

By making two prior assertions, instead of the marginal posterior prevalence, an expression for $\hat{\pi}(\beta)$, averaged over the whole sample, can be given. The first assertion is that $p(X=x_i/PSC=j)$ is uniform across all individuals within each of the j post stratification cells, and secondly, $p(PSC=j)=N_j/N$. The post-stratified prevalence is defined as the average over all j cells, weighted proportional to size, as follows:

$$\begin{aligned}\hat{\pi}(\beta) &= \sum_j \sum_{x: s(x_i)=j} \frac{1}{n_j} \pi_i(X = x_i, \beta) \times \frac{N_j}{N} \\ &= \frac{1}{n} \sum_j w_j \sum_{x: s(x_i)=j} \pi_i(X = x_i, \beta)\end{aligned}\tag{5}$$

where $w_j = n/n_j * N_j/N$, n_j are sampled totals from N_j population totals in $PSC=j$ while n and N are the sum of all PSC in the total sample and population respectively. For Part I, the PSC comprise age, sex, ethnicity and two-level strata. The n_j 's, for the whole sample sum to the sample total $n = 12,992$. These w_j were taken directly using weights defined in NZMHS. A post-stratification adjustment to the 2001 New Zealand Census is made in Te Rau Hinengaro analyses using two weights calculated for individual adjustment for non-response ($W3$) and $W3$ along with post-stratification ($W4$). The ratio $W4/W3$ provides a weight that for post-stratification alone. This weight is applied directly to the posterior predicted estimates from the model output for the appropriate age, sex and ethnic groups.

It does not reflect uncertainty due to the within post stratification cell covariate distribution. This should in turn be close to the marginal prevalence, so long as the coarsening of \mathbf{X} is not too gross. An alternative approach could be to use a multinomial Dirichlet or Bayesian bootstrap model (Rubin, 1981) where each of n points is assigned a probability selected from a uniform distribution and that probability is subsequently assigned a vague $(n-1)$ dimensional Dirichlet prior distribution. The resulting posterior distribution is also Dirichlet on the probabilities for each data point which would allow uncertainty concerning the covariate distribution within post-stratification cells to be propagated through the analysis.

Marginal prevalence estimates by ethnic group adjusted for design with no other covariates

To estimate $\pi_e(\beta)$, the prevalence for a given ethnic group e and conditioned upon other observed variables \mathbf{X} a weighted distribution is calculated by summing the expression in equation (5) over just those PSC that contain the variable ethnicity= e . Thus, equation (5) becomes:

$$\pi_e(\beta) = \kappa_e \sum_{j:eth=e} \mathbf{w}_j \sum_{x:s(x)=j} \pi_i(X = x_i, \beta) \quad (6)$$

where $\kappa_e = \frac{N \times n_e}{N_e \times n}$, n_e and N_e are the sample and population totals for ethnic group e , while w_j , n and N are described above.

Marginal prevalence estimates by covariate

Let $\pi_{e,c}(\beta)$ represent the marginal prevalence for every category of each additional covariate, c , for the ethnic group e . to estimate $\pi_{e,c}(\beta)$. A weighted distribution is then calculated by, not only summing the expression as in equation (6) over those PSC where ethnicity= e , but also the individuals within who have identified a covariate= c . The resulting approximate post-stratified prevalence given above in equation (6) is now extended to:

$$\pi_{e,c}(\beta) = \kappa_{e,c} \sum_{j:eth=e, cov=c} \mathbf{w}_j \sum_{x:s(x)=j} \pi_i(X = x_i, \beta) \quad (7)$$

where $\kappa_{e,c} = \frac{N \times n_{e,c}}{N_{e,c} \times n}$, $n_{e,c}$ and $N_{e,c}$ are the sample and population totals for covariate c within ethnic group e .

3.2.8. Posterior predictive marginal

Adjusting estimates by age and sex only

One means of adjusting for age and sex is to use a predictive marginal where the resulting linear equation using the posterior estimates for the coefficient vector, β , is used to estimate (predict) the value for $\hat{\pi}(\beta)$ as if the whole sample shared the same characteristic, e.g. ethnic group. In this case, ethnicity is fixed so that $\widehat{\pi}_e(\beta)$ is calculated for all people, as for equation (5), except as if the whole sample had ethnic group e . Thus the overall estimate taken over the whole sample was as if ethnic group e had the same age and sex distribution as the total sample. The result of which is then post-stratified back to the New Zealand total population.

$$\hat{\pi}_e(X^{eth} = x_i^{eth}, \beta) = \frac{1}{n} \sum_j w_j \sum_{i:s(x)=j} \pi_i(X^{eth} = x_i^{eth}, \beta) \quad (8a)$$

Where x_i^{eth} is the same as x_i in other expressions for $\pi_i(\mathbf{X}, \beta)$ but with ethnicity set to e .

Adjusting for covariates

Similarly, to adjust for covariates, ethnicity is fixed as above, so that π is calculated for all people, as in equation (8), as if the whole sample shared ethnic group e . Furthermore, the remaining observed covariates, x_i , are given the value that is reported for each individual as required by the model; $x_i(\text{design:without ethnicity})$, $x_i(\text{age and sex})$, $x_i(\text{part II})$, and $x_i(\text{other covariates})$. Thus the overall estimate taken over the whole sample was as if ethnic group k had the same age, sex and covariate distribution as the total sample.

$$\hat{\pi}_{e,c}(\beta) = \frac{1}{n} \sum_j w_j \sum_{i:s(x)=j} \pi_i(X^{eth} = x_i^{eth}, \beta, \text{covariate} = c_i) \quad (8b)$$

3.2.9. Marginal group comparisons in prevalence

Ordinarily, one may use the coefficient taken directly from the model to calculate either an odds ratio or relative risk. In this study comparison between a group k , for example $eth = k$, and a reference group, $eth = l$ has been done by calculating a rate ratio directly from the weighted posterior prevalence estimates. These are calculated using equations 8a or 8b with the rate ratio calculation as follows:

$$RR_k = \pi_k(\beta)/\pi_l(\beta) \quad (9)$$

A posterior distribution for the resulting ratio RR is also derived from the distribution obtained by calculating a value of RR for each iterative posterior estimate for each $\pi(\beta)$.

Furthermore, the results make use of the probability that the risk ratio will be greater or less than 1, where $RR=1$ represents equivalence. If the posterior median for RR is close to 1 then the probability of RR exceeding one will be around 0.5. Similarly, if the numerator prevalence is higher the posterior probability that RR exceeds 1 will approach 1, and if smaller will approach 0.

There are no strict rules about what value of the associated probability represents a “significant” difference, remembering that according to a Bayesian this probability represents the level of uncertainty about the value of RR rather than a test in the non-Bayesian sense. A cut-off of 0.9 and 0.1 has been used to indicate sufficient evidence that a difference exists between the prevalence of one group over another.

3.3. Bayesian Cox proportional hazards models

3.3.1 Background

Models for a single event per person

The Cox proportional hazard regression models (Cox, 1972), are widely used for analysis of survival data and a Bayesian extension of the Cox model was published quite soon after (Ferguson, 1973), where the number of events that occur up to a given time interval were said to have a Poisson distribution with a location that could be expressed as an intensity function. That intensity function was defined as a product

of a cumulative baseline hazard at a point in time, and the exponential of a linear expression of independent variables. In the Ferguson paper, the cumulative baseline hazard was assigned a Dirichlet process prior. A more commonly used alternative was proposed where a Gamma process prior was used to model increments in the cumulative baseline hazard function (Kalbfleisch, 1978). If covariate variables were introduced, these were included as a linear expression in the log of the intensity function with Normal priors for the regression coefficients. Several Bayesian and non-Bayesian overviews of the Cox proportional hazards model with applications that extended to multiple events data have been published (Sinha & Dey, 1997; Therneau, 1996). These also include examples with time dependent covariates. a Bayesian dynamic model with time varying coefficients was applied to survival of internet firms (Bannerjee, Kauffman, & Wang, 2007). The latter provided a departure from typical person year analyses where the terminal event or “failure” is death or ill health. In this study we have used the more common application introduced by Kalbfleisch.

Models for multiple events

Univariate survival model examples deal with a situation where individuals experienced only one or more occurrences of a single type of event, such as a recurrence of symptoms of a disorder or condition. In a multivariate situation where more than one possible event outcome can occur to a single individual, a number of different risk curves result, one from each outcome; for example, the occurrence of two separate conditions or disorders. Several multivariate survival examples have been published with a variety of applications to model data from individuals with multiple events (Ibrahim, Chen, & Sinha, 2001; Sinha, 1998; Sinha, Chen, & Ibrahim, 2003; Yin & Ibrahim, 2005). This family of models was called survival models with cure or survivor fractions that replaced the cumulative baseline hazard, which is treated as a stochastic parameter, with a density function.

Models with competing risks

A variation of the latter application is the situation where several outcomes may be possible, but once one has occurred, the others are prohibited or ignored. Thus, each individual reaches the end point of the observation period as having either experienced one of the outcomes of interest, or is censored. From the point of view

of the non-observed outcome the observation is censored. In this situation, cause-specific observations are said to occur under competing risks. Statistical and epidemiological literature has given moderate attention to survival analyses with competing risks in recent years (Friedlin & Korn, 2005; Gichangi & Vach, 2005; Pintillie, 2002). There has also been several published examples of Bayesian competing risk models. A latent competing risks model was applied to the time to first hospital visits following diagnosis of acquired immune deficiency syndrome (Gelfand et al., 2000) and a bivariate suite of models with competing risks (Wang & Ghosh, 2000). Sen et al. (2008) gave an example of an applied competing risks model with masked causes of death including the model code for WinBugs.

In the analysis in this thesis, individuals who reported having a diagnosed mental disorder had some probability of first receiving treatment (seeing someone for their mental problems), or another probability of recovery without treatment. At this stage we will ignore the event of relapse. A third outcome is the residual probability of having an untreated disorder from which that individual has not recovered. This is calculated as one minus the sum of the probability of treatment and the probability of recovery without treatment.

In addition, no studies were found of Bayesian survival analyses that have either been applied to complex survey data or broken down by ethnic groups. In this study we adjust for age, sex, ethnicity, and strata in both the short and long forms of the New Zealand Mental Health Survey (Wells et al., 2006). The NZMHS is a cross-sectional survey, so the survival analyses have a bit more uncertainty associated with them than a longitudinal cohort study. As such, the sample is comprised of respondents who have “survived” to the date of interview, may have additional recall errors and reside in New Zealand. Te Rau Hinengaro (Oakley Browne et al., 2006a) reported the onset curves by diagnosis groups for Pacific peoples. In the case of time to onset, treatment and recovery from birth we are also interested in probability of onset curves that are:

1. adjusted for complex survey design;
2. reported for the four ethnic groups of interest.

In addition, for model of time to treatment and recovery from onset of disorder:

3. diagnosis specific;
4. a further analysis by place of birth, a dichotomous variable indicating birth in New Zealand or elsewhere.

3.3.2. Cox proportional hazard regression model for a single event, using WinBugs

For each survey respondent, $i = 1, \dots, 12992$, $onset_i(t)$ represents the i th individuals age that or their time elapsed from a start point to when disorder symptoms first occurred. If no disorder was observed at the time of the survey an individual's age was assigned to $onset_i(t)$. This latter type of observation is said to be right censored.

Using the notation of the WinBUGS's Cox regression example (Spiegelhalter et al., 2003), the model begins with an expression for the hazard function given a covariate vector x , $\lambda_0(t)exp(\beta x)$. This is comprised of two components, the baseline hazard function, $\lambda_0(t)$ and a log linear expression of the covariates. An alternative way of viewing the latter is as a representation of the log of the ratio of the instantaneous hazard to the baseline hazard, the hazard ratio, in terms of the linear combination of independent variables.

The proportional hazards model uses a multiplicative intensity model for counting processes (Clayton, 1991). An intensity function, $I_i(t)$, is assumed which corresponds to the probability of subject i failing in the interval $[t, t+dt)$. As dt approaches 0 then this probability becomes the instantaneous hazard at time t for subject i . This is assumed to have the proportional hazards form:

$$I_i(t) = Y_i(t) \lambda_0(t) exp(\beta x_i)$$

where $Y_i(t)$, an observation process, takes on the value 1 if a respondent i has been observed at time t and 0 otherwise. As for any cross-sectional surveys, all

individuals' histories have been observed up to their age reported at the time of the survey.

Let $N(t)$ denote the number of events observed up to time period t . and $\Lambda_0(t)$ be the integral of λ_0 over the interval zero and t . Thus, in terms of observed data there is: $\mathbf{D} = \{N(t), Y_i(t), x_i; i = 1, \dots, 12992\}$, and in terms of unknown parameters: β and $\Lambda_0(t)$. A joint posterior distribution for the above model is defined by:

$$P(\beta, \Lambda_0() \mid \mathbf{D}) \sim P(\mathbf{D} \mid \beta, \Lambda_0()) P(\beta) P(\Lambda_0())$$

In WinBUGS, the likelihood $P(\mathbf{D} \mid \beta, \Lambda_0(t))$ and prior distributions for $\Lambda_0(t)$ and β are specified (Spiegelhalter et al., 2003). The occurrence of disorder observed in any given year $dN_i(t)$ are assumed independent Poisson random variables with means $I_i(t)dt$:

$$dN_i(t) \sim \text{Poisson}(I_i(t)dt) \quad (10)$$

In turn $I_i(t)dt$ can be written:

$$I_i(t)dt = Y_i(t) \exp(\beta x_i) d\Lambda_0(t)$$

where $d\Lambda_0(t)$ is the increment or jump in the integrated baseline hazard function occurring during any given year, t . Further, a conjugate independent increments prior for the cumulative baseline hazard function, $d\Lambda_0(t)$, will assume a gamma distribution (Kalbfleisch, 1978), namely:

$$d\Lambda_0(t) \sim \text{Gamma}(c \times d\Lambda_0^*(t), c)$$

Here, $d\Lambda_0^*(t)$ can be thought of as a prior guess at the unknown hazard function, with c representing the degree of confidence in this guess. Small values of c correspond to weak prior beliefs. In the example below, we set $d\Lambda_0^*(t) = r$ where r is a guess at the failure rate per year (Spiegelhalter et al., 2003).

The fixed effect regression coefficients β are derived from the usual hierarchical regression structure described in section 3.3.

A cumulative incidence curve up to time t and for a given covariate set, (X, Z) . Where Z and γ are an indicator and parameter for the linear expression for covariates of interest while X and β_{design} are an indicator and parameter vector for the linear expression for design variables is given by:

$$F_{event}(t | \gamma, Z, X, \beta) = e^{-\int_0^t d\Lambda_0 e^{\mu}} \quad (11)$$

$$\mu = X\beta_{design} + Z\gamma$$

Values for $F(t | \gamma, Z)$ are then calculated as weighted sums of $F(t | \gamma, Z, X, \beta)$ across the design groups and expressed for each level of the covariates of interest as used in the usual model as parameterised in section 3.3.

Cumulative incidence by ethnicity adjusted for age and sex

An adjusted cumulative incidence for a given event, F_{event} , in each ethnic group, age and sex can be calculated by fixing μ in equation (11) as follows:

$$\mu = \beta_{eth=k} + \beta_{sex=s} + \beta_{age=a} + \dots$$

Then for each age group calculate a population weighted estimate as in section 3 by inserting F_{event} in place of π into equations (4-8). The result of which is then post-stratified back to the New Zealand total population.

$$F_{event}(t | \beta_{eth=k}, \Theta) = \frac{1}{n} \sum_{age} \sum_{sex} w_{age,sex} F_{event}(t | \beta_{eth=k}, \beta_{sex=s}, \beta_{age=a}, \Theta) \quad (12)$$

In practice, however, many of the models did not run successfully with age and sex included. A remedy was found by setting the priors for $\beta_{sex=s}$ and $\beta_{age=a}$ to a distribution with a location equal to an average value for β_{sex} and β_{age} as follows:

$$\beta_{age=a} \sim N(\bar{\beta}_{age}, \tau_{age}),$$

$$\beta_{sex=s} \sim N(\bar{\beta}_{sex}, \tau_{sex})$$

Thus, the age adjusted expression required is a simplified version of expression in equation (12) where $\beta_{sex=s}$ and $\beta_{age=a}$ are replaced by $\bar{\beta}_{sex}$, the average contribution across male and female and similarly for age $\bar{\beta}_{age}$. A normal prior distribution for $\bar{\beta}_{sex}$

and $\bar{\beta}_{age}$ was specified with a mean of zero and a standard deviation assigned to represent a low informative prior. Equation (12) then reduces to:

$$\begin{aligned}
F_{event}(t | \beta_{eth=k}, \Theta) &= \frac{1}{n} \sum_{age} \sum_{sex} w_{age,sex} F_{event}(t | \beta_{eth=k}, \beta_{sex=s}, \beta_{age=a}, \Theta) \\
&= \frac{1}{n} \sum_{age} \sum_{sex} w_{age,sex} F_{event}(t | \beta_{eth=k}, \bar{\beta}_{sex}, \bar{\beta}_{age}, \Theta) \\
&\approx \frac{n}{n} \times F_{event}(t | \beta_{eth=k}, \bar{\beta}_{sex}, \bar{\beta}_{age}, \Theta) \\
&= F_{event}(t | \beta_{eth=k}, \bar{\beta}_{sex}, \bar{\beta}_{age}, \Theta)
\end{aligned}$$

This means that the cumulative estimates, while adjusted for age and sex, are not standardized to the New Zealand total population. Instead the standardization will be to the total sampled population.

3.3.3 Bayesian survival models with competing risks in NZMHS

It has been suggested that Cox regression models are appropriate for analysing such data (Gichangi & Vach, 2005), so two sets of analysis each with separate approaches have been applied that utilise the Bayesian Cox proportional hazards model proposed in the previous section.

The first analysis is not conditioned upon any disorder and is applied to all respondents and estimates a Cox model for onset of disorder, onset of recovery or treatment and treated disorder only. Thus:

the first model estimates the cumulative incidence of mental disorder by a given age which, using the notation of equation (11), is denoted by $F_{disorder}(t|z, \mathbf{x}, \gamma_{disorder}, \beta_{disorder})$;

the second estimates the probability of either first treatment or recovery, as a result of their mental disorder is denoted by $F_{trt+rec}(t|z, \mathbf{x}, \gamma_{trt+rec}, \beta_{trt+rec})$; and

the third model estimates the age at first treatment alone, denoted by $F_{trt}(t|z, \mathbf{x}, \gamma_{trt}, \beta_{trt})$.

A fourth model estimates the age at first treatment in a mental health specialist setting and is a subset of any treatment setting alone is denoted by $F_{MHS}(t|z, x, \gamma_{MHS}, \beta_{MHS})$.

The probabilities for recovery are obtained from the differences between the last second and third curves. Similarly, the probabilities of untreated disorder are obtained from the difference between the onset of any disorder and age at treatment or recovery. Thus, we can compare the probabilities that a person within a particular cohort has received treatment, recovered without treatment or may still require treatment by a given age. Therefore, individual curves are obtained by applying equation (11) to a sequence of aggregated events from which each is individually derived by subtracting the curve for the previous level of aggregation:

$$\begin{aligned} F_{trt}(t | \gamma, z) &= \sum_x F_{trt}(t | \gamma, z, x_{trt}, \beta_{trt}) \times w_x \\ F_{rec}(t | \gamma, z) &= \sum_x F_{trt+rec}(t | \gamma, z, x_{trt+rec}, \beta_{trt+rec}) \times w_x - F_{trt}(t | \gamma, z) \\ F_{none}(t | \gamma, z) &= \sum_x F_{disorder}(t | \gamma, z, x_{disorder}, \beta_{disorder}) \times w_x - F_{trt}(t | \gamma, z) - F_{rec}(t | \gamma, z) \end{aligned}$$

An extension to this analysis was to estimate onset curves conditioned upon a subset of individuals who were observed with a lifetime disorder. This only requires two models, using variables that are similar to the last two variables in the unconditional regression. The main difference is that the indicator of interest is the time to treatment and recovery since the onset of disorder. Thus, we can compare time since the onset of a mental disorder to treatment, or recovery, and derive the proportion of people who still require treatment, among those who had that disorder.

In this case, the procedure is the same but the final curve is derived by

$$1 - F_{trt}(t | \gamma, z) - F_{rec}(t | \gamma, z).$$

3.4. Hierarchical Bayes model diagnostics

One of the essential parts of using statistics generated using MCMC is to ensure that the Markov chains have converged to the posterior distribution. Starting from initial values the chains explore the parameter space but early draws do not generally approximate the posterior distribution. Eventually conditional estimates

drawn from the chains hopefully settle to fall within a stable range at which point the chain is said to have converged to the target distribution. After that point, the previous estimates are discarded and only subsequent estimates are used from which inferences are made. The main question becomes: how many runs do I have to make to ensure my models output have converged?

A set of characteristics are recommended that one monitors for each parameter estimate that has been generated (Spiegelhalter et al., 2003). The simplest method is to visually check that a histogram of the estimates are the shape of the distribution one might expect to see for that estimate, and track the draws for each estimate themselves to see that each settles within a relatively constant range without any obvious systematic patterns. At the end of a burn-in period where the estimates should have satisfactorily converged, after which a subsequent sequence of draws is created from which inference will be made. The Geweke statistic tests a hypothesis that the mean of a subset of estimates at the start of the latter sequence run is the same as the mean for a subset at the end of the sequence. This statistic shows that the start and end of the analysis run are the same but will miss any deviations that may occur in between (Fan, Brooks, & Gelman, 2006). It does, however, give a good start to show that the mean estimate at the point one has chosen for a cut-off for the burn-in period is the same as at the end of the analysis run.

Gelman et al. (2004) recommended an R statistic, the Gelman-Rubin R which tests the convergence of a number of separate chains of sequential draws for each parameter. The Gelman-Rubin R, is a calculated using ratio of the pooled variance over the total within chain variance. A slightly modified version is usually applied that has a more general form with appropriate degrees of freedom developed by Brooks and Gelman (Brooks & Gelman, 1998). Using the notation from Brooks and Gelman, having drawn m chains of n sequential estimates for a parameter then:

$$B = \frac{1}{n(m-1)} \sum_{j=1}^m (\hat{\mu}_{j\cdot} - \hat{\mu}_{\cdot\cdot})^2, \quad W = \frac{1}{m(n-1)} \sum_{j=1}^m ((\sum_{t=1}^n y_{j,t}^2) - n\hat{\mu}_j^2)$$

$$\hat{V} = \frac{(n-1)}{n} W + \frac{1}{n(1+m)} B, \quad \text{and} \quad \hat{R} = \frac{(d+3)}{(d+1)} \frac{\hat{V}}{W}$$

Where: $y_{j,t}$ are the t th draw in the j th chain; $\hat{\mu}_{j,}$ the mean for the j th chain; d , the degrees of freedom (given by $2V/\widehat{\text{var}}(\hat{V})$); and $\hat{\mu}_{..}$, the total mean for all chains.

The Brooks and Gelman showed that R will converge to 1 if a number of parallel chains of runs (sequential estimates) for each parameter have converged to a similar value. A recommended cut-off value for R is 1.2 and has been adopted in this study. WinBugs has provided a graphical display that sequentially displays a series of R calculated after enough estimates have been accrued to calculate the pooled, between and within variances for the chains. In addition to tracking that R converges to 1 it is also recommended that both the pooled and within chain variances converge. Since R is a ratio of the two variances it should be expected that the two will look like a single line as R approaches 1.

A number of other statistical and graphical tools have been developed to establish that sequential draws have converged. WinBugs also generates auto-correlation coefficients, while SAS calculates a number of auto-correlation-based statistics alongside R and Geweke. Additionally, a score statistic has been developed to provide univariate and multivariate tests based around the distribution for each estimate (Fan et al., 2006). Figure 3.2 shows WinBugs output for the 13 parameters used in the model for the part I disorder group: mood disorders.

Distribution and trace plots are performed using the last 10,000 estimates, after a 10,000 run burn-in, from the first chain of 20,000. The Gelman-Rubin statistics used 3 chains of 20,000 runs. Figure 3.3 shows that R for all the parameters seemingly converge to 1 and both pooled and within variances also converge. The blue line

Table 3.1 Model diagnostic summary for 12 month prevalence of mood disorder; Geweke and Gelman-Rubin statistics.

Parameter	Geweke		Gelman-Rubin
	z	P(Z>0)	R
Posterior prevalence estimates			
Cook Island	0.10698	0.91480	1.00043
Other Pacific	0.00392	0.99687	1.00010
NZ Māori	0.00879	0.99298	1.00061
NMNP	0.00245	0.99804	0.99994
Model coefficients			
16-19	0.24539	0.80615	1.00204
20-24	0.24359	0.80755	1.00181
25-29	0.29122	0.77088	1.00046
30-44	0.01546	0.98767	1.00001
45-64	0.01225	0.99022	1.00062
65 and older	0.28886	0.77269	1.00297
Cook Island	0.06262	0.95007	1.00081
Other Pacific	0.04395	0.96494	1.00159
NZ Māori	0.03496	0.97211	1.00191
NMNP	0.02727	0.97824	1.00289
Sex(Female)	0.23785	0.81200	1.00232
Strata	0.26387	0.79188	1.00219
Sample Unit	0.29039	0.77152	1.00243

represents the sequence of W, within chain variances, that have been normalized to a mean of one so that they fit on the same scale as R in the graphical output.

In practice, inference in this thesis has been made from the last half of draws from the first of three chains. In some cases, longer chains were required to obtain satisfactory convergence. Every prevalence estimate or survival curve represents separate individual models that each requires individual assessment. The most common remedy for a lack of convergence is to run a model with a larger number of draws until convergence is reached.

If a series of draws appears sporadic with a “jerky” quality to the plot, it is worth investigating serial autocorrelation between the draws. This can be checked also and sometimes remedied by using only every nth draw to reduce the auto correlation. If all else fails the least desired option is to re-parameterise the model.

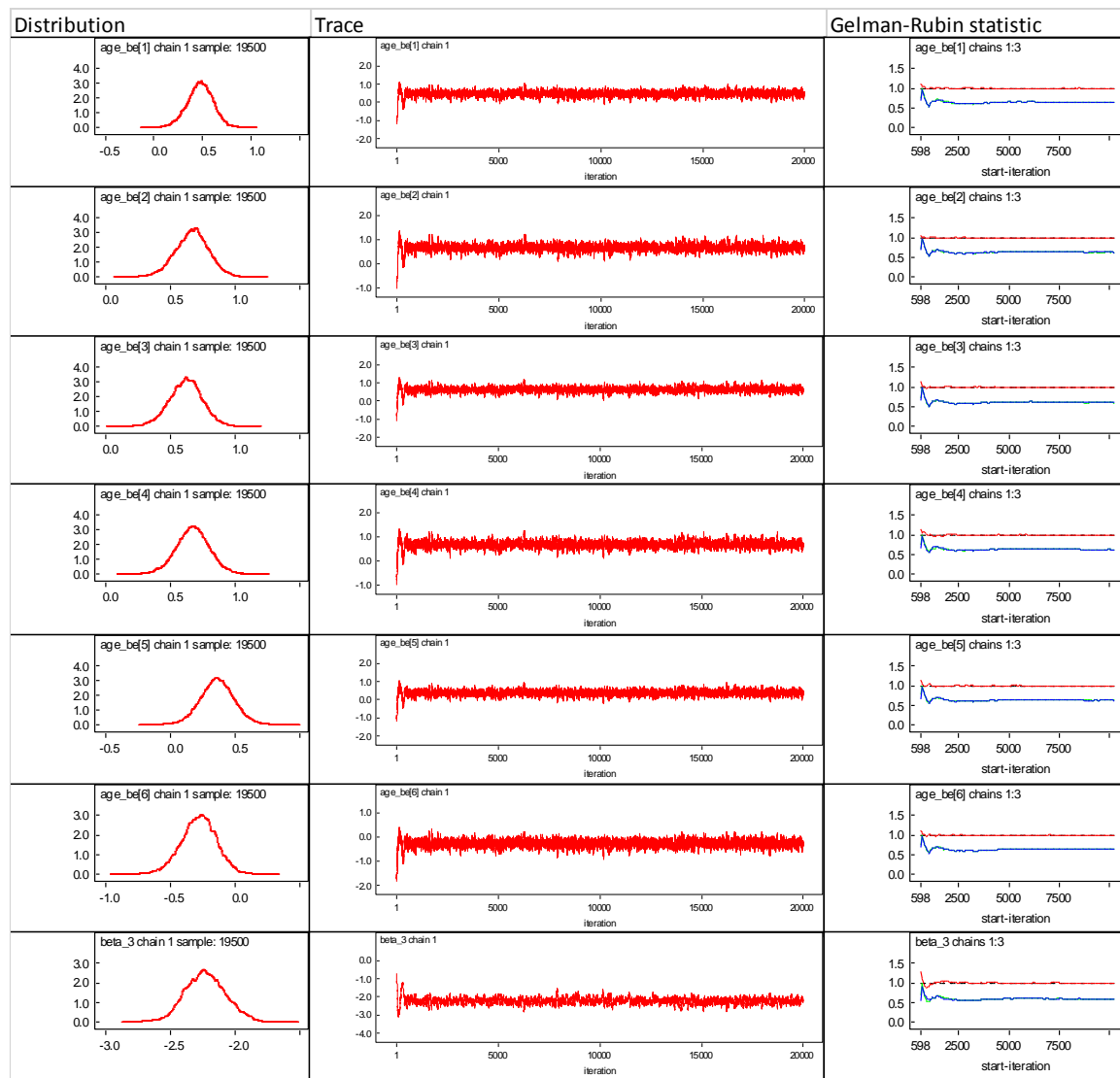


Figure 3.2a Twelve-month prevalence of mood disorder WinBugs model diagnostic plots: distribution, trace and Gelman-Rubin plot. (5 chains of 40,000 runs)

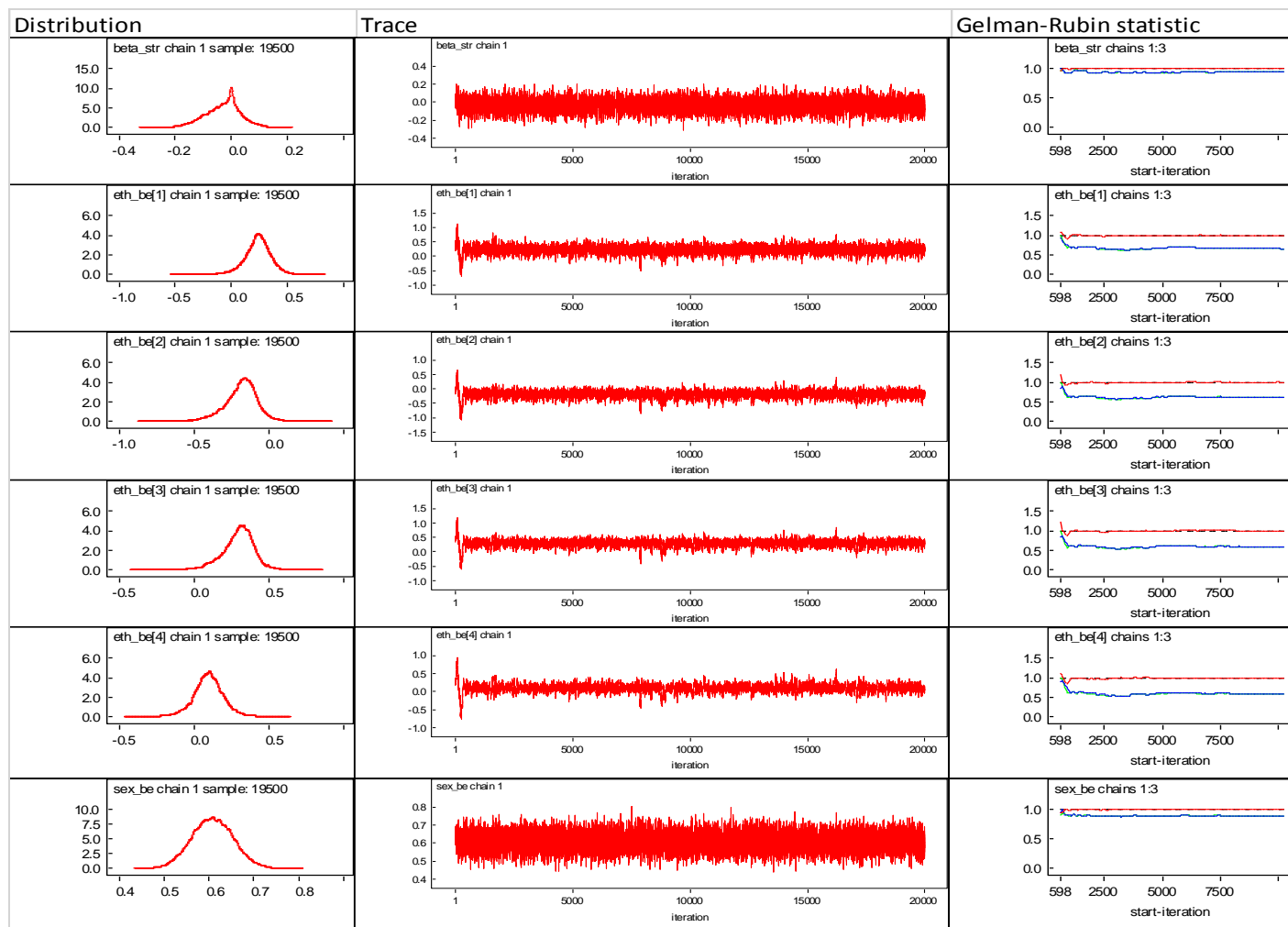


Figure 3.2 b Twelve-month prevalence of mood disorder WinBugs model diagnostic plots: distribution, trace and Gelman-Rubin plot. (5 chains of 40,000 runs)

The Gelman-Rubin plots in Figure 3.2 show convergence and this is confirmed by the Geweke and instantaneous Gelman-Rubin statistics (table 3.1). Brooks and Gelman (1998), also developed an iterative method to assess multiple parameters using a single value for R. The algorithm that had been employed for this analysis involves estimating an instantaneous value for R at every 100 draws of the k parameters. The statistic R_t^{\max} is the maximum R for all k parameters at sequence t. A recommended threshold value for R^{\max} is given by:

$$R_t^k = \frac{(n+1)}{n} + \frac{(m+1)}{m} \lambda_t$$

where λ_t is the largest eigenvalue from the positive definite matrix $W^{-1}B/n$. In practice a SAS macro named %gelman, originally developed in SAS 9.2 (SAS Institute Inc, 1999), has been modified to produce the sequential values for R_t^{\max} , R_t^k as well as end of sequence values of R for each parameter as reported in Table summaries.

Figure 3.3 shows an example of a multivariate summary of the multiple graphs of the R in Figure 3.2. The plot for mood disorders show that while the R_t^{\max} is less than 1.2 it is over the threshold up to just before 20,000 draws. The second summary graph in figure 3.3 is the distribution of a run of 10,000 predictive values of the proportion of the observed total who have indicated a mood disorder. The predictive values are drawn from the same distribution that we have used to describe the observed prevalence with an estimated value for the conditional mean prevalence. The observed value has been indicated by a solid line in Figure 3.3. The posterior predictive values indicate the adequacy of the model to predict the prevalence.

The same predictive distribution and observed summaries, for mood disorders as well as other disorder groups, have been reported in Table 3.2. These summaries of performance will be used to summarise the model performance in subsequent chapters.

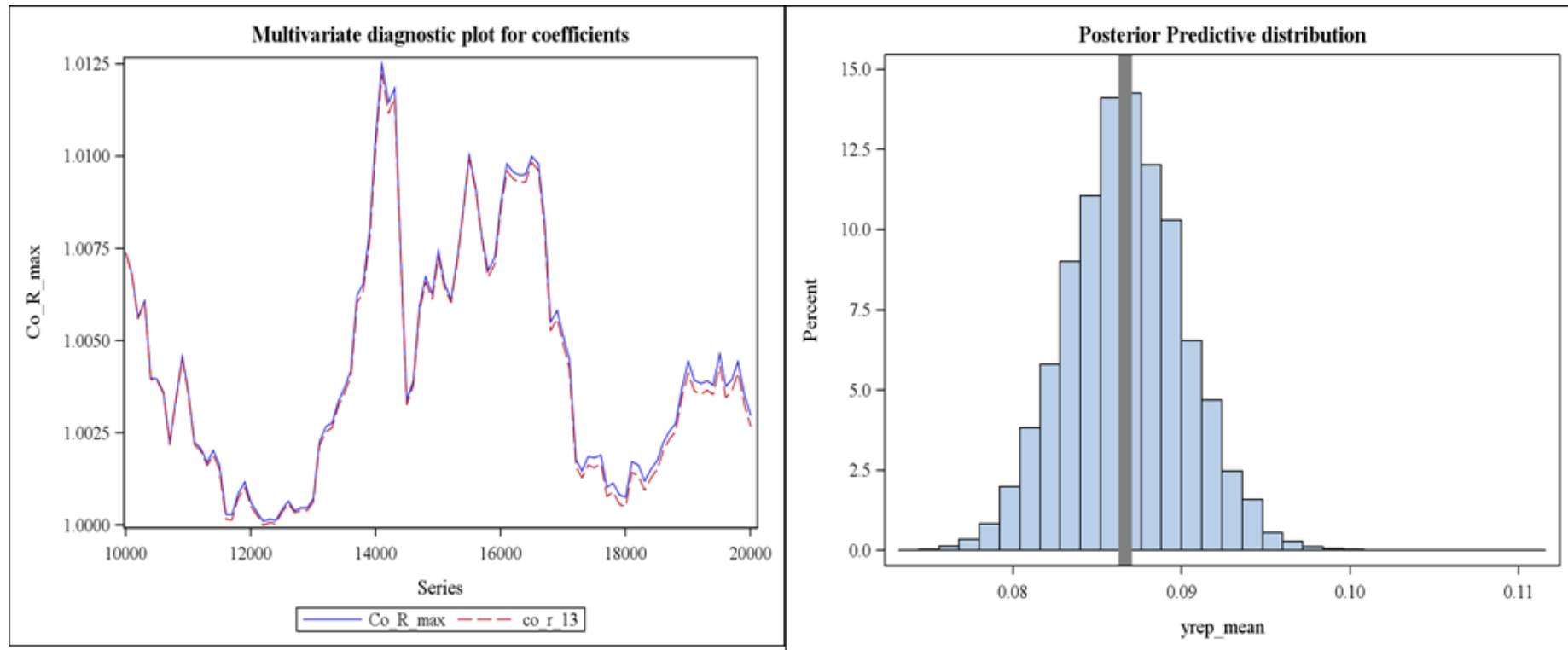


Figure 3.3 Left: Multivariate R diagnostic graphs for mood (3 chains 20,000 draws). Right: Posterior predictive distribution for the unweighted proportion of total sample observed with a mood disorder (10,000 draws) the actual observed proportion indicated by a solid line.

Table 3.2 Summary posterior predictive distribution for the proportion of total sample observed with a disorder (10,000 draws), the observed proportion and proportion of predictive draws greater than or equal to the observed proportion.

Disorder	Distribution of 10,000 predictive draws (Y_{Rep})	Observed percentage (y_{Obs})	Difference between Y_{Rep} and Y_{Obs}
	% (95% CR)	%	$P(y_{Rep} > y_{Obs})$
Any mental disorder	23.12 (22.32,23.92)	23.09	0.5177
Anxiety disorders	16.81 (16.06,17.56)	16.77	0.5275
Mood disorder	8.67 (8.10,9.24)	8.67	0.5025
Substance disorders	3.99 (3.60,4.38)	3.99	0.4993
Serious disorder	6.17 (5.68,6.67)	6.13	0.5484

3.5. An example of SAS code for a model prevalence in WinBUGS

The hierarchical Bayes model results presented in subsequent chapters were calculated using WinBUGS 1.4. The raw data from the collated NZMHS responses, as well as the results produced from running WinBUGS, are processed in SAS. Zhiyong et al. (Zhiyong et al., 2008) provide a general description of process, the code required to call WinBUGS from within SAS, as well as processing the resulting output. Carrigan et al. (2007), also use a similar procedure for a model that imputes missing data in longitudinal analyses. The WinBUGS website recommends a number of references for using WinBUGS with SAS.

This section presents the algorithm used to run a prevalence model in WinBUGS with an example of the SAS code required to specify the model and run WinBUGS from SAS. In some ways, this process has been made redundant in later versions of SAS as several SAS procedures are now able to run MCMC and Bayesian analyses without requiring an external Gibbs sampler. The use of WinBUGS has been retained in this study as its limitations were more familiar than those of the SAS procedures at the time of writing this thesis.

WinBUGS reads the model and data values from a number of text files that have to be set up by SAS. All the text files must be saved into the working directory

that holds the WinBUGS programme. A summary of the steps used in the SAS macros used for these analyses are essentially as described in Zhiyong et al. (2008). They are:

- 1) Set up the data to be used in WinBUGS and export to a text file,
- 2) Set up a description of the model that will be used in WinBUGS and save to a text file. A general example of the model code for most of the analyses in this thesis is as follows:

```
FILENAME model "&path./WinBUGS14/nzmhs/&modelfile..txt";
data _null_;
  file model;
  put@1 "model";
  put@1 "{";
  put@1 "## LOOP THROUGH INDIVIDUALS SAMPLED";
  put@1 "for( i in 1:N) {";
  put@1 "  yobs[i] ~ dbern(pi[i]);";
  put@1 "  logit(pi[i]) <- eth_be[eth[i]] ";
  put@1 "    + sex_be*sex[i] + age_be[age[i]] ";
  put@1 "    + beta_psu[ssu[i],psu[i]]";
  %if (&part = 2) %then %do;
  put@1 "    + pre_co[slct[i]] "; %end;
  %if (&nco. > 0) %then %do;
    %do j=1 %to &nco;
      put@1 "    + cov_b&j[cov&j[i]]"; %end; %end;
  put@1 "}";
  put@1 "## END LOOP THROUGH Yi ";
  put@1 "for( ki in 1 : &neth.) {";
  put@1 "  # PRIOR Beth ";
  put@1 "  eth_be[ki] ~ dnorm(mueth[ki],tau_eth)";
  put@1 "  # END LOOP THROUGH ETHNICITY";
  put@1 "}";
  %if (&nco. > 0) %then %do;
    %do j=1 %to &nco; %let lvl=nlevel&j
    put@1 "  for( cc in 1 : &lvl) {";
    put@1 "    cov_b&j[cc] dnorm(co&j[cc],tau_age) ";
    put@1 "  }";%end; %end;
  put@1 "  # PRIORS 6 AGE groups";
  put@1 "  for( aa in 1 : 6) {";
  put@1 "    age_be[aa] ~ dnorm(0.0,tau_age)";
  put@1 "  }";
  put@1 "sex_be ~ dnorm(sexpre,tau_sex)";
  put@1 "  # LOCAL AREA SAMPLE UNIT";
  put@1 "  for( s in 1 : 2) {";
  put@1 "    for( j in 1 : 1260) {";
  put@1 "      beta_psu[j] <- beta_3*pssu[j] + beta_str*(s-1) ";
  put@1 "    }";
  %if (&part = 2) %then %do;
  put@1 "## PART II SELECTION ";
  put@1 "  pre_co[1] ~ dnorm(pre_sub0[1],tau_sub1) ";
  put@1 "  for( q in 2 : 6) {";
  put@1 "    pre_co[q] <- pre_sub0[2] + pre_co2[q] ";
  put@1 "    pre_co[q] ~ dnorm(0,tau_sub2) ";
  put@1 "  }";
  put@1 "  for( phh in 7 : 11) {";
  put@1 "    pre_co[phh] ~ dnorm(pre_sub0[3],tau_sub3) ";
```

```

put@1 "                                }";%end;
put@1 " #      CLUSTER HYPER_PRIORS";
put@1 "beta_3 ~ dnorm(0.0,tau_3)";
put@1 " #      PACIFIC STRATA      ";
put@1 "  beta_str ~ dnorm(0.0,tau_str) ";
put@1 "## VARIANCE PRIORS";
put@1 "sigma.tau_0~ dunif(0,sigmax)";
put@1 "tau_0<-1/(sigma.tau_0*sigma.tau_0)";
put@1 "sigma.tau_eth~ dunif(0,sigmax_eth)";
put@1 "tau_eth <-1/(sigma.tau_eth*sigma.tau_eth)";
put@1 "sigma.tau_age~ dunif(0,sigmax_age)";
put@1 "sigma.tau_sub3~ dunif(0,sigmax)";
put@1 "tau_sub3 <-1/(sigma.tau_sub3 *sigma.tau_sub3 )";
put@1 "sigma.tau_3~ dunif(0,sigmax)";
put@1 "tau_3<-1/(sigma.tau_3*sigma.tau_3)";
put@1 "}";
run;

```

- 3) Set up a text file of initial values,
- 4) As an intermediate step, and since all the data has been outputted to text files that can be copied manually into WinBUGS, check that the model will run for at least one set of variables,
- 5) Create a text batch file of WinBUGS code to process the analyses as well as produce and save the desired output. This is produced in SAS using the following code, including the code that runs the batch file from within SAS:

```

filename fileout2 "E:\WinBUGS14\batch.txt";
data _null_;
  file fileout2;
  put@1 "display('log')";
  put@1 "check('&dir.&modelfile..txt')";
  put@1 "data('&dir.&datafile1..txt')";
  put@1 "data('&dir.&datafile2..txt')";
  put@1 "compile(5)";
  put@1 "inits(1, '&dir.&initsfile..txt')";
  put@1 "gen.inits()";
  put@1 "set(eth_be)";
  put@1 "set(age_be)";
  put@1 "set(sex_be)";
  put@1 "set(beta_str)";
  put@1 "set(beta_3)";
  %if (&nco>0) %then %do;
    %do j=1 %to &nco;
      put@1 "set(cov_b&j)";%end;%end;
  %if (&part = 2) %then %do;
    put@1 "set(pre_co)";%end;
    put@1 "update(&modruns.)";
    put@1 "coda(*, '&dir.&logfile._coda')";
    put@1 "stats(*)"; /* print statistical summary */
    put@1 "save('&dir.&logfile..txt')"; /* output */
    put@1 "quit()"; /* output */
run;proc printto; run;

```

```
DATA _NULL_;
```

```

FILE "E:\WinBUGS14\&runcfname.bat";
PUT ' "E:\WinBUGS14\WinBUGS14.exe" /PAR batch.txt';
...repeat line for multiple model runs if required
PUT 'exit';
RUN;

options xmin xwait;
DATA _NULL_;
  X call "E:\WinBUGS14\runcfa.bat";
RUN;

```

Import the WinBUGS output, model coefficient estimates saved as text files, analyse the output, process and format into tables to paste into the text using SAS (SAS Institute Inc, 1999). Note the “Coda” files, 1 for each separate chain, containing the sequential estimates generated by WinBUGS for each conditional parameter is imported into SAS using the “coda2sas” macro available online (Hayat & Sparapani, 2005). Zhiyong et al. (2008) and Carrigan et al. (2007), also provide useful SAS code in their examples that interface between SAS and WinBUGS.

3.6 Comparison to previously published results

For comparison, the prevalence of 12-month prevalence of mental disorders estimates for four ethnic groups in New Zealand, shown in Table 3.3 using a Bayesian model were compared with those reported by Kokaua and Wells (2009). The latter showed that Cook Islanders and Māori had a higher prevalence of mental disorders than other Pacific and non- Māori, non-Pacific (NMNP) groups. These were design-based estimates calculated using SUDAAN.

Two Bayesian models have been employed to show the variation between a model that used non-informative priors and the models used in the analyses in subsequent chapters. The models with non-informative priors have similar results to our chosen priors with slightly lower precision. However, the similarities highlight the weak prior assumptions for parameters with semi-informed priors that have been assumed in the models chosen for the subsequent results chapters (see Fig 3.1).

The Bayesian model for the prevalence rates of any disorder, as well as anxiety and serious disorders using the Part II sample methodology, yielded slightly elevated rates for all ethnic groups compared to the design-based estimates. This could result from a slight over estimation of disorders among those not questioned in the Part II

sample or, conversely, an under weighting for non-response in the design based analyses. The 95% credible regions (CR) or posterior intervals obtained from the hierarchical Bayes models were narrower than the design-based 95% confidence intervals.

The Bayesian model for the 12-month prevalence of Part I disorders, mood or

Table 3.3 Comparisons of estimated 12-month prevalence of mental disorder by diagnosis and ethnicity.

Model		Cook Islands n₁ = 489 (n₂ = 326)	Other Pacific n₁ = 1885 (n₂ = 1106)	Māori n₁ = 2457 (n₂ = 1550)	NMNP n₁ = 8162 (n₂ = 4453)
Any mental disorder, part II sample					
Design (N= n ₂)	% (95% CI)	30.9 (23.3, 38.5)	24.2 (20.3, 28.1)	29.5 (26.5, 32.4)	19.3 (18.0, 20.6)
Bayes ¹ (N= n ₁)	% (95% CR)	30.2 (27.7-32.7)	25.4 (23.9-26.8)	30.9 (29.4-32.3)	19.8 (19.1-20.5)
Bayes ² (N= n ₁)	% (95% CR)	31.1 (28.7-33.5)	25.0 (23.5-26.5)	31.9 (30.3-33.4)	19.9 (19.2-20.6)
Any anxiety disorder, part II sample					
Design (N= n ₂)	% (95% CI)	18.9 (13.4, 24.4)	15.7 (13.0, 18.3)	19.6 (17.2, 22.0)	14.1 (13.0, 15.1)
Bayes ¹ (N= n ₁)	% (95% CR)	19.7 (17.9,21.4)	17.8 (16.6,19.0)	20.4 (19.3,21.5)	14.5 (13.9,15.1)
Bayes ² (N= n ₁)	% (95% CR)	20.1 (17.7,22.5)	17.6 (16.2,19.0)	21.2 (19.9,22.5)	14.7 (14.1,15.4)
Mood disorder, part I sample					
Design (N= n ₁)	% (95% CI)	12.4 (6.9, 17.9)	8.4 (5.9, 10.9)	11.5 (10.0, 13.0)	7.5 (6.7, 8.2)
Bayes ¹ (N= n ₁)	% (95% CR)	12.8 (10.4-15.1)	8.4 (7.4-9.5)	12.4 (11.3-13.5)	7.9 (7.4-8.4)
Bayes ² (N= n ₁)	% (95% CR)	12.4 (10.7-14.0)	8.3 (7.5-9.0)	12.9 (12.0-13.9)	7.9 (7.4-8.3)
Substance disorder, part I sample					
Design (N= n ₁)	% (95% CI)	9.5 (5.3,13.7)	4.6 (3.2,6.0)	9.0 (7.5, 10.5)	2.7 (2.3,3.2)
Bayes ¹ (N= n ₁)	% (95% CR)	9.4 (7.1,11.6)	5.3 (4.4,6.2)	9.7 (8.6,10.8)	2.9 (2.6,3.3)
Bayes ² (N= n ₁)	% (95% CR)	9.3 (7.1,11.4)	5.4 (4.5,6.3)	9.6 (8.6,10.6)	2.9 (2.6,3.3)
Serious disorder, part II sample					
Design (N= n ₂)	% (95% CI)	7.7 (4.3, 11.1)	5.7 (4.2, 7.2)	8.9 (7.5, 10.2)	4.1 (3.6, 4.6)
Bayes ² (N= n ₁)	% (95% CR)	9.3 (8.1,10.6)	6.5 (5.8,7.2)	10.2 (9.4,11.0)	4.8 (4.37,5.1)

¹ results using non-informative priors, ² results for models using priors as described in section 3.2

substance yielded rates that also shared similar patterns across the four ethnic groups

with those produced by the design-based model. Bayesian estimates for Part I disorder groups, as for Part II, had comparatively tighter intervals than the design-based estimates. However, all estimates using Bayesian and design models 95% credible regions/confidence intervals overlap.

3.7 Discussion

Are HB estimates any better than or worse than other estimates? Are the design-based estimates superior to the estimates produced by the HB models? From a naïve perspective, both represent an estimate for a parameter of interest, be it a mean, proportion or coefficient, in that they result in a statement of uncertainty about that parameter. The design-based estimate is based upon observations gleaned solely from the data. The HB model's results express uncertainty for each parameter of interest in terms of a probability and have the potential to incorporate some individually assessed knowledge. Under certain conditions, the intervals calculated using a design-based methodology appear similar to those derived using Bayes model with vague or little prior information assumed, However, the main difference remains that the Bayesian model reports uncertainty about the parameter of interest from the perspective of the analyst.

The transparency of having the variables of analytical interest, post-stratification, and design stated clearly in a single model structure is appealing. The effects from those design variables are clearly identified.

The Bayesian model, using WinBugs (Spiegelhalter et al., 2003), avoids the necessity of re-weighting the Part II sample to address secondary sub-selection. The model self-imputes non-selected individuals. So long as the appropriate selection variables are included in the model, the results can be analysed as if from Part I. In the design-based method a separate set of weights are necessary to compensate for the sub-selection of candidates into Part II with different selection probabilities.

Two essential ingredients of the model approach are that the model is well specified to include all design variables, and the parameter estimates are monitored to ensure that they reach a stable distribution (i.e. the MCMC method has converged).

Finally, the approach in this study has been to produce post-stratified estimates for final analysis as suggested by Little (2004).

As stated earlier, the benefits of a Bayesian model approach to survey data compared to a design-based approach is that they easily incorporate complex survey design, can yield improved efficiency for small sample problems, and similar inferences to other model-based approaches with large samples (Little, 2004).

This is shown in the example showing similar results with design-based results for the large sample estimates of prevalence among the non-Māori/non-Pacific population. At the same time, the Part II estimates for the small sample groups, like Cook Islanders, increased slightly. This is seemingly the result of yielding smoothed estimates in all categories of design strata that have sparse observations for Cook Islanders because of their small number.

The variance “shrinkage” reported in the previous section and the “borrowed” precision has proved useful in comparing two or more groups, in this case ethnic groups. Blakely et al. (2009) reported this aspect of Bayesian models and, as with this thesis, used this characteristic to improve the precision around the estimated relative differences between prevalence rates of ethnic groups.

4 Twelve-month prevalence and correlates of mental disorder among Cook Islanders in NZMHS

4.0. Abstract	81
4.1. Method	82
4.1.1. Prevalence estimates and comparisons between groups	82
4.1.2. Covariate and joint covariate models.....	82
4.1.3. Diagnosis of the performance of the Bayesian models.....	86
4.2. Results	94
4.2.1. Twelve-month prevalence of mental disorder among Cook Islanders.....	94
4.2.3. Ethnic differences.....	97
4.2.3. Covariates of prevalence of any twelve-month disorder	101
4.2.4. Ethnic comparisons adjusted for covariates	105
4.2.5. Percentage of ethnic differences explained by covariates.....	108
4.3. Discussion	111
4.3.1. Background.....	111
4.3.3. Summary of results.....	112
4.3.4. Conclusions.....	114

4.0. Abstract

Aims and objectives

The objective of this chapter is to apply the Bayesian methodology outlined in Chapter 3 to describe the prevalence of 12-month mental disorders in New Zealand's Cook Islands resident communities. Its aim is also to confirm that Cook Islanders have higher 12-month prevalence of mental disorder, and establish what factors beyond ethnicity are associated with this higher prevalence.

Overview

Section 4.1 describes the methods and diagnostics for the models used in this chapter. Section 4.2 is the results section, with section 4.1.2 reporting an overview of the 12-month prevalence of mental disorder among Cook Islanders in New Zealand while section 4.2.2 compares their prevalence with those of people from other ethnic groups. Section 4.2.3 presents covariates of mental disorder among Cook Islanders,

while sections 4.1.4 to 4.2.6 look at ethnic differences by covariate. Section 4.3 provides a brief overview and discussion of the results and method.

Summary of findings

The findings show an overall higher prevalence of 12-month disorders among Cook Islanders compared with other Pacific and non-Māori, non-Pacific peoples (NMNP). Most, if not all, of the differences were explained by age and sex structure of this comparatively young population. Comparatively few covariates, beyond the effects of age and sex, had any association with increased 12-month disorders. Those that stood out was a strong association with age at migration, particularly a negative effect of being born in New Zealand.

4.1. Method

4.1.1. Prevalence estimates and comparisons between groups

Hierarchical Bayes Logistic models, as described in Chapter 3, will be used to produce posterior prevalence estimates and to report comparative rate ratios. This model has been used to improve the precision of estimates for Cook Islanders using results from the NZMHS.

4.1.2. Covariate and joint covariate models

The prevalence of mental disorders during the 12 months prior to the NZMHS has been well documented in Te Rau Hinengaro (Oakley Browne et al., 2006a) and other publications (Wells et.al., 2006b). In this section, the 12-month prevalence of disorders and some correlates of mental illness are reported by ethnic group.

The setup for prevalence models follows the logistic hierarchical methodology described in Chapter 3. The observed occurrence of a disorder for the i th individual is said to be distributed Bernoulli with probability π_i . This parameter in turn is expressed as follows:

$\text{Logit}(\pi_i)$ = linear expression of design variables (including Part II selection variables only if applicable)

The extension to the models used in Sections 4.2.1, 4.2.3 and Section 4.2.3 includes models with covariates that follow the methodology applied in the previous sections for prevalence of disorders. Again, the observed occurrence of a disorder for the i th individual are said to be distributed Bernoulli with probability π_i . This parameter in turn is expressed as follows:

$\text{Logit}(\pi_i) = \text{linear expression of design variables} + \text{linear expression of every level for each covariate included.}$

Section 4.2.3 and 4.2.4 includes multivariable models that analyse the influence of each variable controlled for a number of other non-design variables. However, the model for age of migration excluded Māori, while the models for labour force and parental status excluded those aged 65 years and older. For the multivariable model eight individual binary variables were set up. These were: NZBORN, born in New Zealand; ALONE, sole adult in household; SOLEP, lone parent; MARRD, married or in a marriage-like relationship; NOQUAL, with no educational qualifications; EMPLOYD, employed; LOINC, with an income below half the median income; HIDEP, from a high deprivation quintile. The model imputed NZBORN for Maori and SOLEP and EMPLOYED if respondents were 65 or older, treating those cases as missing responses. This is because these individuals were excluded in each respective individual effects analyses.

Covariates that applied to restricted sub-groups of respondents, NZBORN, SOLEP or EMPLOYED, were assumed distributed Bernoulli with a probability of falling into each group. A separate logistic regression equation was set up for each variable and the resulting posterior probability from each sub-model was included in place of each variable in the overall prevalence model that then proceeded as for other models with complete data.

The priors for the linear coefficients of the design variables with or without covariates are as stated in Chapter 3. Post-stratified estimates for π_i are then summed to produce population-wide estimates within the various subgroups of interest.

Comparisons between groups

Comparisons are drawn using observed ratios of posterior prevalence rates (RR) and the probability that the reported RR is greater than 1 ($P_{RR}(base)=P(RR>1/data)$), where the *base* is the category that is chosen as the reference group for the comparison. As a general guide, if RR is equal 1 then the $P_{RR}()$ will equal 0.5, which means the posterior estimate of RR has an equal chance of being greater than 1. Similarly, if the RR is higher the P_{RR} will approach 1 and if smaller the P_{RR} will approach 0. A P_{RR} in excess of 0.9 or less than 0.1 has been used to indicate a strong difference between the prevalence of one group over another. The reader should also note that 0.0000 and 1.0000 reported in the following tables actually refers to <0.00005 and >0.9999 respectively.

Percentage of ethnic differences explained by a covariate

To assess the covariate effect upon the ethnic differences in the prevalence of mental disorder requires to firstly remove the ever present confounding that is due to age and sex. This is clearly shown by figure 4.1 which portrays the non-directional relationship between age and sex indicating ethnicity has neither a direct influence nor is influenced by age or sex but both may influence the mental health outcome (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Greenland & Robins, 1986). Meanwhile, the effect of ethnicity upon the mental health outcome is assumed to be mediated by the covariate. In order to analyse the extent that the effect of ethnicity

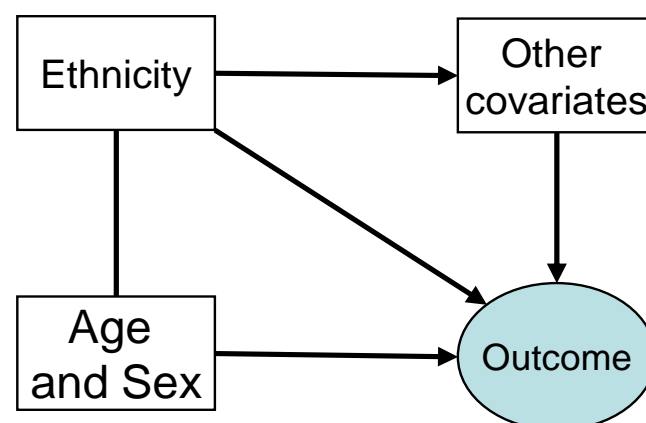


Figure 4.1 A directed acyclic graph (DAG) of the mediation effect of a covariate upon ethnicity in the presence of confounding by age and sex.

is mediated by at least one covariate a conceptual hierarchy has been proposed (Victora, Huttly, Fuchs, & Olinto, 1997):

- Demographic confounding: age and sex
- Mediation by Age at migration, given age and sex
- Mediation by other socio-economic covariates, given age and sex
- Mediation by Age at migration + all other covariates, given age and sex.

The means by which to assess the effect of covariates upon ethnic difference has been to calculate a percentage change in the risk difference between Cook Islanders and a comparison ethnic group before and after controlling for each covariate is calculated. This is a variation of the formula for attributable risk widely used to explain the morbidity or mortality difference that occurs from exposure to a risk factor (Greenland, 1984; 2001; Webb, Bain, & Pirozzo, 2006). The risk difference between Cook Islanders and another ethnic group after taking into account the effects of a covariate, j , is given by (Webb, Bain, & Pirozzo, 2006):

$$RD_j = prev_j \times (RR_j - 1)$$

Where $prev_j$ is the prevalence estimate for Cook Islanders, the reference group, and RR_j is the relative risk between another ethnic group and Cook Islanders from the model which includes, and is therefore adjusted by, a covariate j . In the context of this study this represents the absolute difference in prevalence of mental disorder between Cook Islanders and another ethnic group.

The percent explained (*%Explained*) represents the percentage difference in the percent of ethnic differences that is obtained from a model with no covariate compared with models that include one or more covariate. It is calculated by the percentage difference between risk differences due to ethnicity in the baseline estimate, RD_0 , and the attributable risk due to the same ethnic difference for an estimate adjusted for at least one covariate, RD_j . This is given by:

$$\%Explained(j) = (RD_j - RD_0) / RD_0 \times 100 \quad (1)$$

4.1.3. Diagnosis of the performance of the Bayesian models

Each hierarchical Bayes model took 60 minutes to run 10,000 replicates. As a result of viewing the diagnostic graphs and statistics, it was decided that 20,000 runs were required for each estimate in table 4.2. The number of runs was reached when it was felt that all the model parameter estimates had converged to a stable value. One of the diagnostic statistics required three separate chains of runs. The following section shows a summary of the statistics which informed the choice of models and the number of runs required. The multivariate R (MVR) statistic represents the largest R for all the parameters in each model while the Geweke reports the p-value for a classical test between the means at the start and end of each analysis run. In the latter case the worst case, minimum p-value, is presented to detect if at least one sequence has a difference. The posterior predictive probability, $P(Y_{rep} > Y_{obs})$, is the proportion of replicated estimates of the crude prevalence of disorder, Y_{rep} , that are greater than the actual observed crude proportion, Y_{obs} .

Table 4.1 shows the mean of the predictive estimates compared to the mean of the observed number of people in the sample with each disorder: that is, the proportion of the unweighted sample observed with disorder compared to a modeled predictive estimate of the number in the sample with disorder. The predictive distribution test, $P(Y_{rep} > Y_{obs})$, particularly for the disorder estimates, appeared to yield satisfactory predicted distribution around the actual location of the observed proportion.

Table 4.1 Predictive diagnostic summary for models of 12-month prevalence of disorders: predictive proportion and observed proportion.

Disorder	MVR	Min Geweke	Mean Y_{rep}	Mean Y_{obs}	$P(Y_{rep} > Y_{obs})$
			% (95% CR)	%	
Any mental disorder	1.0064	0.75805	23.12 (22.32,23.92)	23.09	0.5194
Anxiety	1.0002	0.52864	16.81 (16.06,17.56)	16.77	0.5234
Eating	1.0011	0.79862	0.62 (0.46,0.78)	0.57	0.6933
Mood	1.0029	0.77088	8.67 (8.10,9.24)	8.64	0.5289
Substance	1.0066	0.70094	3.99 (3.60,4.38)	3.96	0.5453
Alcohol	1.0052	0.66873	3.29 (2.93,3.65)	3.26	0.5514
Serious	1.0005	0.22686	6.17 (5.68,6.67)	6.13	0.5422

Table 4.2a Model diagnostic summary for models of 12-month prevalence by disorders; Gelman Rubin and Geweke statistics.

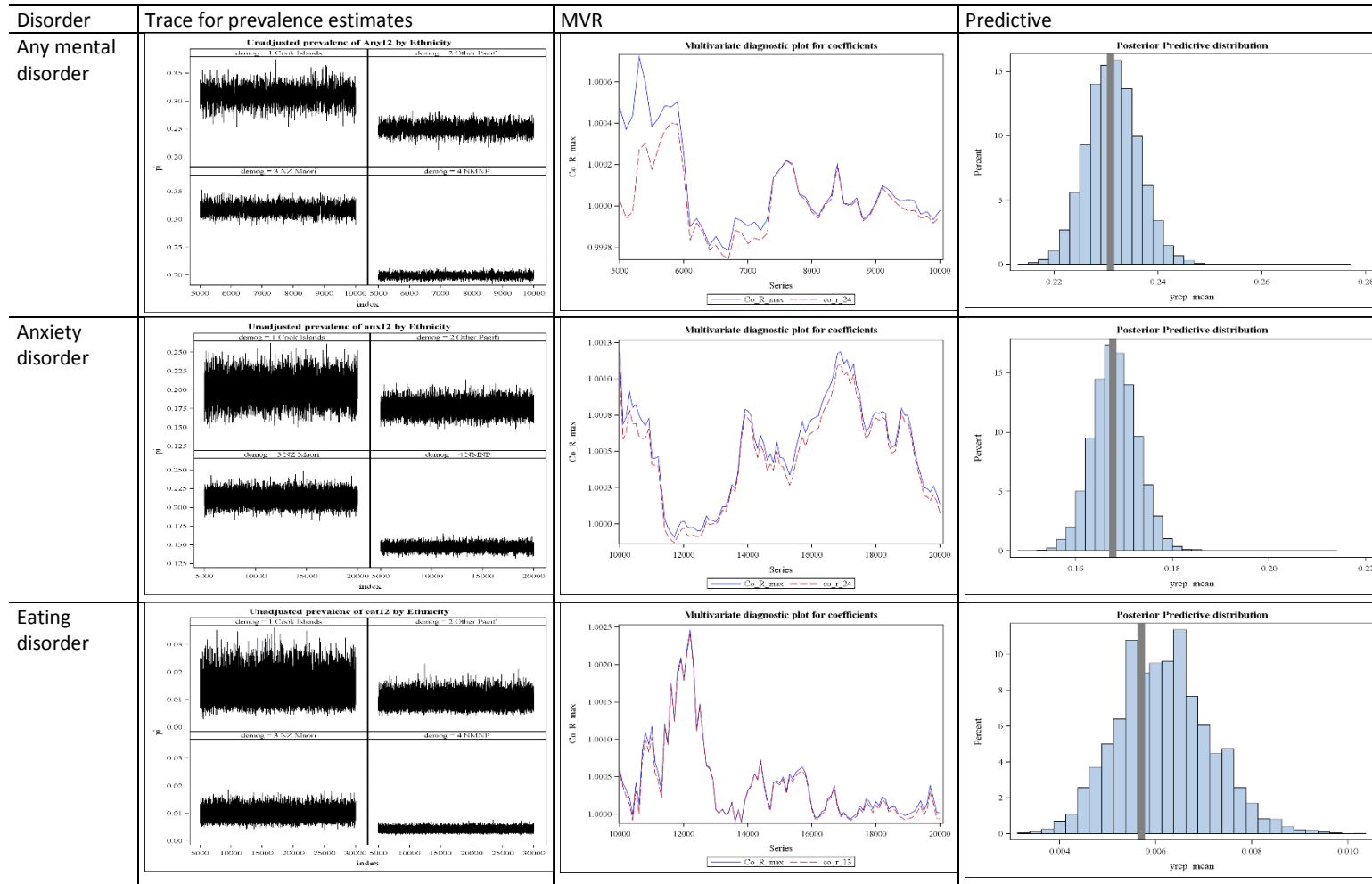
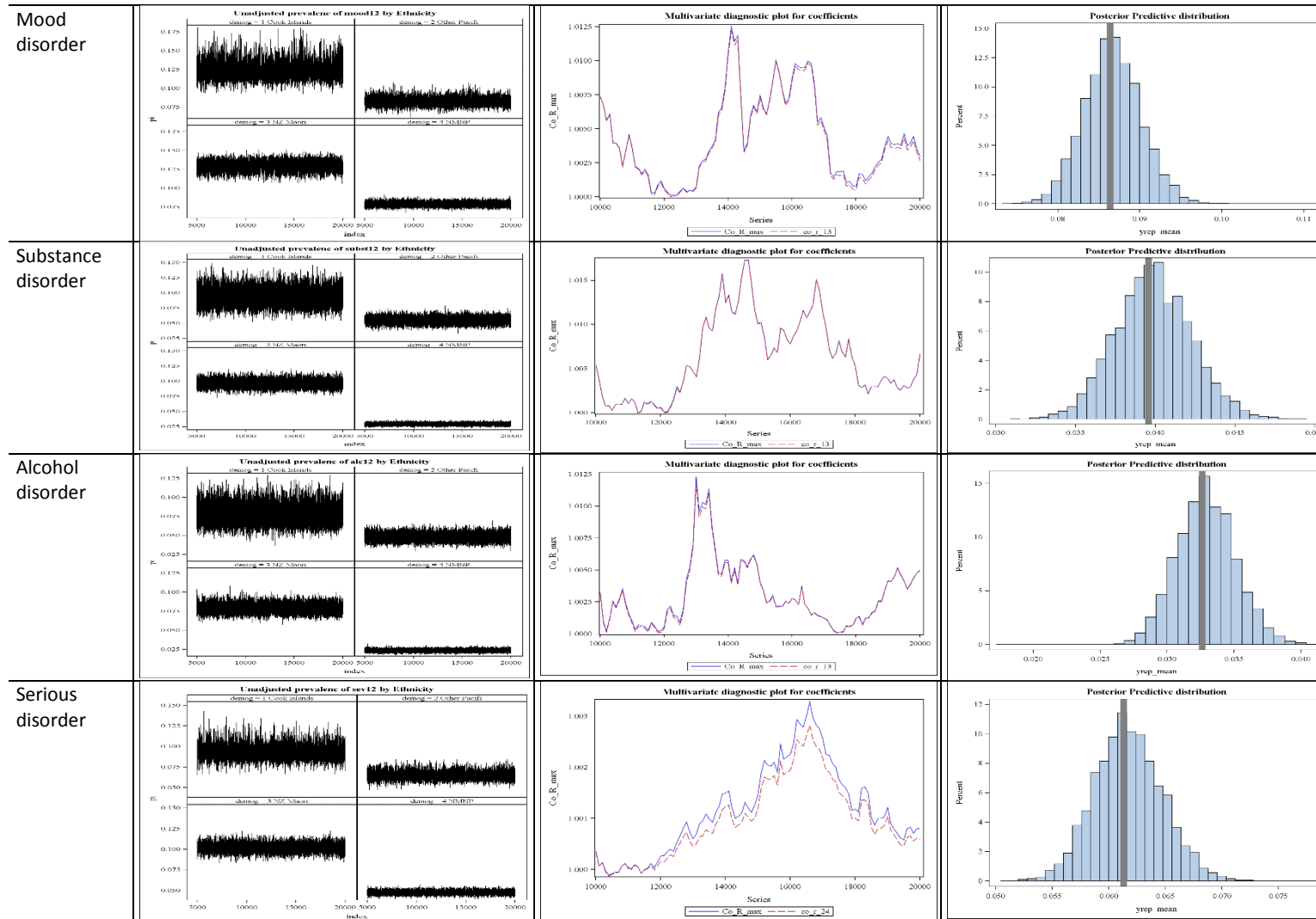


Table 4.2b Model diagnostic summary for models of 12-month prevalence by disorders; Gelman Rubin and Geweke statistics.



Finally, tables 4.2 show a diagnostic plot of the MVR, a summary of the R statistics for all the coefficients used in the model. The MVR appeared to exceed the threshold but in spite of the deceptive scale of the graphs, all of them fell within 1.02 and 1.00 by the end of the runs. Most ended up around 1.00 by the end of each run, partly because the number of replicates in each run was chosen to be long enough to help ensure that all the individual R would either eventually converge or the model would be discarded. The Geweke statistic shows the mean at the start of each run was not statistically different from the mean at the end of each run. The trace plots for the prevalence estimates characterise a sequence of estimates, shown visually in columns 2 of table 4.2, have converged to a stable distribution. The predictive probability checks, $P(Y_{rep} > Y_{obs})$ in Table 4.1, all reported the ability of each model to predict the proportion of people with each disorder. The predicted plots, represented visually in the last column of Table 4.2, confirmed this by showing the predicted distributions were generally located near the actual observed proportion of disorders.

Table 4.3 shows all of the multivariate R (MVR) statistics for single covariate models fell below the recommended 1.02 threshold. That is to say, for three separate chains of runs, the ratio of within-chain and between-chain variance converged to a single value, in spite of the fact that several of the individual R statistics exceeded the threshold value. Upon closer inspection almost of the other R statistics for all the parameters in each model fell below the recommended threshold so the models were retained.

Table 4.3 Predictive diagnostic summary for single fixed effect models with single covariate of 12-month prevalence of any mental disorder: predictive proportion and observed proportion.

Covariates	MVR	Min Geweke	Mean Y_{rep}	Mean Y_{obs}	$P(Y_{rep} > Y_{obs})$
			% (95% CR)	%	
Age at migration*	1.0000	0.59947	27.45 (26.63,28.27)	27.45	0.4953
Number of adults	1.0000	0.61823	23.39 (22.56,24.21)	23.38	0.4965
Marital status	1.0074	0.38476	23.38 (22.56,24.20)	23.37	0.5016
Parental status**	1.0013	0.75463	23.38 (22.56,24.20)	23.37	0.5016
Qualifications	1.0009	0.15491	23.36 (22.53,24.18)	23.35	0.4977
Labour force**	1.0014	0.38878	26.41 (25.46,27.35)	26.41	0.4976
Income	1.0020	0.71077	23.36 (22.55,24.17)	23.36	0.5003
Deprivation	1.0001	0.72472	23.38 (22.56,24.19)	23.36	0.5048

* Analysis for place of birth excludes Maori **analyses for parental and labour-force status excludes those aged 65 and older

Table 4.4a Individual covariate model diagnostic summaries for models of 12-month prevalence of any mental disorder; Gelman Rubin and Geweke statistics, multivariate R and predictive analysis.

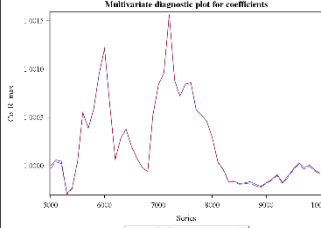
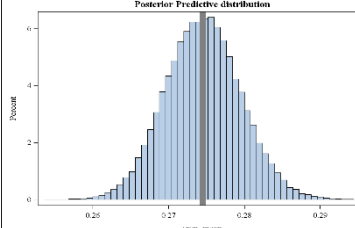
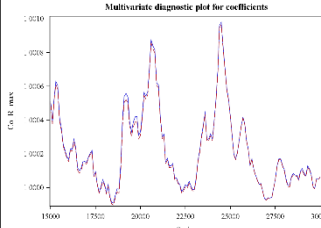
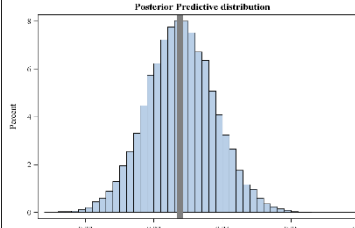
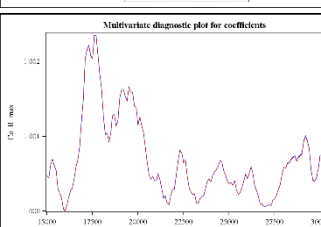
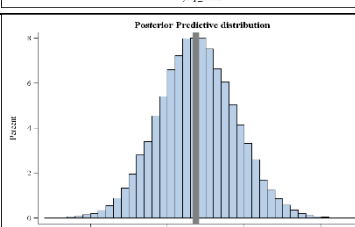
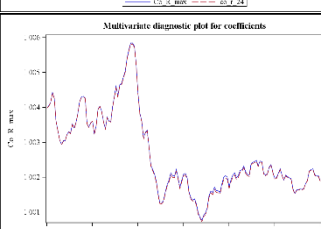
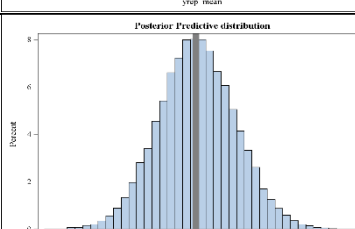
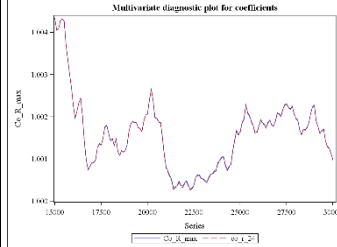
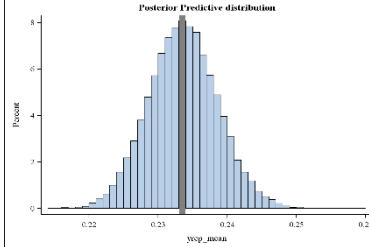
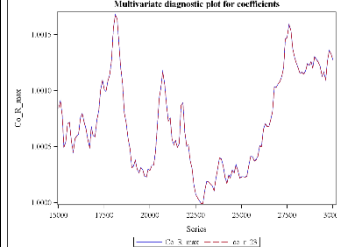
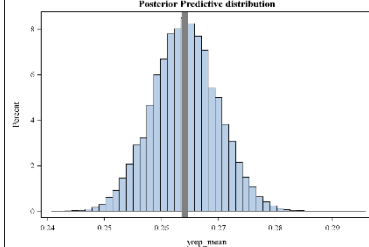
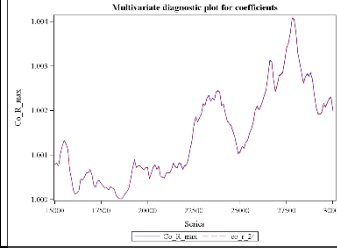
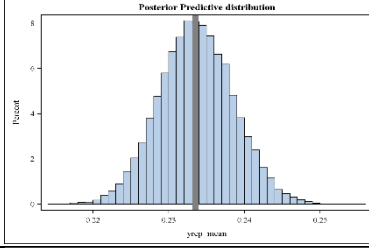
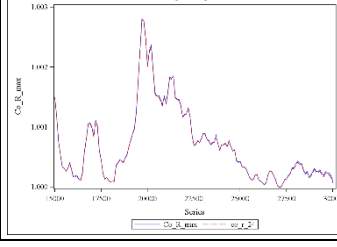
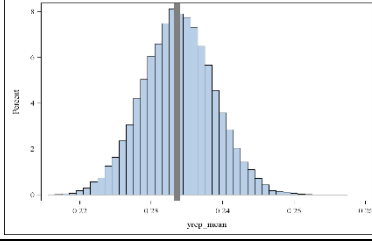
Covariate	Category	R	Geweke	MVR	Predictive
Age at migration	Non migrant/NZ-born Young migrant Older migrant	1.01287 1.01109 1.01226	0.80200 0.77859 0.76181		
Number of other resident adults	Sole adult 1 other adult 2+ other adults	1.02080 1.02130 1.02096	0.96648 0.95517 0.98311		
Marital status	Married Defacto Separated or divorced Widowed Never married	1.00750 1.00738 1.00701 1.00753 1.00739	0.81417 0.80306 0.82176 0.82686 0.82342		
Parents and couples aged under 65 years	Not parent Sole parent Couple with children	1.09834 1.09556 1.09680	0.98085 0.97887 0.98208		

Table 4.4b Individual covariate model diagnostic summaries for models of 12-month prevalence of any mental disorder; Gelman Rubin and Geweke statistics, multivariate R and predictive analysis.

Covariate	Category	R	Geweke	MVR	Predictive
Educational qualifications	No qualification School or post school School plus	1.02174 1.02216 1.02232	0.82158 0.78013 0.75183		
Labour force	Employed Unemployed Not in labour force	1.02607 1.02440 1.02533	0.99952 0.95683 0.98030		
Equivalised household income	Low income To median To half (median-max) High income	1.03357 1.03364 1.03322 1.03331	0.93686 0.95224 0.91798 0.94508		
NZDEP2001	Q1 low deprivation Quintile 2 Quintile 3 Quintile 4 Q5 High deprivation	1.00140 1.00140 1.00141 1.00146 1.00150	0.97376 0.98358 0.96929 0.97906 0.81843		

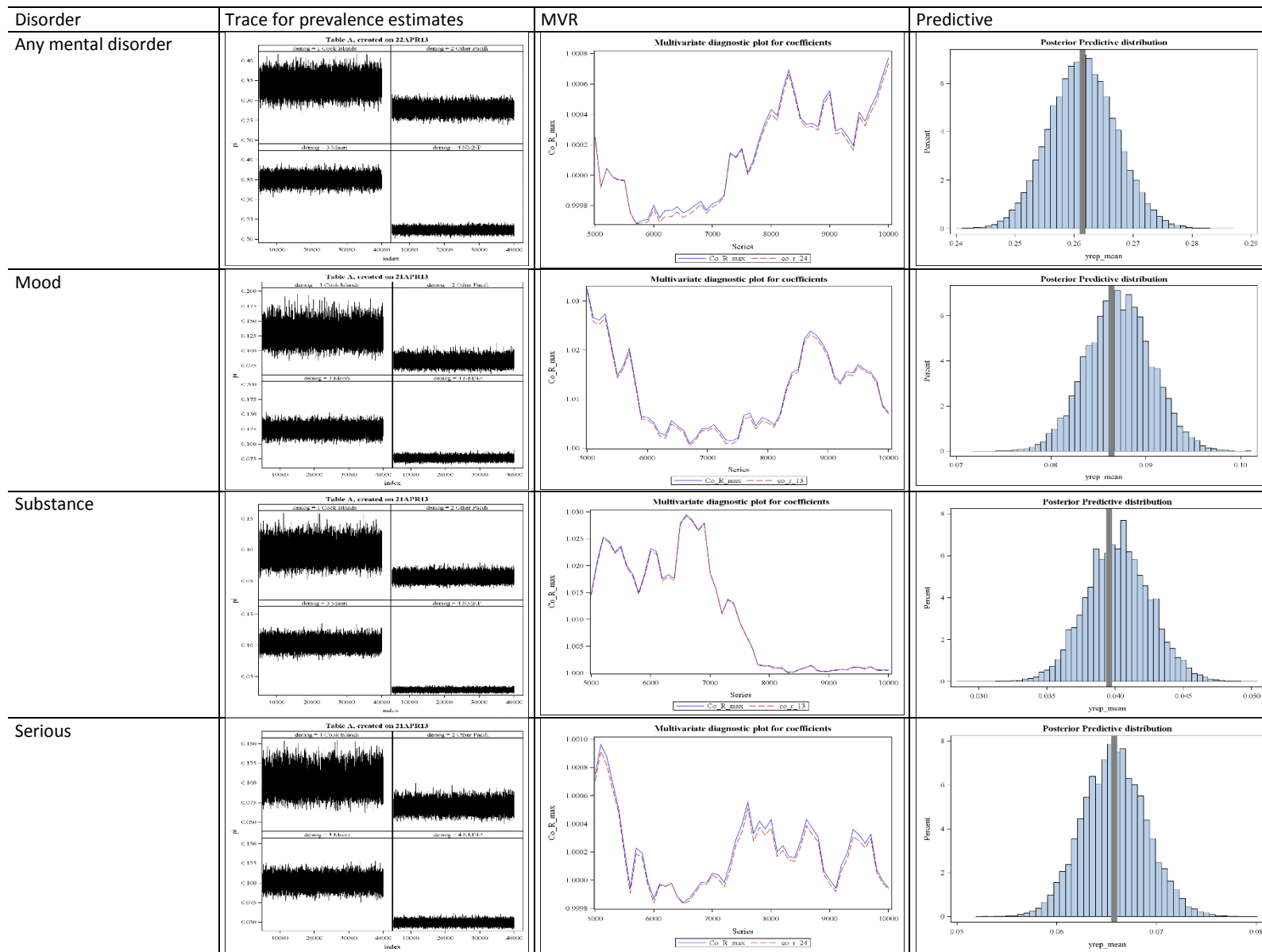
The Geweke statistics in table 4.3 also shows the mean at the start of each run was not statistically different from the mean at the end of the same run. This is shown visually in columns 2 of table 4.4. The trace plots for the prevalence estimates characterise a sequence of estimates that have converged to a stable distribution. The predictive probability checks in Tables 4.3 and 4.4, $P(Y_{rep} > Y_{obs})$, all reported the ability of each model to predict the proportion of people with each disorder.

Finally, tables 4.5 and 4.6 show, like the other models above, the MVR for the joint covariate models all fell below the 1.02 threshold. The Geweke statistics in table 4.5 also shows the mean at the start of each run was not statistically different from the mean at the end of the same run. This is shown visually in columns 2 of table 4.4. The trace plots for the prevalence estimates characterise a sequence of estimates that have converged to a stable distribution. The predictive probability checks in Tables 4.5 and 4.6, $P(Y_{rep} > Y_{obs})$, all reported the ability of each model to predict the proportion of people with each disorder.

Table 4.5 Predictive diagnostic summary for joint covariate models of 12-month prevalence of disorders: predictive proportion and observed proportion.

Disorder	MVR	Min Geweke	Mean Yrep % (95% CR)	Mean Yobs %	$P(Y_{rep} > Y_{obs})$
Any mental disorder	1.0008	0.79606	26.14 (25.22,27.07)	26.14	0.4967
Mood	1.0072	0.76244	8.72 (8.15,9.28)	8.64	0.5880
Substance	1.0005	0.74159	4.02 (3.63,4.41)	3.96	0.6006
Alcohol	1.0067	0.84088	3.33 (2.97,3.69)	3.26	0.6226
Serious	0.9999	0.89893	6.58 (6.05,7.10)	6.57	0.4961

Table 4.6 Joint covariate model diagnostic summaries by disorder; Gelman Rubin and Geweke statistics, multivariate R and predictive analysis.



4.2. Results

4.2.1. Twelve-month prevalence of mental disorder among Cook Islanders

Table 4.7 shows that the 12-month prevalence of mental disorder in Cook Islands adults at the time of their inclusion into the NZMHS was 31%. That is, just under a third of Cook Islands adults had been diagnosed with a disorder at some time in 12 months prior to the NZMHS. Around one in five experienced a 12-month anxiety disorder, 20% of all Cook Islands adults. A substantial proportion of Cook Islands adults with a 12-month disorder, more than a third of those with a disorder (12% of Cook Islanders), had a mood disorder. A similar proportion had more than one diagnosed disorder at some time in the previous year when surveyed. One Cook Islander in eleven had a substance use disorder, while a similar proportion had a serious disorder. Nearly one in four, 22%, had a mild or moderate disorder.

For most of the individual disorders shown in table 4.7, there is a reduction in prevalence of around 20% as a result of adjusting for age and sex. The lowest effect was on the rates for mild disorders (a 12% decrease) and the largest decrease was for dual substance disorders and overall serious disorders for which the decrease was more than 30%.

As expected from relatively high rates of disorder overall, nearly one in ten Cook Islanders had a severe disorder. A further 13.4% and 8.5% had moderate and mild disorders respectively. Another reflection of severity, multiple disorders reflected more complicated

Table 4.7 Twelve-month prevalence Cook Islanders for disorder groups.

	Unadjusted	Adjusted*
	% (95%CR)	% (95%CR)
Any mental disorder	31.0 (28.1-33.9)	23.0 (20.2-25.7)
Any anxiety	20.1 (17.2-23.0)	15.4 (12.7-18.1)
Any mood disorder	12.4 (10.8-14.7)	10.2 (8.8-12.3)
Any eating disorder	1.4 (0.7-2.3)	1.1 (0.5-2.0)
Any substance disorder	9.3 (6.9-12.0)	7.2 (5.2-9.6)
Any alcohol disorder	7.8 (5.7-10.3)	6.2 (4.3-8.5)
Serious disorder	9.4 (8.0-11.2)	6.5 (5.4-8.0)
Moderate disorder	13.4 (10.8-16.1)	9.7 (7.5-12.1)
Mild disorder	8.5 (6.4-10.8)	7.5 (5.5-9.7)
More than 1 disorder	13.4 (11.0-15.9)	9.8 (7.7-12.0)
Substance disorder + another disorder	5.2 (3.7-7.1)	3.3 (2.2-4.6)

**Adjusted for age and sex to the New Zealand total population (see section 3.3.7).*

disorder patterns, placing a greater demand upon specialist mental health and other health or complementary services in any given year.

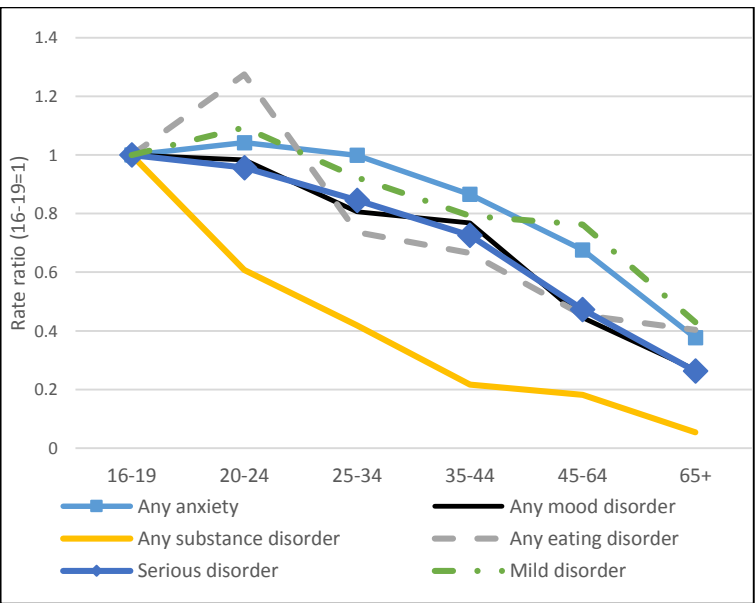
Disorder by age and sex

After adjusting for age and sex, the Cook Islands prevalence of mental disorders at some time in the previous 12 months reduced to 23%. Table 4.7 shows that the prevalence of any 12-month disorder among Cook Islanders was highest in the 20-24 age group, with RR relative to the 16-19 age group declining from age 25 on. The absolute prevalence peaked at 36.2% in the 20-24 age group and declined to 14.7% for those aged 45-64 years.

Table 4.8 shows that the 12-month prevalence of disorders among Cook Islanders introduces a typical pattern for mental disorders of a peak prevalence rate at the youngest age groups, either 16-19 or 20-24 year olds, followed by a monotonic decrease to a low among those aged 65 years or older. The prevalence of disorders at 65 years and older was fifth to a third that for the youngest age group.

One exception to the usual pattern was among those diagnosed with an eating disorder. Although comparatively rare, eating disorders peaked among 20-24 year olds.

One in seven Cook Islanders aged 16-19 years had a 12-month prevalence of any



substance disorder, including those with alcohol and dual diagnosis. Figure 4.2 (and Table 4.8) show that substance disorders are a young person's disorder among Cook Islanders with the 12-month prevalence in the youngest age group at least 4 times higher than for those 45 years or older.

Figure 4.2 Rate ratios across Cook Islands age groups; anxiety, eating, substance, serious and mild disorder groups.

Table 4.8 Twelve-month prevalence* and rate ratios (RR) for any mental disorder among Cook Islanders by age and sex.

	Age						Sex	
	16-19	20-24	25-34	35-44	45-64	65+	Male	Female
	% (95% CR))	% (95% CR))	% (95% CR))	% (95% CR))	% (95% CR))	% (95% CR))	% (95% CR)	% (95% CR))
Any mental disorder	32.6 (29.1-36.1)	36.2 (32.8-39.6)	34.2 (30.7-37.9)	25.0 (22.0-28.1)	14.7 (12.6-16.9)	15.4 (12.7-18.1)	27.8 (24.8-30.8)	33.5 (30.4-36.5)
	% (95% CR))	RR (P _{RR} [16-19])	RR (P _{RR} [16-19])	RR (P _{RR} [16-19])	RR (P _{RR} [16-19])	RR (P _{RR} [16-19])	% (95% CR)	RR (P _{RR} [Male])
Any anxiety	18.1 (14.9-21.4)	1.0421 (0.7632)	0.9989 (0.4920)	0.8655 (0.0064)	0.6760 (<.0001)	0.3764 (<.0001)	11.1 (9.0-13.4)	1.7412 (>.9999)
Any mood disorder	13.9 (11.5-16.9)	0.9830 (0.4185)	0.8069 (0.0023)	0.7685 (0.0004)	0.4454 (<.0001)	0.2666 (<.0001)	8.1 (6.8-9.9)	1.4963 (>.9999)
Any eating disorder	1.4 (0.7-2.7)	1.2750 (0.8073)	0.7370 (0.0738)	0.6655 (0.0253)	0.4532 (<.0001)	0.4036 (<.0001)	0.9 (0.4-1.6)	1.4496 (0.9813)
Any substance disorder	16.8 (12.2-22.3)	0.6075 (<.0001)	0.4188 (<.0001)	0.2166 (<.0001)	0.1818 (<.0001)	0.0542 (<.0001)	9.6 (6.9-12.9)	0.5105 (<.0001)
Any alcohol disorder	14.4 (10.1-19.6)	0.6106 (<.0001)	0.4179 (<.0001)	0.2113 (<.0001)	0.2110 (<.0001)	0.0649 (<.0001)	8.3 (5.8-11.4)	0.5114 (<.0001)
Serious disorder	8.8 (7.2-11.1)	0.9567 (0.3334)	0.8452 (0.0177)	0.7257 (<.0001)	0.4733 (<.0001)	0.2627 (<.0001)	5.4 (4.4-6.8)	1.4110 (>.9999)
Moderate disorder	12.8 (9.9-16.0)	0.9957 (0.4782)	0.8242 (0.0013)	0.7372 (<.0001)	0.5424 (<.0001)	0.3228 (<.0001)	8.4 (6.4-10.6)	1.3062 (>.9999)
Mild disorder	8.8 (6.3-11.8)	1.0933 (0.7973)	0.9230 (0.2149)	0.7923 (0.0114)	0.7629 (0.0176)	0.4301 (<.0001)	5.7 (4.1-7.7)	1.5792 (>.9999)
More than 1 disorder	14.6 (11.6-17.9)	0.8302 (0.0031)	0.7702 (<.0001)	0.6322 (<.0001)	0.4275 (<.0001)	0.2125 (<.0001)	8.0 (6.2-9.9)	1.4338 (>.9999)
Substance disorder + another disorder	8.6 (5.8-12.1)	0.5145 (<.0001)	0.4114 (<.0001)	0.1276 (<.0001)	0.1421 (<.0001)	0.0586 (<.0001)	4.0 (2.6-5.6)	0.6968 (0.0001)

*Rates are unadjusted. **The RRs are reported relative to the population indicated

Cook Islands women were 21% more likely than Cook Islands men to have any diagnosable disorder at some point 12 months prior to the survey. However, Cook Islands women were half as likely to have a substance use disorder compared to men: 4.7% and 9.6% respectively, reflecting the result that Cook Islands men had a higher probability of alcohol disorders than women. This confirms, for Cook Islanders, previous published results that described substance use disorders as predominantly a male disorder for New Zealanders as a whole (Wells et al., 2007).

Other than that difference for substance-related disorder groups, for the other mental disorder groups in general, Cook Islands women were at least 40% more likely than men to have had a serious disorder at some time in the previous 12 months. At the extreme end, Cook Islands women were 76% more likely than men to have an anxiety disorder.

4.2.2. Ethnic differences

Figure 4.3 depicts the posterior probability distributions for the 12-month prevalence of any mental disorder by ethnicity, unadjusted and adjusted to the age and sex proportions for all New Zealanders. It shows the posterior distribution from which were taken the credible intervals reported for Cook Islanders in table 4.6 as well as the distributions for the other ethnic groups. The unadjusted prevalence of any 12-month mental disorder among Cook Islands respondents in the NZMHS was 31%. Figure 4.3(A) shows that unadjusted rates for Cook Islands and Māori overlap, and this impression is reinforced by the rate ratio in table 4.6 of 1.03. The corresponding P_{RR} of 0.79 is within 0.1 and 0.9 which indicates no difference for this study. Figure 4.3 (B) highlights the reduced differences as a result of adjusting for age and sex, as also shown in table 4.6. The four histograms overlap more in Figure 4.3(B), indicating the differences between the four ethnic groups were reduced not only in terms of their location (mean) but also the probability that one distribution was different from another.

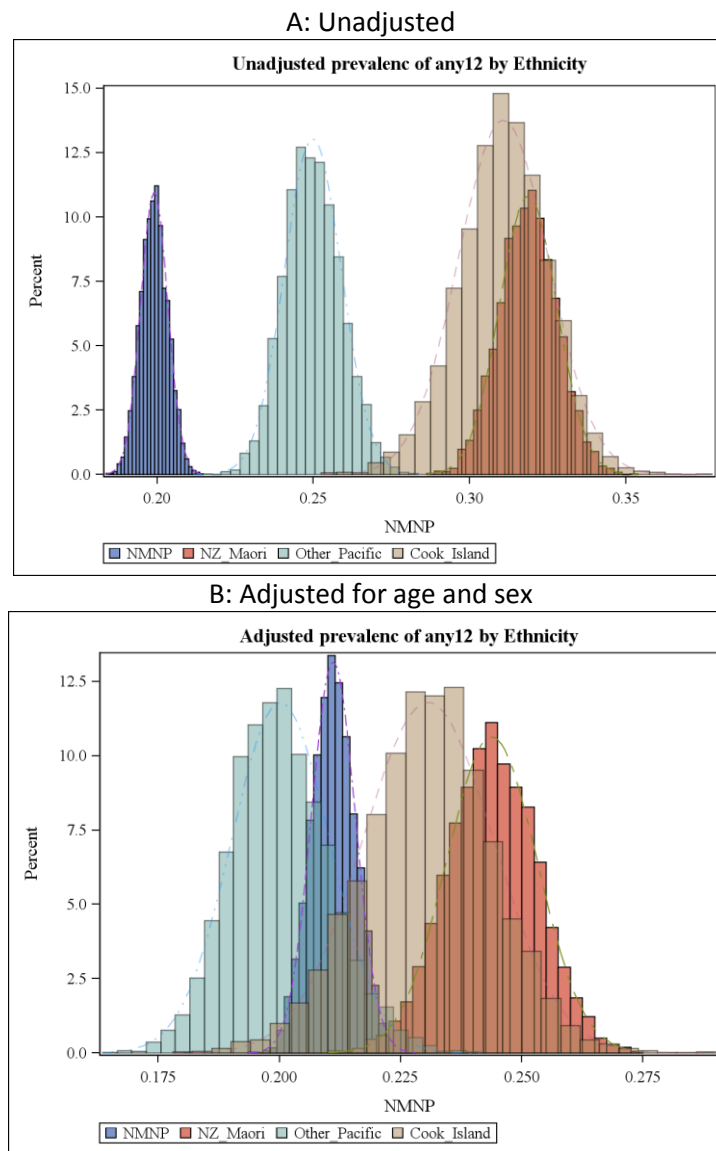


Figure 4.3 Probability distribution of estimates for twelve-month prevalence of any mental disorders by ethnicity.

After adjusting for age and sex, the Cook Islands prevalence of mental disorders at some time in the previous 12 months reduced to 23%. Conversely, the 12-month prevalence of any mental disorder among NMNP, which was by far the largest ethnic group, barely changed after adjustment. The difference between Cook Islanders and NMNP reduced to within 8% of the prevalence among Cook Islanders, the P_{RR} for the comparison remained less than 0.9. The difference between Cook Islanders and the lower rate for other Pacific peoples also reduced from 19% to 13%. A strong difference still remained after adjustment with a P_{RR} greater than the upper threshold of 0.9.

Table 4.9 Cook Islands twelve-month prevalence of any mental disorder. Rate ratios relative to Cook Islands prevalence for each age group or sex.

	Cook Islands	Other Pacific	Māori	NMNP
	% (95% CI)	Rate Ratio (P _{RR})	Rate Ratio (P _{RR})	Rate Ratio (P _{RR})
Total				
Unadjusted	31.0 (28.1-33.9)	0.8068 (<.0001)	1.0278 (0.7015)	0.6429 (<.0001)
Adjusted*	23.0 (20.2-25.7)	0.8717 (0.0107)	1.0602 (0.8393)	0.9208 (0.0930)
Age				
16-19	32.6 (29.1-36.1)	1.0231 (0.6585)	1.1247 (0.9870)	0.8059 (<.0001)
20-24	36.2 (32.8-39.6)	0.8519 (0.0006)	1.0391 (0.7852)	0.7040 (<.0001)
25-34	34.2 (30.7-37.9)	0.6713 (<.0001)	0.9479 (0.1514)	0.6581 (<.0001)
35-44	25.0 (22.0-28.1)	0.6263 (<.0001)	1.1036 (0.9473)	0.8055 (<.0001)
45-64	14.7 (12.6-16.9)	0.8645 (0.0180)	1.3465 (1.0000)	1.1066 (0.9289)
65+	15.4 (12.7-18.1)	0.7128 (<.0001)	0.8847 (0.0391)	0.5408 (<.0001)
Sex				
Male	27.8 (24.8-30.8)	0.8344 (0.0007)	0.9272 (0.0820)	0.5856 (<.0001)
Female	33.5 (30.4-36.5)	0.8019 (<.0001)	1.1111 (0.9806)	0.6986 (<.0001)

*Adjusted for age and sex to the New Zealand total population (see section 3.3.7).

A general pattern has emerged for ethnic comparisons of prevalence of mental disorders, with Cook Islanders having similar rates to Māori, who both had rates higher than people from other Pacific ethnic groups, who in turn had similar levels to people from NMNP ethnic groups (Cook Islands=Māori>Other Pacific≈NMNP).

Ethnic differences in twelve-month prevalence by age and sex

Table 4.9 also shows the prevalence of any 12-month disorder among Cook Islanders decreased with relative comparisons to other ethnic groups. With only two exceptions, table 4.9 shows the overall pattern for comparisons between ethnic groups held within age and sex groups: Cook Islands=Māori>Other Pacific≈NMNP.

Another feature of prevalence rates across age groups is that Cook Islanders and Māori rates peaked at the 20-24 year age group while other Pacific peoples and those of NMNP had prevalence rates that declined monotonically from 16-19 years to 65 years and older. Although most of the rates remained high among 20-24 year olds, rates among older Cook Islanders remained similar to those for younger age groups. Even for 25-34 year olds prevalence remained elevated before declining in the typical fashion toward older age groups.

Cook Islands women were 21% more likely than Cook Islands men to have a diagnosable disorder at some point 12 months prior to the survey. Over one in four Cook Islands men compared to a third of women had any 12-month mental disorder.

Although not specifically shown, the gender difference carries through to the other ethnic groups. As shown earlier, as well as in other publications for Cook Islanders women typically were more likely to have a 12-month disorder except for substance use disorders.

Ethnic differences by disorder group

Table 4.10 shows the relative prevalence of other Pacific ethnic groups compared with rates for Cook Islanders. Results in table 4.10 are another way of reporting the spread of the posterior distributions as shown above in figure 4.1. As P_{RR} falls more and more outside the interval [0.1, 0.9] the further apart the distributions have become.

The distributions for prevalence of overall substance and any alcohol disorders for Cook Islanders, and Māori, were distinct from those of NMNP ($P_{RR} < 0.0001$). Cook Islands prevalence rates for substance and alcohol were three times and twice the

Table 4.10 Twelve-month prevalence among and ethnic relative risks by disorder group.

		Cook Islands	Other Pacific RR (P_{RR})**	Māori RR (P_{RR})**	NMNP RR (P_{RR})**
Any disorder	Unadjusted	1	0.8068 (<.0001)	1.0278 (0.7015)	0.6429 (<.0001)
	Adjusted*	1	0.8717 (0.0107)	1.0602 (0.8393)	0.9208 (0.0930)
Anxiety	Unadjusted	1	0.8820 (0.0647)	1.0622 (0.7680)	0.7360 (<.0001)
	Adjusted*	1	0.9622 (0.3373)	1.0698 (0.7753)	1.0163 (0.5657)
Mood	Unadjusted	1	0.6700 (<.0001)	1.0520 (0.7182)	0.6399 (<.0001)
	Adjusted*	1	0.7131 (<.0001)	1.1204 (0.8964)	0.7979 (0.0009)
Eating	Unadjusted	1	0.7709 (0.1987)	0.7861 (0.2143)	0.3322 (<.0001)
	Adjusted*	1	0.8331 (0.2840)	0.8560 (0.3129)	0.4392 (0.0003)
Substance	Unadjusted	1	0.5964 (<.0001)	1.0530 (0.6281)	0.3201 (<.0001)
	Adjusted*	1	0.6309 (0.0004)	1.1466 (0.7918)	0.4349 (<.0001)
Alcohol	Unadjusted	1	0.6271 (0.0007)	1.0351 (0.5807)	0.3079 (<.0001)
	Adjusted*	1	0.6630 (0.0032)	1.1133 (0.7259)	0.4045 (<.0001)
Serious disorder	Unadjusted	1	0.6960 (<.0001)	1.0955 (0.8540)	0.5112 (<.0001)
	Adjusted*	1	0.7345 (<.0001)	1.1460 (0.9337)	0.7957 (0.0034)
Moderate disorder	Unadjusted	1	0.8965 (0.1686)	0.9910 (0.4673)	0.7004 (<.0001)
	Adjusted*	1	0.9728 (0.4121)	1.0314 (0.6028)	1.0362 (0.6049)
Mild disorder	Unadjusted	1	0.8447 (0.1226)	1.0436 (0.6143)	0.7715 (0.0157)
	Adjusted*	1	0.9308 (0.3184)	1.0116 (0.5317)	0.9099 (0.2626)
More than 1 disorder	Unadjusted	1	0.7393 (0.0009)	1.0987 (0.8123)	0.5935 (<.0001)
	Adjusted	1	0.7853 (0.0105)	1.1251 (0.8462)	0.8712 (0.1198)
Substance plus other disorder	Unadjusted	1	0.8026 (0.1034)	1.1675 (0.7758)	0.3509 (<.0001)
	Adjusted	1	0.8393 (0.1672)	1.2963 (0.8830)	0.6089 (0.0007)

*Adjusted for age and sex to the New Zealand total population (see section 3.3.7). **The RRs are reported relative to Cook Islanders

rates for NMNP before and after adjusting for age and sex differences. Compared with other ethnic groups, Cook Islanders' 12-month prevalence of substance disorders and alcohol were lower than rates for Māori. However, the P_{RR} for these differences were between 0.1 and 0.9.

Cook Islanders and NZ Māori had higher 12-month prevalence of serious disorders than those of other ethnicities. Although the posterior distributions for serious disorders remain clearly separated after adjusting for age and sex, the estimated prevalence of mild and moderate disorders for each ethnic group overlap show a general lack of ethnic differences for these two disorder severity groups.

Table 4.10 shows the 12-month prevalence of any comorbid mental disorder among Cook Islanders compared with other ethnic groups followed the typical pattern of 12-month prevalence rates, Cook Islands=Māori>Other Pacific≈NMNP.

However the twelve-month prevalence rates for dual diagnosis across ethnic groups diverged from that familiar pattern with all Pacific, including other Pacific peoples, and Māori sharing similar levels of disorder. The 12-month rates of dual diagnosis among NMNP were 30% of the same rates for Cook Islanders, a proportion that increased to 60% after adjustment for age and sex. Thus, Cook Islanders, as well as Māori and other Pacific peoples, were three times before adjustment and 67% more likely after adjustment to have a dual (substance plus other) diagnosis ($P_{RR}=0.007$).

After adjusting for age and sex, most differences between Cook Islanders and other Pacific or NMNP remained except for Anxiety, moderate or mild, and multiple disorders.

4.2.3. Covariates of prevalence of any twelve-month disorder

Age at migration

Table 4.11 shows the unadjusted prevalence of any 12-month mental disorder, at the time of interview, estimated for Cook Islanders by a number of covariates. It shows that a prevalence rate among Cook Islanders born in New Zealand was 37.9%. This was 65% higher than those born overseas (mostly in the Cook Islands) who were

older than 12 years when they migrated ($P_{RR} < 0.0001$). For people born overseas, those who migrated at a young age (12 years) were also less likely as New Zealand-born Cook Islanders to have had a 12-month disorder.

Household

Cook Islanders living alone were 13% and 14% higher than people living with another adult or more than one other adult ($PRR < .0001$) respectively. Sole parents with at least one child under 16 years of age had prevalence rates 6% higher than parents in two-parent (couple) families and 10% higher than non-parents ($P_{RR} > .99$). Those who were married were least 12% less likely to have any disorders than others. Conversely, those who were separated or divorced were most likely to have elevated levels of 12-month disorder ($P_{RR} > .99$).

Socio-economic

Around one-third of Cook Islanders without any educational qualification had a 12-month mental disorder. There was little difference between those who had only a school or post-school qualification, and those with no educational qualifications. These combined groups captured those with limited schooling who gained a “post-school” qualification which was most likely to be a low-level trade qualification. In contrast with the other group who gained a school qualification then, it is assumed, went on to tertiary education. The prevalence rates of any 12-month disorders among those with a school and post-school qualification were 15% lower than those with no qualification ($PRR < .0001$).

The prevalence of any 12-month mental disorder among employed Cook Islanders was 17% lower than those who were not employed or in the labour force ($P_{RR} > 0.999$). The results point to a dichotomous split between those who were employed with a lower probability of disorders than those who were not employed, irrespective of whether or not they were part of the workforce.

There was a monotone decrease in prevalence of disorders with increased income. The prevalence among those with the lowest incomes was 25% higher than respondents with the highest incomes. The prevalence of any 12-month disorder among Cook Islanders was lowest among those living in areas of lowest deprivation

(relative wealth). The 12-month rate of disorders for people from areas in other deprivation levels were 12-16% higher than the areas of lowest deprivation but with little difference between them.

Controlling for multiple covariates

In this section a model has been used that includes the joint covariate model described in section 4.1.2. In the analyses of single covariates for age at migration (NZBORN in this model), parental status (SOLE PARENT) and labourforce status (EMPLOYED) a subset of the sample was used. In this model the whole sample has been included but data imputed where they would have been excluded in the single covariate models.

Table 4.11 Unadjusted twelve-month prevalence of any mental disorder among Cook Islanders by covariate with rate ratios.

		Unadjusted	
		% (95% CR)	Relative Risk (P _{RR} [First])
Age at migration	Non migrant/NZ born	37.9 (32.2-44.0)	1.0000
	Young migrant	28.2 (20.3-34.7)	0.6222 (0.0188)
	Older migrant	24.5 (21.5-28.0)	0.6028 (<.0001)
Number of other resident adults	Sole adult	34.8 (30.8-38.9)	1.0000
	1 other adult	30.3 (26.6-34.0)	0.8700 (<.0001)
	2+ other adults	29.9 (26.3-33.5)	0.8586 (<.0001)
Marital status	Married	27.2 (23.5-30.9)	1.0000
	Defacto	32.0 (27.9-36.2)	1.1802 (>.9999)
	Separated or divorced	33.4 (28.3-38.7)	1.2310 (0.9986)
	Widowed	30.2 (26.2-34.3)	1.1152 (0.9804)
	Never married	32.3 (28.6-36.0)	1.1907 (0.9999)
Parents and couples aged under 65 years	Not parent	30.7 (26.9-34.6)	1.0000
	Sole parent	33.9 (29.8-38.2)	1.1049 (0.9890)
	Couple with children	29.0 (25.3-32.9)	0.9454 (0.0501)
Educational qualifications	No qualification	32.3 (28.5-36.0)	1.0000
	School or post school	31.1 (27.5-34.8)	0.9652 (0.1427)
	School plus	27.5 (24.0-31.2)	0.8543 (<.0001)
Labour force	Employed	28.9 (25.4-32.6)	1.0000
	Unemployed	33.8 (28.2-39.5)	1.1700 (0.9830)
	Not in labour force	33.7 (29.9-37.6)	1.1655 (>.9999)
Equivalised Household Income	To half (median-min)	33.9 (30.2-37.6)	1.0000
	To median	30.6 (27.0-34.2)	0.9032 (0.0007)
	To half (max-median)	26.8 (23.2-30.5)	0.7903 (<.0001)
	High income	26.0 (22.4-29.8)	0.7679 (<.0001)
NZDEP2001	Q1 low deprivation	26.9 (23.0-31.1)	1.0000
	Quintile 2	30.0 (25.9-34.1)	1.1144 (0.9753)
	Quintile 3	30.5 (26.6-34.5)	1.1347 (0.9916)
	Quintile 4	30.2 (26.4-34.2)	1.1238 (0.9845)
	Q5 High deprivation	31.3 (27.9-34.9)	1.1660 (0.9976)

The posterior estimated coefficients from each of single covariate models used above to estimate the unadjusted 12-month prevalence of mental disorders have not been used directly as they are adjusted for all the design variables, notably age and sex. It is appropriate to consider them in this instance, as they indicate the direction and magnitude of the effect of a covariate in the presence, or controlled for, the effect of other covariates. All of the models are logistic, and as such, taking the exponential of each coefficient results in a ratio of the odds that a disorder occurs within the covariate group to the odds that a disorder will occur if not in the covariate group. In that case the notation for P_{RR} for a rate ratio is replaced by P_{OR} the posterior probability that the odds ratio is greater than 1, $P(OR>1|data)$.

Table 4.12 shows that for any 12-month mental disorders that those married or in a marriage-type relationship and those in employment were at lower risk of disorder ($P_{OR}<0.1$). Conversely, those with no educational qualifications, those living in a household with no other adults or those with a low equivalised household income, had increased odds of having a disorder ($P_{OR}>.9$).

Marriage-type relationships were associated with lower prevalence for all the disorders. The odds of having a substance disorder among those who were married were half that of those who were not. The odds of a married person with a mood disorder were two thirds that for those who were not married and the odds of severe disorders were of a similar proportion ($P_{RR}<0.001$).

Employment also was associated with decreased odds for all the disorder groups. The odds of having a mood or severe disorder among those who were married were 69% and 57% of that for those who were not employed. The odds of an employed person with a substance disorder, though higher than for other disorder groups, were only 85% of the odds for those who were not employed ($P_{OR}=0.03$).

Conversely, those in households with low incomes had increased odds for all the disorders. The odds of having a substance disorder among those in low income households increased by 38% compared to those who were not. The odds of a mood or serious disorder increased by 18-19% for those in low income households ($P_{OR}>.95$).

The impact of no educational qualifications resulted in a 10% increased odds of severe disorders and 56% increased odds for substance disorders. Those living in single adult households experienced increased odds of mood and serious disorders by 28% and 33% respectively ($P_{OR} > .99$).

The odds of having a serious disorder for those who were born in New Zealand were 88% of the odds for those born elsewhere, while their odds of having a substance disorder increased by 43%.

4.2.4. Ethnic comparisons adjusted for covariates

This section looks at the effect on posterior prevalence estimates after including covariates, individually and jointly, Table 4.13 shows the most obvious feature of these estimates: that, with only the slight exception of age at migration, income and geographic deprivation, adjusting for age and sex removed any differences that exist between Cook Islanders and other Pacific peoples. The latter is true for all comparisons with NMNP.

Table 4.12 Odds ratios among Cook Islanders for covariates by twelve-month disorder adjusted for all covariates.

	Any mental disorder	Mood	Serious	Substance
	OR (P_{OR})	OR (P_{OR})	OR (P_{OR})	OR (P_{OR})
NZ born	1.06 (0.854)	1.07 (0.841)	0.88 (0.058)	1.43 (0.999)
Sole parent	1.01 (0.565)	1.15 (0.953)	0.98 (0.412)	1.00 (0.506)
Sole adult	1.11 (0.947)	1.28 (0.999)	1.33 (0.999)	1.04 (0.640)
Married	0.83 (<.001)	0.66 (<.001)	0.7 (<.001)	0.53 (<.001)
No qualification	1.10 (0.960)	0.96 (0.249)	1.18 (0.983)	1.56 (>.999)
Employed	0.81 (<.001)	0.69 (<.001)	0.57 (<.001)	0.85 (0.034)
Low income	1.25 (>.999)	1.18 (0.995)	1.19 (0.985)	1.38 (>.999)
High deprivation area	0.96 (0.217)	0.99 (0.443)	1.11 (0.91)	0.95 (0.273)

Place of birth and age at migration

An analysis of the impact of migration on 12-month prevalence of any disorder among Pacific peoples as a whole was published in 2009 (Kokaua et al., 2009). Consistent with the method used in that paper, Māori were excluded from the analyses of age at migration. Few Māori were born overseas, especially after Pacific-Māori were included in the Pacific ethnic group. Compared with other ethnic groups, the prevalence of any disorder for other Pacific Islanders was 20% lower than those for Cook Islanders ($P_{RR} < 0.001$), while people of NMNP ethnic groups were a third lower than those of Cook Islanders.

Household

Adjusting for the number of adults per household shows that at the time of interview, the prevalence of any 12-month mental disorders among Cook Islanders

Table 4.13 Twelve-month prevalence and ethnic relative risks of any mental disorder adjusted for each individual and all covariates.

	Cook Islands	Non CI Pacific	Māori	NMNP
	% (95% CR)	RR (P_{RR})	RR (P_{RR})	RR (P_{RR})
Adjusted for each covariate only				
No covariate	31.0 (28.1-33.9)	0.8068 (<.0001)	1.0278 (0.7015)	0.6429 (<.0001)
Age at migration**	32.6 (28.4-36.6)	0.8087 (0.0001)	-	0.6647 (<.0001)
Number of adults	30.5 (27.0-34.0)	0.8413 (0.0028)	0.9292 (0.1206)	0.7306 (<.0001)
Married	30.7 (27.2-34.2)	0.8464 (0.0035)	0.9441 (0.1812)	0.7185 (<.0001)
Parent**	30.7 (27.1-34.5)	0.8602 (0.0108)	0.9694 (0.3203)	0.8268 (0.0024)
Qualification	30.5 (27.1-34.0)	0.8442 (0.0029)	0.9661 (0.2923)	0.7179 (<.0001)
Labour force**	30.8 (27.2-34.5)	0.8528 (0.0065)	0.9767 (0.3598)	0.8232 (0.0020)
Income	30.7 (27.3-34.2)	0.8381 (0.0017)	0.9704 (0.3149)	0.7016 (<.0001)
Deprivation	30.7 (27.3-34.2)	0.8394 (0.0021)	0.9494 (0.2044)	0.7232 (<.0001)
All covariates	31.1 (27.5-34.8)	0.8433 (0.0038)	0.9277 (0.1540)	0.7166 (<.0001)
Adjusted for age and sex				
Age and sex only	23.0 (20.2-25.7)	0.8717 (0.0107)	1.0602 (0.8393)	0.9208 (0.0930)
Age at migration**	23.4 (20.2-26.8)	0.8892 (0.0460)	-	0.9896 (0.4417)
Number of adults	22.3 (19.2-25.6)	0.9182 (0.1207)	0.9534 (0.2673)	1.0598 (0.7828)
Married	22.1 (19.0-25.4)	0.9303 (0.1629)	0.9725 (0.3608)	1.0628 (0.7925)
Parent**	24.2 (20.7-27.9)	0.9372 (0.1946)	0.9945 (0.4724)	1.1011 (0.8924)
Qualification	21.9 (18.8-25.1)	0.9174 (0.1181)	0.9939 (0.4695)	1.0702 (0.8169)
Labour force**	24.4 (20.9-28.0)	0.9249 (0.1431)	0.9915 (0.4566)	1.0898 (0.8727)
Income	21.7 (18.6-24.9)	0.9059 (0.0845)	1.0048 (0.5243)	1.0654 (0.8011)
Deprivation	22.2 (19.0-25.4)	0.9018 (0.0737)	0.9788 (0.3921)	1.0681 (0.8122)
All covariates	22.7 (19.3-26.3)	0.9264 (0.1547)	0.9554 (0.2921)	1.0412 (0.7004)

** Analysis for Place of birth excludes Maori while analyses for Parental and labour-force status excludes those aged 65 and older

living alone was 8-16% higher than that of other families. After adjusting for age and sex of respondent, the probability of any mental disorder among Cook Islanders alone living in households remained higher than for other Cook Islanders. Another separate analysis showed that Cook Islands sole parents had higher prevalence of 12-month mental disorders than parents in two-parent (couple) families or non-parents. The prevalence of any mental disorder among Cook Islands sole parents with young children was high, and low for non-parents. The result reported above for one-adult households would be a combination of both these results. As reported previously in section 4.2.2 couples, with or without children, and families with adult children, reported 12-month prevalence rates that were at least a third lower than those for sole parents.

Cook Islands married couples and widowers had the lowest unadjusted 12-month prevalence of any mental disorder. This was not the case after adjustment for age and sex, at which point there was little difference between Pacific and Māori probability of disorder, but rates among Cook Islanders remained higher than NMNP peoples. However, the difference between the marital groups was removed, unlike the result for the population overall, as reflected in the NMNP rates where rates among married respondents remained about 10% lower than others.

Socio-economic

Compared with other ethnic groups, after accounting for age and sex differences, the probability of any 12-month mental disorder for Cook Islanders was around 10% higher than other Pacific and NMNP peoples at all levels of education. Levels of 12-month disorders amongst Cook Islanders were about the same as Māori (around 4% lower). Even after adjusting for age and sex the prevalence of any disorder among employed Cook Islanders remained 15% lower than those not employed. The prevalence of any disorder among Cook Islanders was around 13% higher than NMNP peoples irrespective of labourforce status. The prevalence of 12-month disorders for Cook Islanders was about the same as those from other Pacific Islands and Māori. Taking account for differences in age and sex, the 12-month prevalence of any mental disorder among Cook Islanders with the lowest incomes dropped slightly to 26.7%. Compared with other ethnic groups, after accounting for age and sex differences, the

probability of Cook Islanders having a 12-month mental disorder was around 8-10% higher than NMNP peoples at all levels of income and about the same as Māori (around 3% lower) and other Pacific (about 7% higher). Compared with other ethnic groups, after accounting for age and sex differences, the probability of Cook Islanders having a 12-month mental disorder was around 12-15% higher than non-Māori/non-Pacific peoples at all levels of education. Cook Islanders were also about the same as Māori (around 3% lower) and other Pacific peoples (about 7% higher). Cook Islands women were 38-42% more likely than men to have a 12-month disorder. Cook Islands women living alone had the highest prevalence of any 12-month disorder, in excess of 31%.

Adjusting for multiple covariates

Including all the covariates into a single model appears to have had little effect on the overall unadjusted prevalence rate for Cook Islanders only. The main affect was on the comparative relative risk for NMNP which was reduced to within 70% of the 12-month prevalence rate of Cook Islanders. Though adjusting for all variables, including age and sex, had a greater affect upon the prevalence rate of Cook Islanders, once again the most dramatic effect was to remove any of the difference between Cook Islanders and NMNP that remained after adjusting for age and sex alone.

Interestingly, the individual effects models for the number of adults, marital status, educational qualifications and income had a marginally greater upon the differences between Cook Islanders and NMNP.

4.2.5. Percentage of ethnic differences explained by covariates

This section introduces the percentage explained by adjusting the prevalence rates for covariates. Equation (1), introduced in section 4.1.2, for the comparisons in Table 4.14 is as follows:

$$\%Explained = (RD_0 - RD_j / RD_0) \times 100$$

Table 4.14 The percent of ethnic difference in twelve-month prevalence of mental disorder between Cook Islanders and NMNP that is explained by covariates.

	Cook Islanders'	NMNP		Other Pacific	
	Baseline Prevalence	RR	% explained*	RR	% explained*
Attributable to age and sex					
Unadjusted (baseline)	31.0	0.6429	-	0.8068	-
Adjusted	23.0	0.9208	83.5	0.8717	50.7
Attributable after adjustment for age and sex					
Adjusted (baseline)	23.0	0.9208	-	0.8717	-
Place of birth**	23.4	0.9896	86.6	0.8892	12.1
Living alone	22.3	1.0598	173.2	0.9182	38.2
Parental status**	22.1	1.0628	176.2	0.9303	47.8
Married	24.2	1.1011	234.3	0.9372	48.5
No qualification	21.9	1.0702	184.4	0.9174	38.7
Labour-force**	24.4	1.0898	220.3	0.9249	37.9
Income	21.7	1.0654	177.9	0.9059	30.8
Deprivation	22.2	1.0681	183.0	0.9018	26.1
All variables	22.7	1.0412	151.3	0.9264	43.4

*The % explained will exceed 100 if the attributable fraction for Cook Islands ethnicity, with the introduction of a covariate to the model, has decreased by more than the baseline attributable fraction.

** Analysis for Place of birth excludes Maori while analyses for Parental and labour-force status excludes those aged 65 and older

A feature of table 4.13 reported earlier is that the individual effects of adjusting for any of the covariates were overwhelmed by the effect of adjusting for age and sex alone. Even the model including all covariates had comparatively minimal effect on the overall adjusted 12-month prevalence of any mental disorder for Cook Islanders.

Table 4.14, shows that 84% and 51% of the attributable fraction from the unadjusted prevalence differences between Cook Islanders and NMNP or Other Pacific, respectively, was explained by age and sex alone. After adjusting for age and sex differences, Place of birth mediate most of the NMNP ethnic risk differences but little of the other ethnic group difference. "Explaining" more than 100% means the adjusted prevalence rate for NMNP has exceeded the rate for Cook Islanders, having adjusted for a covariate. Other covariates other than place of birth all mediate more than the remaining ethnic risk differences between NMNP and Cook Islanders. Other factors mediate between 26% and over 55% of the ethnic risk differences with other Pacific.

Table 4.15 Twelve-month prevalence and relative risk for other ethnic groups by disorder: unadjusted, adjusted for age and sex and adjusted for all covariates.

	Cook Islands	Other Pacific	Māori	NMNP
	% (95% CR)	RR (P _{RR})	RR (P _{RR})	RR (P _{RR})
Unadjusted				
Mood disorder	12.4 (10.8-14.7)	0.6700 (<.0001)	1.0520 (0.7182)	0.6399 (<.0001)
Substance	9.3 (6.9-12.0)	0.5964 (<.0001)	1.0530 (0.6281)	0.3201 (<.0001)
Alcohol	7.8 (5.7-10.3)	0.6271 (0.0007)	1.0351 (0.5807)	0.3079 (<.0001)
Serious	9.4 (8.0-11.2)	0.6960 (<.0001)	1.0955 (0.8540)	0.5112 (<.0001)
Adjusted for age and sex only				
Mood disorder	10.2 (8.8-12.3)	0.7131 (<.0001)	1.1204 (0.8964)	0.7979 (0.0009)
Substance	7.2 (5.2-9.6)	0.6309 (0.0004)	1.1466 (0.7918)	0.4349 (<.0001)
Alcohol	6.2 (4.3-8.5)	0.6630 (0.0032)	1.1133 (0.7259)	0.4045 (<.0001)
Serious	6.5 (5.4-8.0)	0.7345 (<.0001)	1.1460 (0.9337)	0.7957 (0.0034)
Adjusted for all covariates				
Mood disorder	10.0 (8.0-12.5)	0.7292 (0.0012)	1.0196 (0.5633)	0.8037 (0.0229)
Substance	6.7 (4.8-8.9)	0.6939 (0.0045)	1.0993 (0.7201)	0.4732 (<.0001)
Alcohol	5.9 (4.1-8.1)	0.7153 (0.0157)	1.0630 (0.6351)	0.4339 (<.0001)
Serious	7.0 (5.3-9.0)	0.7409 (0.0081)	1.0336 (0.5941)	0.7791 (0.0290)

Table 4.10 revealed that many ethnic differences between Cook Islands and NMNP were explained for most disorder groups by adjusting for differences in age and sex. The exceptions were for mood, alcohol and substance disorders along with the composite disorder groups, dual diagnosis and serious disorders. Table 4.15 shows, for those exceptions, the effect on ethnic comparisons of adjusting for all covariates included in the previous two sections.

These results show that for all four disorder groups, even after adjusting for all covariates, rates among people with NMNP ethnic groups were all lower than Cook Islanders. At the extreme end, rates of substance disorders among NMNP were less than half those for Cook Islanders ($P_{RR}<0.0001$) while rates for mood and serious disorders were 80% of the rates for Cook Islanders ($P_{RR}<0.03$).

Table 4.16 shows that less than 40% of the ethnic differences between Cook Islanders and NMNP in substance disorders and alcohol disorders were explained by adjusting for age and sex alone. Well over half of the differences for mood and 70% of the differences for serious disorders were explained by age and sex. With adjustment for other covariates explained less than 15% of ethnic differences with NMNP for

Table 4.16 The percent of ethnic difference in twelve-month prevalence of mental disorder between Cook Islanders and NMNP that is explained by covariates.

	Cook Islands Prevalence	NMNP		Other Pacific	
	%	RR	%Explained	RR	%Explained
Adjusted for age and sex					
Mood disorder	12.4	0.7979	53.8	0.7131	28.5
Substance	9.3	0.4349	35.7	0.6309	29.2
Alcohol	7.8	0.4045	31.6	0.663	28.2
Serious	9.4	0.7957	71.1	0.7345	39.6
Adjusted for other covariates as well as age and sex					
Mood disorder	12.4	0.8037	4.8	0.7292	7.5
Substance	9.3	0.4732	13.3	0.6939	22.8
Alcohol	7.8	0.4339	9.5	0.7153	19.6
Serious	9.4	0.7791	-16.4	0.7409	-5.1

substance and alcohol disorders, the very little mood and serious disorders changed little.

In comparison with the percentage of differences between Cook Islanders and NMNP explained by covariates, as much as 40% of the differences between rates of disorders among Other Pacific and Cook Islands peoples were explained by age and sex as well as other covariates. The latter had a greater affect upon substance and alcohol disorders in particular. However, only for alcohol disorders were the differences reduces so rate ratio probabilities fell to within the threshold, $P_{RR} > 0.1$.

4.3. Discussion

4.3.1. Background

Te Rau Hinengaro reported that among Pacific peoples in New Zealand, an age distribution for 12-month prevalence of any mental disorder ranged from a high at 16-24 years (29%) and low among people 65 years and older (16.1%). Te Rau Hinengaro also showed that Pacific women had observed higher rates than men, 26.7% and 22.0% respectively. However, there was insufficient data for the difference to be deemed “significant”.

Furthermore, previously published results showed that the prevalence of disorders among “New Zealand-born” Cook Islands people was higher than those who migrated to New Zealand, as was also shown in an analysis of ethnicity, migration and disorder (Kokaua & Wells, 2009). The results suggested that early exposure to New Zealand society may be associated with higher levels of mental disorder. The effect of place of birth on rates of disorder seemed greater than that of ethnicity. Thus, simply being a Cook Islander did not increase the likelihood of having a disorder. Nonetheless, even after adjustment for demographic factors, substance-related disorders, predominantly alcohol, were still high for this population.

4.3.3. Summary of results

One purpose of this thesis is to document the estimated prevalence of mental disorders and resulting patterns of treatment seeking and service used by Cook Islanders living in New Zealand. This chapter documents for the first time an extensive picture of 12-month disorders among Cook Islanders living in New Zealand and some of its determinants. The intent is to report: a) the inherent levels, reported as unadjusted prevalence or crude rates that occurs in the Cook Islands population, and b) comparative levels of 12-month disorders by disorder sub-group and by a selection of possibly related variables.

Nearly one third of Cook Islands adults in New Zealand had a diagnosable 12-month mental disorder. One in five had an anxiety disorder, one in eight a mood disorder, one in eleven a substance disorder and fewer than one in seventy had an eating disorder. Alcohol, a subgroup disorder, affected 85% of those with substance disorders. The 12-month prevalence of serious, multiple and dual diagnosis disorders was 9.4%, 13.4%, and 5.2% respectively. Mental disorders were most prevalent among those aged between 16 and 25 years, then declined to that for 65 years and older to be around 30-40% of the rate of among the younger ages. Substance disorders, particularly alcohol, fell sharply after 25 years to that of 65 years and older around 10% of the rate among the youngest age group. Women had higher rates of disorders than men except for substance and related disorders, alcohol and dual diagnosis.

It has been widely reported that NZ Māori have had an elevated 12-month prevalence of all mental disorders when compared with other groups (comparisons usually were with a composite Pacific group or composite non-Māori and non-Pacific ethnic groups (Baxter et.al., 2006a; Baxter et.al., 2006b; Oakley Browne et al., 2006a). Typically, Māori had highest prevalence and NMNP had lowest with Pacific somewhere between the two, usually closer to the latter than to Māori. Cook Islanders and the composite group of peoples from other Pacific nations together usually comprised the broader “Pacific” ethnic group. Te Rau Hinengaro (Foliaki et al., 2006a) reported that ethnic comparisons for any mental disorder for Cook Islands, Tongan and Samoan peoples showed initial indications that Cook Islanders had a higher 12-month prevalence of disorders than other Pacific groups.

This chapter reiterates the results previously published (Kokaua & Wells, 2009) that also showed Cook Islanders had elevated 12-month rates of mental disorders. A typical pattern was for Cook Islands and New Zealand Māori rates to be similar but higher than rates among other Pacific, and in turn above those for NMNP. The largest difference was usually between Cook Islanders and NMNP. The results show that these differences for most disorders were almost entirely explained by differences in age and sex distributions within each population group.

Excluding age and sex, other factors that explained the elevated risk of any mental disorder among Cook Islanders compared with NMNP were marital status and labour force. In particular, being in a marriage-type relationship or being employed explained over half the difference on their own. Most other factors explained around 20% of the difference. Combined with age and sex, any of the factors apart from age at migration explained nearly, all if not all, of the difference. Adjusting for all covariates explained as much of the difference as any of the individual covariates. And combined with age and sex, after adjustment NMNP were 14% more likely to have any disorder than Cook Islanders.

While all ethnic differences in anxiety were explained by adjusting for age and sex alone, ethnic differences in mood, eating, substance, alcohol and serious disorders

were reduced, but not fully explained, by population, age and sex differences. The differences remained after adjusting for other social and economic covariates.

4.3.4. Conclusions

In short, the findings show that over a 12-month period, a third of Cook Islands adults had any disorder, one in ten a serious disorder and a similar number had a substance disorder. The 12-month prevalence of disorders among Cook Islanders were high compared to other Pacific and NMNP peoples. Many of the differences were explained by age and sex structure of this comparatively younger Cook Islands population. Ethnic differences in mood, eating, substance and serious disorders remained after adjusting for age and sex. After adjustment for other covariates, ethnic differences in mood, eating, substance and serious disorders still remained. Other covariates that stood out after adjustment for both demographic and other socio-economic covariates were the higher levels of disorder for those living in a single adult home and the lower levels among those who were married, and employed.

5 Lifetime prevalence and risk of mental disorder among Cook Islanders in NZMHS

5.0. Abstract	115
5.1. Method	116
5.1.1. Diagnosis of Bayesian model performance	116
5.2. Results	122
5.2.1. Lifetime prevalence of mental disorder among Cook Islanders	122
5.2.2. Ethnic differences.....	125
5.3. Onset of disorder among Cook Islanders	126
5.3.1. Onset of disorder.....	126
5.3.2. Onset of mental disorder by place of birth and sex	128
5.3.3 Ethnic comparisons of onset of disorder.....	129
5.4. Discussion	131
5.4.1. Background.....	131
5.4.2. Method	132
5.4.3. Summary of results.....	132
5.4.4. Conclusions.....	133

5.0. Abstract

Aims and objectives

The objective of this chapter is to describe the lifetime prevalence and the cumulative incidence of mental disorder in New Zealand's Cook Islands resident communities using data from Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS).

Overview

Section 5.2 presents results from analyses of lifetime prevalence of mental disorder produced by hierarchical Bayesian logistic models. Section 5.3 presents results from the analysis of cumulative incidence of mental disorder over the course of a lifetime. Chapter 5 also looks at lifetime prevalence and cumulative incidence of mental disorder broken down by age at migration. Age at migration is one of the few covariates, chosen in Chapter 4, which is not time dependent and as such, changes over the course of a lifetime. Section 5.4 discusses the impact of the results for Cook Islanders living in New Zealand. The diagnostic summary of an assessment of performance of models used in this chapter is reported in section 5.1.

Summary of findings

The findings show that at the time of the survey, half of Cook Islanders in the NZMHS had a disorder at some time in their life. There was an overall higher prevalence of lifetime disorders among Cook Islanders compared with other Pacific and a composite non-Māori, non-Pacific peoples (NMNP). Many, and in some instances all, of the differences are explained by age and sex structure of this comparatively young population. Survival analysis also suggests that half of Cook Islanders could expect to have a diagnosable disorder of some degree by age 50. If someone did not have a diagnosed disorder by the age of 50, there was a five percent chance that an onset of a mood disorder after this age but only little chance that one of the other disorders would occur. For Cook Islanders born in New Zealand at age 50 years the risk of alcohol disorder was twice compared that of migrant Cook Islanders.

5.1. Method

As with Chapter 4, hierarchical Bayes logistic models will be used to produce posterior prevalence estimates and to report comparative rate ratios. As for the estimated 12-month prevalence of mental disorders, these models are set up to produce estimates that address the complex survey design of the NZMHS and its differentiated Part I and Part II disorders. Also, as in Chapter 4, comparisons between the prevalence rates of two groups are drawn using rate ratios (RR) and P_{RR} , the posterior probability that the reported RR is greater than 1.

Chapter 5.2 introduces the use of a Bayes Cox regression model, the methodology of which is described in Chapter 3.5. These models are used to report the cumulative incidence of mental disorder over the course of a lifetime.

5.1.1. Diagnosis of Bayesian model performance

Models for prevalence of disorder adjusted for design attributes alone

The models for lifetime prevalence of disorder perform in much the same way as models for twelve month disorders in Chapter 4. Table 5.1 shows posterior predictive mean and 95% credible regions (95%CRs) for estimates for several lifetime disorder groups observed in the NZMHS. It also reports the observed proportion of

Table 5.1 Predictive diagnostic summary for models of lifetime prevalence of disorders; predictive proportion and observed proportion.

Disorder	MVR	Minimum Geweke	Yrep	Yobs	P(Yrep> Yobs)
			% (95% CR)	%	
Any mental disorder	1.041	0.7247	42.48 (41.64,43.32)	42.46	0.5028
Anxiety	1.018	0.7247	27.22 (26.37,28.07)	27.20	0.5160
Eating	1.001	0.6096	2.01 (1.73,2.30)	1.97	0.5805
Mood	1.046	0.6066	21.36 (20.54,22.18)	21.34	0.5184
Substance	1.030	0.6066	13.74 (13.07,14.42)	13.72	0.5144
Alcohol	1.002	0.9500	12.81 (12.15,13.47)	12.79	0.5180
More than one disorder	1.001	0.8695	22.91 (22.17,23.65)	23.30	0.1964
Dual diagnosis	1.001	0.7428	10.46 (9.85,11.06)	10.97	0.0829

the sample with a lifetime disorder along with the probability that the predicted distribution exceeds the observed mean. Likewise, the last column in table 5.2 shows the same result visually.

The first column of table 5.2 shows the trace plots for the weighted posterior lifetime prevalence estimates by ethnicity. The middle column reports the multivariate R (MVR), a summary of the Gelman-Rubin R as reported in table 5.6 for each model coefficient and ethnic groups estimate for each Part I disorder group reported in this chapter's results section.

All the models, except for the dual diagnosis model, successfully predict the proportion with each lifetime disorder observed in the sample. In spite of this, comparative poor ability for the model to predict lifetime prevalence of dual diagnosis the trace plot and other statistics appear acceptable, though not exceptional.

Table 5.2a Visual diagnostic summary for models of lifetime prevalence by disorders; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.

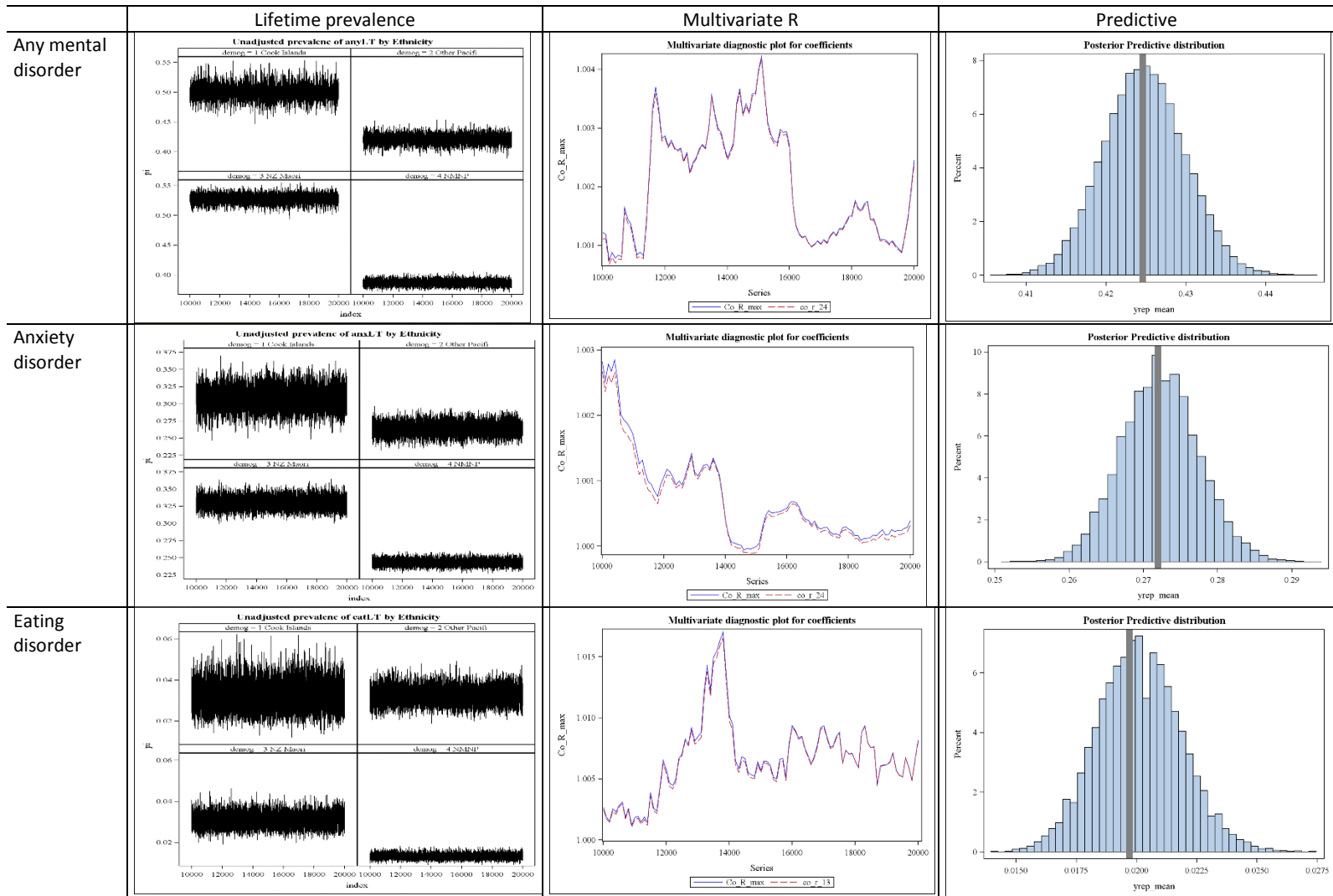
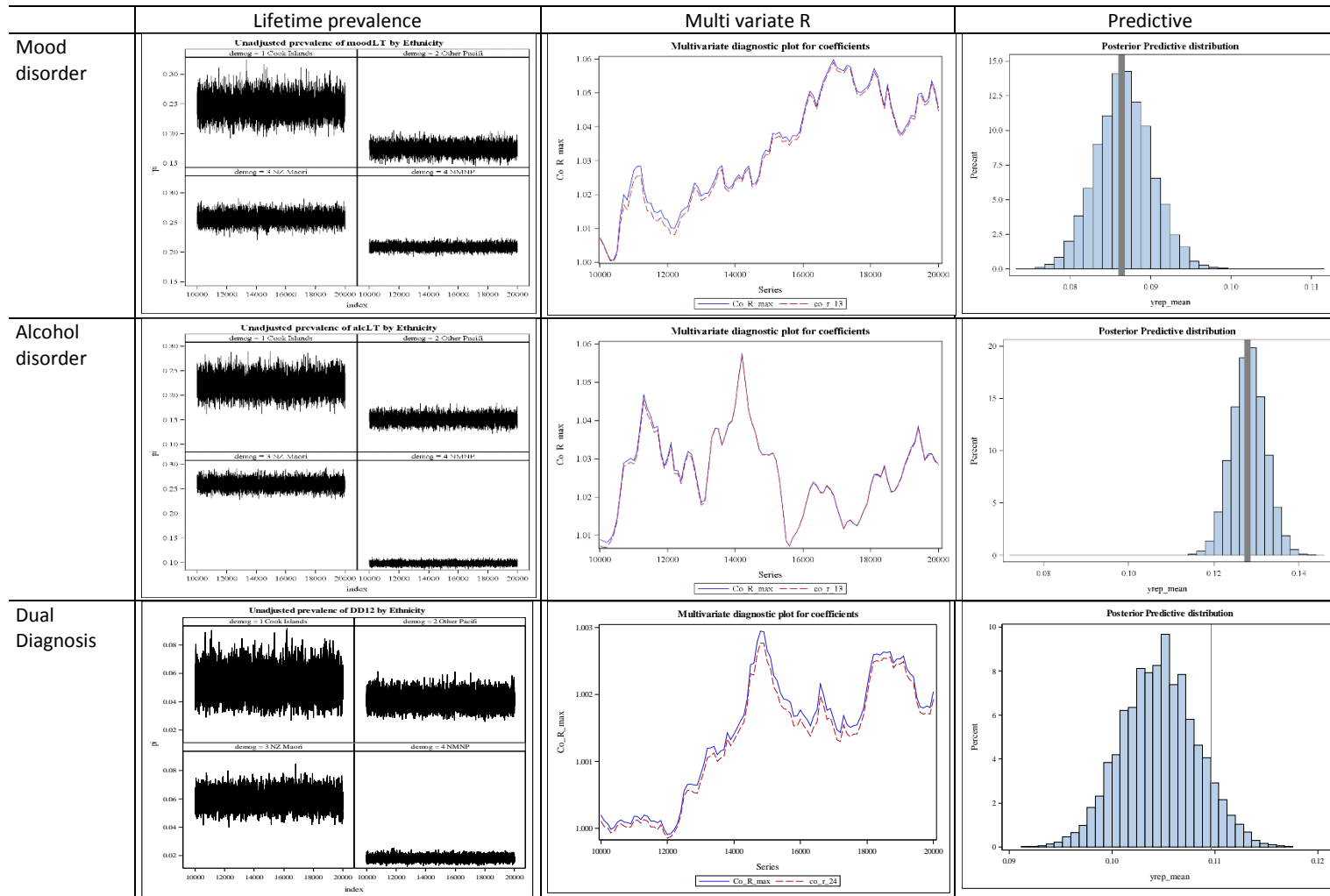


Table 5.2b Visual diagnostic summary for models of lifetime prevalence by disorders; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.



The univariate Gelman-Rubin R was calculated using three separate chains of 20,000 runs along with the Geweke z-score. The Gelman-Rubin R shows that many of the individual coefficients for the mood disorders model exceed 1.02, the threshold for the Gelman-Rubin R. This confirms the multivariate-R finding shown above. Otherwise the Gelman-Rubin and Geweke statistics for the individual coefficients in the models for the other disorders show they have converged reasonably well.

The Geweke score reports the probability that the mean of the first 1,000 runs at the start of the diagnostic sequence of coefficients or estimates is greater than the mean of the last 1,000 runs.

Table 5.2 also shows the trace plots all show the familiar form of a converging series of estimates. The MVR for all disorders all fall close to 1. With the exception of the mood disorders model they all fall below 1.02. The MVR for mood disorders is a bit concerning as it appears to move away from 1 by the end of the run which might suggest a longer run may be required. However, the latter, as for the other models of part I disorders, appear to predict the proportion of disorder very well.

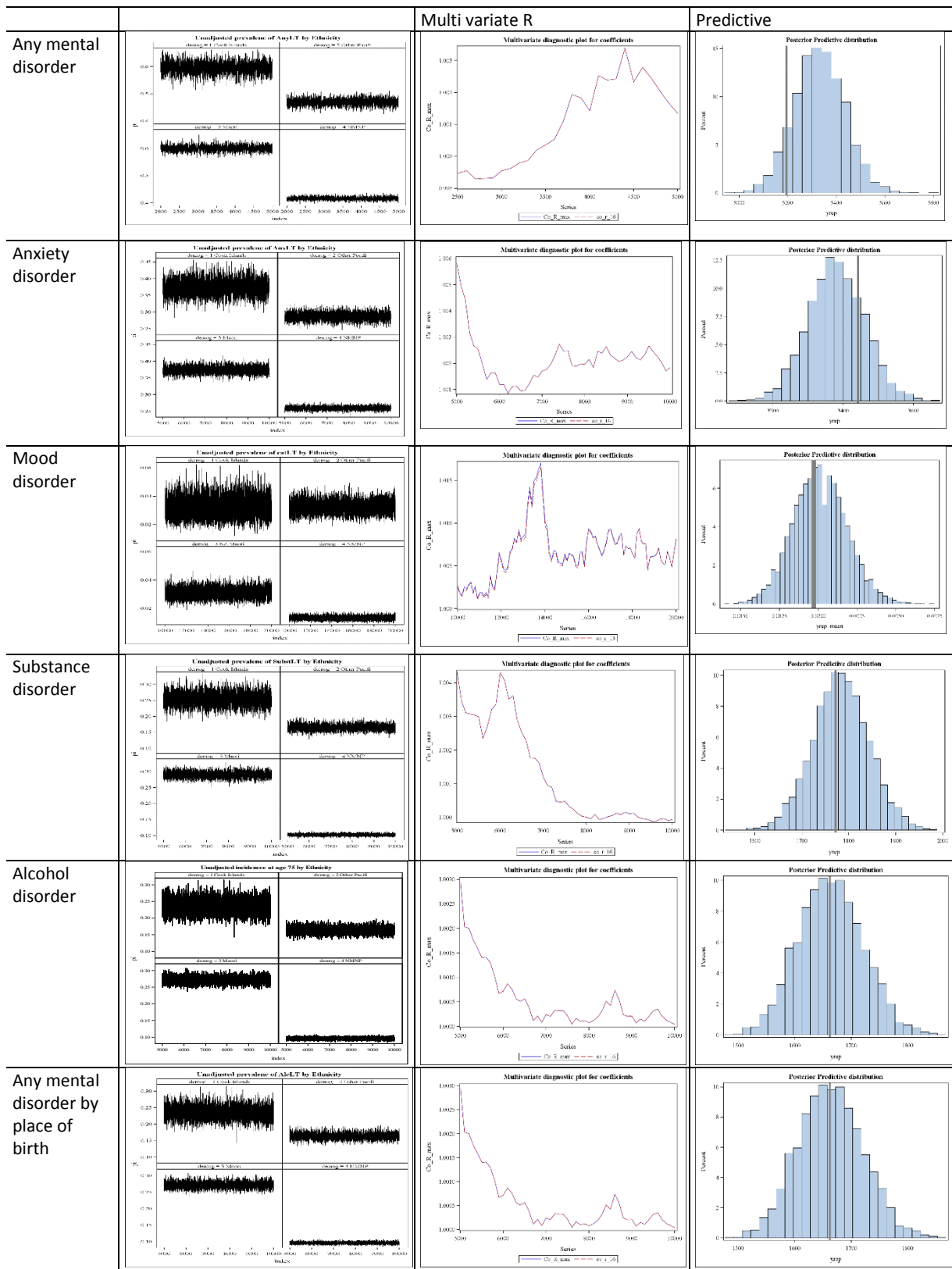
Cox regression models for disorder adjusted for survey design

To evaluate the convergence and predictive ability of the Cox regression models used in this chapter, table 5.3 shows a summary of the MVR, Geweke, and posterior predictive distribution for the number of observed events specified in each model. The ideal outcome for the latter is that the 95% CR for the posterior predicted events should include the actual number of events that are reported by the NZMHS dataset.

Table 5.3 Predictive diagnostic summary for models of lifetime prevalence of disorders; predictive proportion and observed proportion.

Disorder	MVR	Minimum Geweke	Yrep	Yobs	P(Yrep> Yobs)
			% (95% CR)	%	
Any mental disorder	1.0014	0.9120	5330 (5127,5533)	5337	0.52771
Anxiety	1.0018	0.9372	3380 (3227,3535)	3379	0.50567
Mood	0.99946	0.95514	2778 (2634,2927)	2772	0.53292
Substance	1.0006	0.9362	1783 (1663,1903)	1783	0.50044
Alcohol	1.0004	0.9515	1663 (1553,1776)	1662	0.50659

Table 5.4 Visual diagnostic summary for models of lifetime prevalence by disorders; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.



Figures presented in table 5.4 confirm the convergence reported by the statistics shown in table 5.3. Column 1 shows one series of runs that contributes to the Geweke p-value, column 2 presents a series of MVR values while column 3 shows the predictive distribution and observed number of lifetime disorder occurrences. The trace plots of the cumulative incidence at 75 years and MVR and the posterior predictive distributions for the observed number of disorders are also shown in table 5.4, all confirm that the estimates have all converged satisfactorily. In addition to the mean and 95% CR of for the number of events have means that are close to the actual observed number.

5.2. Results

5.2.1. Lifetime prevalence of mental disorder among Cook Islanders

Table 5.5 shows the lifetime prevalence of mental disorder in Cook Islands adults at the time of their inclusion into the NZMHS was 50%. That is, half of Cook Islanders surveyed had experienced a diagnosable disorder at some time in their lifetime when surveyed. Just under two thirds of those with a lifetime disorder had experienced an anxiety disorder, 30% of all Cook Islands adults. A substantial proportion of those with a lifetime disorder (57% of those with a disorder, 29% of all Cook Islanders) had more than one diagnosed disorder at some time in their lifetime when surveyed.

Table 5.5 Lifetime prevalence of mental disorder among Cook Islanders with comparisons to other ethnic groups.

	Unadjusted	Adjusted*
	% (95%CR)	% (95%CR)
Any mental disorder	50.1 (47.9-52.4))	42.3 (40.1-44.4)
Any anxiety	30.9 (27.9-33.9)	26.5 (23.4-29.4))
Any mood disorder	24.7 (21.6-27.9)	23.4 (20.2-26.7)
Any eating disorder	3.2 (2.0-4.6)	2.3 (1.4-3.5)
Any substance disorder	24.4 (20.9-28.1)	23.1 (19.3-27.2)
Any alcohol disorder	22.2 (18.7-25.8)	21.2 (17.5-25.2)
More than 1 disorder	28.5 (25.5-30.6)	22.7 (20.0-24.6)
Substance disorder + another disorder	17.7 (14.7-20.8)	13.8 (11.2-16.6)

**Adjusted for age and sex to the New Zealand total population (see section 3.3.7).*

Half of those with any lifetime disorder, a quarter of all Cook Islands adults, had a mood disorder. A similar proportion of Cook Islanders had a substance disorder. Less than one in six Cook Islanders (18%) were estimated to have a substance disorder along with another mental disorder diagnosis.

Adjusting for age and sex resulted in a reduction in lifetime prevalence of any disorder by around 20%. Eating and multiple disorders were affected by as much as 39% and 25% respectively. Mood and substance disorders, including alcohol, were only slightly lower than the unadjusted rates.

Lifetime disorder by age and sex

Table 5.6 also shows the prevalence of any lifetime disorder among Cook Islanders increased by 22% from the youngest age groups to peak among 25-34 year olds. Age specific prevalence then dropped with age to a low among 65 years and older. This pattern is similar for most other disorder groups

Cook Islands women were only 5% ($P_{RR}=.99$) more likely than men to have any lifetime mental disorder. This comparatively small difference was due to two different groups of disorders with respect to gender differences. Women were at least 50% more likely to have had an anxiety, mood and eating disorder at some time in their life prior to the survey.

Conversely, the lifetime prevalence of substance and alcohol disorders among women was half those of men, or men were twice as likely to have had a substance disorder.

Table 5.6 Prevalence of lifetime disorder among Cook Islanders by age and sex.

	Age						Sex	
	16-19	20-24	25-34	35-44	45-64	65+	Male	Female
	% (95% CR))	RR (P _{RR} [16-24])	RR (P _{RR} [16-24])	RR (P _{RR} [16-24])	RR (P _{RR} [16-24])	RR (P _{RR} [16-24])	% (95% CR)	RR (P _{RR} [Male])
Any mental disorder	47.7 (44.6-50.9)	1.1888 (>.9999)	1.2230 (>.9999)	0.9676 (0.1372)	0.6597 (<.0001)	0.7327 (<.0001)	48.8 (46.3-51.4)	1.0459 (0.9940)
Anxiety	26.6 (23.2-30.0)	1.1530 (0.9988)	1.1343 (0.9970)	1.0587 (0.8898)	0.9370 (0.1038)	0.5838 (<.0001)	20.8 (18.0-23.6)	1.5250 (>.9999)
Mood	23.1 (19.5-27.0)	1.1719 (0.9941)	1.1296 (0.9777)	1.1680 (0.9917)	0.9259 (0.1221)	0.5594 (<.0001)	18.1 (15.2-21.1)	1.5729 (>.9999)
Eating	2.6 (1.5-4.2)	1.3657 (0.9298)	1.1144 (0.7105)	0.8640 (0.2230)	0.4412 (<.0001)	0.2659 (<.0001)	1.3 (0.7-2.0)	2.6111 (>.9999)
Substance	32.1 (26.9-37.6)	0.9701 (0.2815)	0.7686 (<.0001)	0.6758 (<.0001)	0.5002 (<.0001)	0.2772 (<.0001)	31.0 (26.2-36.1)	0.5129 (<.0001)
Alcohol	28.5 (23.5-33.9)	0.9900 (0.4314)	0.7991 (<.0001)	0.7065 (<.0001)	0.5458 (<.0001)	0.3038 (<.0001)	28.8 (24.1-33.9)	0.4900 (<.0001)
More than 1 disorder	26.5 (23.2-29.2)	1.0557 (0.8924)	0.9629 (0.1843)	0.9183 (0.0272)	0.7323 (<.0001)	0.3467 (<.0001)	19.8 (17.2-21.6)	1.2864 (>.9999)
Substance + another	16.0 (13.1-18.9)	1.1420 (0.9817)	1.1787 (0.9953)	1.1546 (0.9855)	0.9680 (0.3195)	0.4381 (<.0001)	11.2 (9.1-13.2)	1.8364 (>.9999)

5.2.2. Ethnic differences

Table 5.7 shows the unadjusted lifetime prevalence of any disorder in Other Pacific peoples and NMNP were 84% and 77% of those for Cook Islanders ($P_{RR} < 0.0001$) while the lifetime prevalence for Māori was 6% higher ($P_{RR} = .99$). This pattern, though similar to the general pattern of ethnic group differences reported for 12-month prevalence of mental disorders in Chapter 4, is more distinct than that shown in the last chapter. The P_{RR} for Maori is now above 0.9 thus the pattern is now Māori > Cook Islanders > Other Pacific \approx NMNP.

This latter pattern is consistent for anxiety and mood disorders, however Māori had in excess of 15% higher levels of substance disorders than others. Another exception was for eating disorders. All Pacific and Māori had similar levels of eating disorder prevalence (around 3% lifetime prevalence) that was over twice the prevalence for NMNP.

The other main difference is the magnitude of differences between Cook Islands and NMNP. Lifetime prevalence of mood disorders for NMNP was 85% of that

Table 5.7 Lifetime prevalence of mental disorder among Cook Islanders with comparisons to other ethnic groups.

		Cook Islands	Other Pacific	Māori	NMNP
			RR (P_{RR})	RR (P_{RR})	RR (P_{RR})
Any Disorder	Unadjusted %	1	0.8409 (<.0001)	1.0545 (0.9906)	0.7725 (<.0001)
	Adjusted* %	1	0.9081 (<.0001)	1.0433 (0.9694)	0.9452 (0.0075)
Anxiety	Unadjusted %	1	0.8539 (0.0021)	1.0712 (0.8927)	0.7879 (<.0001)
	Adjusted* %	1	0.9206 (0.0819)	1.0378 (0.7423)	0.9507 (0.1980)
Mood	Unadjusted %	1	0.7086 (<.0001)	1.0458 (0.7260)	0.8500 (0.0047)
	Adjusted* %	1	0.7232 (<.0001)	1.0485 (0.7372)	0.9046 (0.0816)
Eating	Unadjusted %	1	1.0574 (0.5874)	1.0088 (0.5150)	0.4342 (<.0001)
	Adjusted* %	1	1.1416 (0.6924)	1.1159 (0.6722)	0.6407 (0.0148)
Substance	Unadjusted %	1	0.6426 (<.0001)	1.1617 (0.9544)	0.4395 (<.0001)
	Adjusted* %	1	0.6396 (<.0001)	1.1588 (0.9483)	0.4709 (<.0001)
Alcohol	Unadjusted %	1	0.6859 (<.0001)	1.1792 (0.9590)	0.4476 (<.0001)
	Adjusted* %	1	0.6775 (<.0001)	1.1700 (0.9486)	0.4740 (<.0001)
More than one disorder	Unadjusted %	1	0.8024 (<.0001)	1.1490 (0.9930)	0.6915 (<.0001)
	Adjusted* %	1	0.8541 (0.0008)	1.1467 (0.9889)	0.9113 (0.0371)
Substance plus other disorder	Unadjusted %	1	0.7180 (0.0001)	1.2690 (0.9880)	0.4364 (<.0001)
	Adjusted* %	1	0.7428 (0.0007)	9896)	0.5929 (<.0001)

*Adjusted for age and sex

for Cook Islanders ($P_{RR}=0.005$) while levels of eating and substance disorders among NMNP were 43% to 45% of the rate for Cook Islanders ($P_{RR}<0.0001$).

After adjusting for age and sex, similar to that reported in Chapter 4, the ethnic differences in lifetime prevalence between Cook Islanders and NMNP were reduced to varying degrees. Perhaps not entirely surprising, the ethnic differences between Cook Islanders and Other Pacific or Māori were affected only slightly. Ethnic differences between NMNP and Cook Islanders for anxiety disorders were effectively removed to within 95% of each other ($P_{RR} >.1$).

Table 5.7 also shows while most RR for any disorder on NMNP are usually somewhere close to the RR for Anxiety (>60% of any NMNP disordered) and Mood (54%), most are close to a weighted average of the RRs except for the age and sex adjusted lifetime disorders in table 5.7. This may be a feature that, while Cook Islanders to higher co-morbidity, when converted to prevalence the comorbidity prevalence for NMNP is 54% that for any disorder. The same ratio for Cook Islanders is 46%. Thus, while they have a higher prevalence of comorbidity, it comprises a smaller proportion of those with a disorder than NMNP. It is possible that the HB model has introduced some bias, after age and sex adjustment, in how comorbidity was detected between Cook Island and NMNP influencing the overall RR.

5.3. Onset of disorder among Cook Islanders

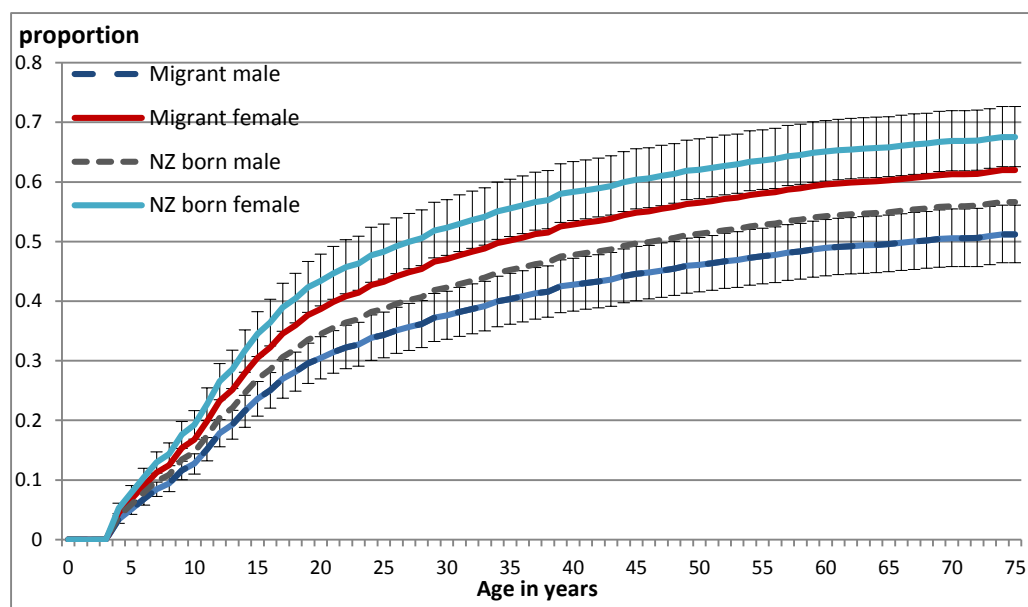
5.3.1. Onset of disorder

Te Rau Hinengaro reported in Chapter 4, the lifetime risk at age 75 and percentiles of risk at selected ages calculated using survival analyses. A similar Bayesian model has been used to calculate the estimated cumulative incidence of disorder at selected ages (lifetime risk) in much the same way, and is reported in figure 5.1.

The prevalence of lifetime disorder reported in the previous section is the estimated probability that disorder is observed at the time of survey. The estimated lifetime risk is the probability that someone had a disorder by a particular age. The method accounts for the fact that younger people surveyed may yet still have a disorder at some time after the survey.

The earliest onset of mental disorder among Cook Islanders before 10 years of age was comprised almost entirely of anxiety disorders (see figure 5.1). During teenage years the onset of substance related disorders start to become evident. Most of the substance disorders among Cook Islanders were alcohol disorders. By 25 years of age the onset of alcohol disorder tapered off as did anxiety disorders to a lesser degree, after which the increased incidence of first time disorders were mood disorders.

By the age of 50 half of Cook Islanders had a diagnosable disorder of some degree at some time in their life. A third had a diagnosable anxiety disorder and a third had experienced a mood disorder. A quarter had a substance related disorder while just under a quarter had an alcohol disorder. From figure 5.1 it can also be seen that beyond 50, if one didn't already have a diagnosed disorder, there was a small, around



*Intervals are shown for the highest and lowest groups

Figure 5.2 Cumulative probability for any mental disorder amongst Cook Islanders by place of birth and sex (vertical bars* represent 95% CRs).

five percent, chance of onset of mood disorder subsequently but little chance of one of the other disorders occurring.

5.3.2. Onset of mental disorder by place of birth and sex

This section reports the lifetime cumulative incidence of mental disorder among Cook Islanders by birthplace and sex. What differentiates the groups in this section is that for most disorders the cumulative incidence for women increased more quickly than for men, and New Zealand-born incidence increased more sharply than migrant. The rate of increased incidence was comparatively similar after 20 years of age.

By 20 years of age, the cumulative incidence for any mental disorder among women was around 26% higher than for men. New Zealand-born Cook Islanders had 13% increased risk compared to those who migrated to New Zealand. By 75 years of age the comparative gender difference, women to men, remained at around 20% higher while the risk associated with birthplace had reduced to less than 10%.

This pattern of comparative risk was similar in most of the disorder groups. The earliest onset of mental disorder among all Cook Islanders was mostly anxiety

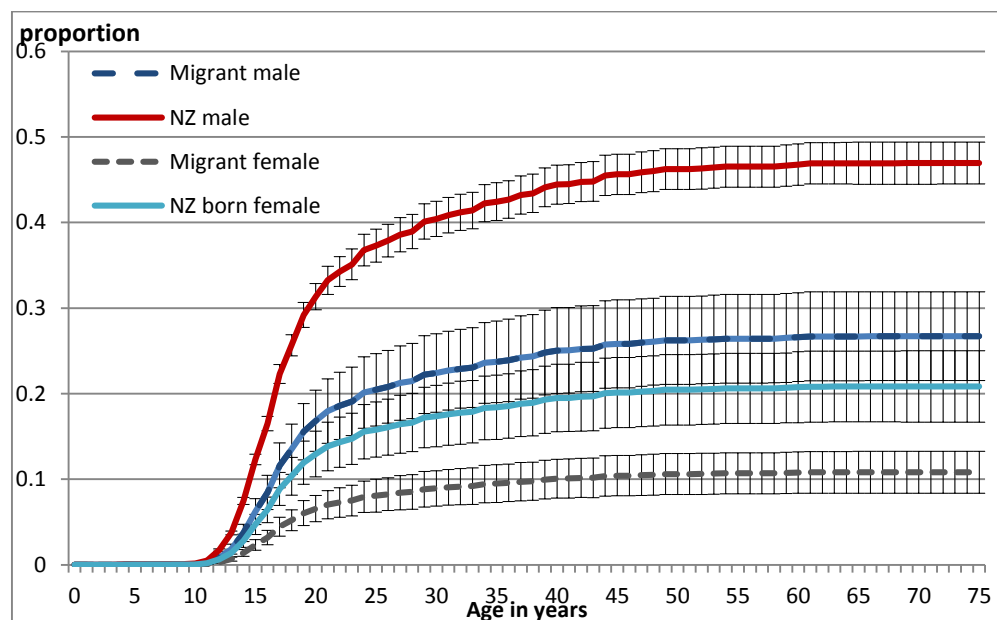


Figure 5.3 Cumulative probability for any alcohol disorder amongst Cook Islanders by place of birth and sex.

disorders and followed a pattern similar to that for any mental disorder combined (data not shown). During teenage years the onset of substance related disorders started to become evident. Most of the substance disorders among Cook Islanders were alcohol disorders.

After 25 years of age the accelerated onset of alcohol disorder tapered off as did anxiety disorders to a lesser degree, after which the greatest contribution to the total increased incidence of first time disorders was from mood disorders.

Cook Islands women had 25% and 50% greater risk than men of having anxiety or a mood disorder respectively. These disorders were the most prevalent of any mental disorders. However Cook Islands men were more than twice as likely to have substance disorders, predominantly alcohol-related disorders.

Even after the gender differences, by the age of 75, New Zealand-born Cook Islanders, male or female, were 40% and 20-25% more likely than migrant Cook Islanders to have had an anxiety or a mood disorder respectively. Though the latter disorders were the most prevalent, the risk of substance use or alcohol disorder for New Zealand-born compared to migrant Cook Islanders was twofold.

The net effect is that by 75 years of age New Zealand-born Cook Islands men were over 4 times more likely than women to have had a substance related disorder or 4 times more likely to have had an alcohol related disorder.

5.3.3 Ethnic comparisons of onset of disorder

For any mental disorder, the general pattern of increase with age was similar for all the ethnic groups. What differentiated them from early on is that Cook Islanders and Māori cumulative incidence increased more quickly than other Pacific peoples who in turn increased more sharply than NMNP. The rate of increased incidence was comparatively similar after 20 years of age.

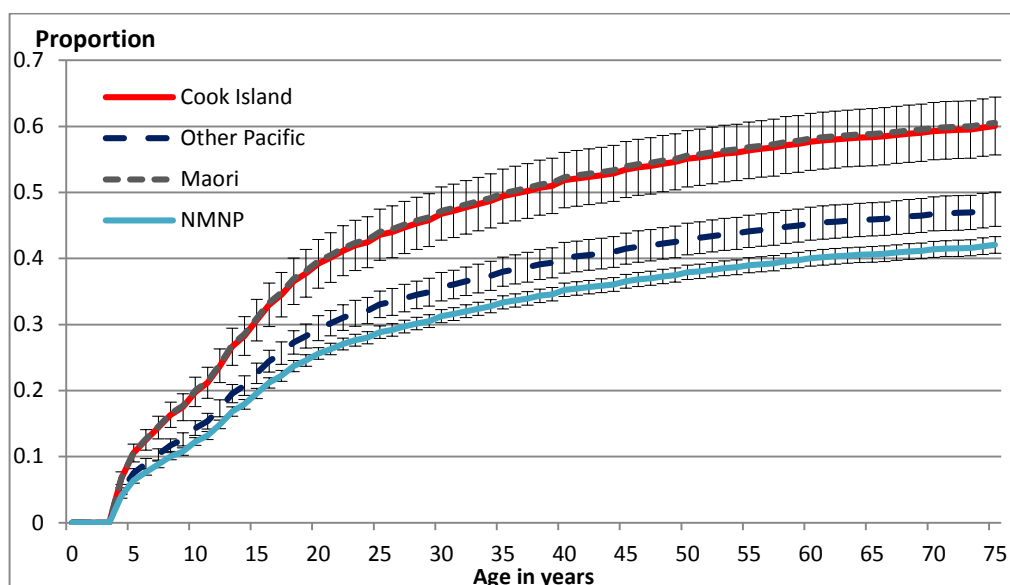


Figure 5.4 Cumulative incidence of any mental disorder by ethnicity and age.

Figure 5.4 shows the cumulative incidence by 20 years of age, for Cook Islanders, was around 8% lower than NZ Māori, more than 32% higher than NMNP and 14% above other Pacific peoples. By 75 years of age the comparative difference with NZ Māori had reduced to within 2% of each other and to 26% higher than NMNP. The relative difference in cumulated incidence between Cook Islanders and people from other Pacific nations remained about the same.

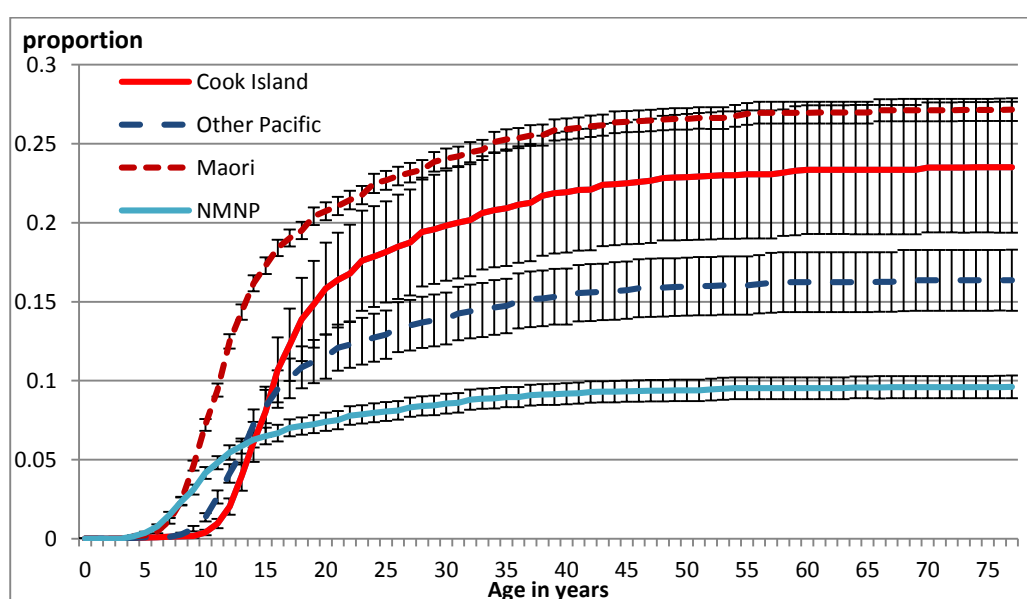


Figure 5.5 Cumulative incidence of alcohol disorder by ethnicity and age.

Comparisons between ethnic groups show that most of the disorder grouped totals followed a relatively similar pattern to that shown in figure 5.1, with the exception of substance disorders and, in particular, alcohol-related disorders (see figure 5.5). The cumulative incidence of substance disorders was highest among NZ Māori followed by Cook Islanders, other Pacific peoples and lowest among NMNP. Figure 5.3 also highlights the delayed onset of alcohol disorders among all Pacific peoples, including Cook Islanders, compared with others. That characteristic is consistent with results for alcohol use by ethnic groups that report onset of alcohol use for Pacific peoples was two to five years behind either Māori or others (Wells et al., 2009).

5.4. Discussion

5.4.1. Background

Very little has been reported on the lifetime prevalence of mental disorder among Cook Islanders or even the use of mental health services by Cook Islanders in New Zealand. Some research (Foliaki et al., 2006b; Kokaua & Wells, 2009) has reported on 12-month prevalence rates of mental disorder and shown that Cook Islanders had rates that were 50% higher than that of New Zealand as a whole. However, none have compared lifetime prevalence of mental disorder across ethnic groups. This chapter has extended the analyses of Te Rau Hinengaro: the New Zealand Mental Health Survey (Foliaki et al., 2006a) and those published in Pacific Health Dialogue 2009 (Kokaua & Wells, 2009) to include lifetime prevalence by disorder group.

Previously published results from this study show the 12-month prevalence of disorder among New Zealand-born Cook Islands people was higher than those who migrated to New Zealand. This is also shown in a recent analysis of ethnicity, migration and disorder (Kokaua & Wells, 2009) which suggested that early exposure to New Zealand society may be associated with higher levels of mental disorder. Though that study was for 12-month prevalence the effect of place of birth seem to carry through to lifetime rates and risk of disorder and still seem greater than that of ethnicity. Thus, the conclusion that simply being a Cook Islander did not increase the likelihood of

having a disorder still holds for any lifetime mental disorder. Nonetheless, even after adjustment for demographic factors, substance related disorder, and in particular alcohol disorder, was still high.

5.4.2. Method

The method applied in Chapter 4 has been used to estimate the lifetime prevalence of mental disorders. The Hierarchical model is adapted in the same way to address the complex survey design of the NZMHS. Each model appears to converge successfully as well as showing good posterior predictive properties.

Estimating lifetime prevalence of mental disorder using a survey tool such as the NZMHS has also been shown to be problematic. Moffitt et al. (2010) reported that problems with respondent recall can lead to substantial under-representation of lifetime prevalence estimates. It is possible to develop a hierarchical Bayes model for lifetime prevalence that includes a hyper-parameter to represent this under-representation. This could conceivably be done by adding a conditioning parameter into the model and using the Moffitt estimates as a prior distribution for that parameter. This has not been done in this study.

A Hierarchical Bayesian Cox regression model has been also included to analyse onset of mental disorder. As for the prevalence models, the number of runs has been chosen to help ensure successful convergence of the model's parameters and also show good posterior predictive properties.

5.4.3. Summary of results

In spite of any concerns raised about the under-reporting of lifetime mental disorder, at the time of the NZMHS a substantial number of Cook Islanders reported some disorder at some time in their life. Half of Cook Islanders reported symptoms which resulted in a diagnosis of a lifetime mental disorder. Women were more likely to have had any mental disorder; in particular they were at least 50% more likely to have had anxiety, eating or mood disorders. They were also half as likely to have had an alcohol disorder.

Compared with other ethnic groups, the pattern for lifetime disorder paralleled that for 12-month prevalence of mental disorders in Chapter 4, where Māori > Cook Islanders > Other Pacific \approx NMNP. Adjustment for age and sex accounted for the differences in anxiety, eating and mood disorders between Cook Islanders and other Pacific or NMNP. Age and sex alone did not explain differences in alcohol and substance disorders.

This section also looked at the cumulated proportion of people that have had a mental disorder for the first time in their life by a given age. It shows an early onset of anxiety disorder and a compressed onset of alcohol disorders among adolescent groups. It also reveals that New Zealand-born Cook Islanders were more likely to have a disorder over the course of their lifetime compared with migrant Cook Islanders. To a lesser extent, Cook Islands women were more likely than men to have any mental disorder over the course of their lifetime. The exception was for alcohol disorders whereby New Zealand-born Cook Islands males had elevated levels after 15 years of age. Compared with other ethnic groups, Cook Islanders had a delayed onset of alcohol disorder but in spite of the delayed onset, by 20 years their risk was twice that for NMNP.

These results show that half of New Zealand-born Cook Islanders at age 50 had a diagnosable disorder of some degree at some time in their life. A third had a diagnosable anxiety disorder and a quarter had experienced a mood disorder. Just under a half had a substance related disorder and a slightly smaller proportion had an alcohol disorder. Beyond 50, if one hadn't already had a diagnosed disorder, there was a five percent chance of onset of mood disorder and little chance of one of the other disorders occurring.

By 50 years of age, Cook Islanders born in New Zealand had twice the risk of alcohol disorder compared to migrant Cook Islanders.

5.4.4. Conclusions

While the prevalence of mental disorders among Pacific peoples has been seriously understated prior to the NZMHS, this chapter has further highlighted that

Cook Islanders have extremely high level of lifetime disorder that had previously gone unrecognized in New Zealand. Most differences are a consequence of the make-up of the Cook Islands population. However, the increased risk of alcohol disorder, particularly among New Zealand-born men, is somewhat dramatic.

Evidence seems to point to low levels of mental disorder for people who have not been raised in New Zealand. There are implications in terms of Cook Islanders and their descendants adapting to contemporary New Zealand society are exhibiting some of its negative consequences of that adjustment without being prepared. Clearly this is only a problem if the Cook Islands society is not over-burdened by increased levels of mental disorder.

6 Treatment for mental health problems among Cook Islanders in NZMHS

6.0 Abstract	135
6.1 Method	136
6.1.1 Diagnosis of Bayesian model performance	137
6.2 Results	140
6.2.1 Twelve-month prevalence of use of services for the treatment of mental health problems by Cook Islanders in the NZMHS	140
6.2.2 Ethnic comparisons of twelve-months service use for any mental health problems in the NZMHS.....	142
6.3 <i>The effect of correlates on ethnic differences in twelve-month service use for those with any mental disorder</i>	143
6.3.1 Treatment in any service settings	143
6.3.2 Treatment in a specialist mental health setting.....	145
6.4. <i>Cumulative incidence of mental disorder, treatment and recovery</i>	146
6.4.1 Time to first treatment or recovery	148
6.4.2 Treatment or recovery by place of birth and gender	149
6.5 Discussion	151
6.5.1 Background.....	151
6.5.2 Method.....	152
6.5.3 Summary of results.....	153
6.5.4 Conclusions.....	154

6.0 Abstract

Aims and objectives

Using data from Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS) (Oakley Browne et al., 2006a), the objectives of this chapter are twofold. First, to describe patterns and determinants of 12-month treatment for mental disorder received by Cook Islanders. Second, to estimate the cumulative incidence of not only treatment for mental health problems, but recovery without treatment over the lifetime of Cook Islanders or since the onset of disorder.

Overview

Chapter 6 is divided into two parts defined by separate methodologies. Sections 6.2 and 6.3 use prevalence models, as used in Chapters 4 and 5. Section 6.2 presents the 12-month prevalence of services seen for mental health problems,

including mental health specialist and general health services among Cook Islanders in New Zealand, with ethnic comparisons. Section 6.3 examines the factors that may be associated with high or low use of services for mental health problems.

Sections 6.4 and 6.5 report the onset of treatment for mental health problems. These sections extend the Cox regression models applied in the previous chapter to report results from survival analyses with competing risks

Summary of findings

Cook Islanders' use of health services, and in particular by those with any mental disorder, was as high as Māori and NMNP. However, their patterns of use were similar to those of NMNP peoples in spite of their prevalence of any mental disorders at levels comparable to Māori. Another finding was for Other Pacific peoples who, in spite of comparatively low risk of disorder, and service use, have the greatest risk of non-treated disorders or recovery over time. While place of birth explained some of the differences between Cook Islands and Other Pacific peoples few of the differences were explained by other socio-economic correlates.

6.1 Method

Hierarchical Bayes Poisson models will be used to produce posterior prevalence estimates of 12-month service use and to report comparative rate ratios. Chapter 6 will also include analyses of cumulative incidence curves similar to those introduced in Chapter 5 which use Bayes Cox regression models, the methodology of which is also described in Chapter 3. The subtle difference between the portrayal of a number of curves overlaid upon each other in the last chapter, for example for each disorder, and the graphs overlaid upon each other in this chapter, allow for competing risks to exist for separate outcome events. In this example the competing risks are for people receiving treatment for a mental health issue versus those who recover without any external intervention.

At this point it seems appropriate to remind the reader that in terms of Bayesian analyses, the prevalence estimates reported in this chapter are an expected prevalence from the posterior probability distribution for each prevalence. The 95%

credible interval is the 2.5th and 97.5th percentile for that posterior distribution. As for previous chapters, comparisons between the prevalence rates of two groups are drawn using rate ratios (RR) and P_{RR} the posterior probability that the reported RR is greater than 1.

Chapter four presents the impact of socio-economic correlates upon the prevalence of 12-month disorder by ethnicity. This section looks at the relationship between those variables with 12-month service use. Many of the correlates used in those analyses were introduced in Te Rau Hinengaro and subsequent publications (Oakley Browne et al., 2006a; Tobias et al., 2009). Similar to the other publications and Chapter 4, these correlates have been grouped into individual factors: age at migration, household and family type variables and educational qualifications; and socio-economic related variables: labourforce participation or employment, equivalised household income and local area deprivation (NZDEP, 2001). All of which are explained in greater detail in Chapter 2. Following the methodology introduced in other papers (Foliaki et al., 2006a; Kokaua et al., 2009) New Zealand Māori have been excluded from the analyses of Age at Migration as nearly all of Māori were born in New Zealand. In addition, a multi-variable regression model has been used to analyse the combined effect of all the variables as in chapter 5 with the further addition of severity. For the multi-variable model, age at migration was modelled separately for Māori as if they had the migration characteristics in the rest of the population

Chapter 6.2 introduces the use of a Bayes Cox regression model, the methodology of which is described in Section 3.5. These models are used to report the cumulative incidence of mental disorder over the course of a lifetime.

6.1.1 Diagnosis of Bayesian model performance

Models for prevalence of service use

Table 6.1 shows the summary diagnostic output for the models of service use by disorder groups. Each model was run with three separate chains, each with a different start point, for 10,000 replications (reps). As with previous chapters, the

Table 6.1 Model diagnostic summaries for 12-month service use by disorder.

Service setting*	MVR	Minimum Geweke	Yrep % (95% CR)	Yobs %	P(Yrep> Yobs)
No Disorder (N=10077)					
ANY	1.0030	0.8463	653 (583,724)	640	0.6382
CAM	1.0054	0.8593	130 (100,163)	115	0.8195
GHS	1.0188	0.5419	590 (524,659)	577	0.6477
MHS	1.0072	0.7007	282 (237,331)	268	0.7232
Any mental disorder (N=2915)					
ANY	1.0140	0.7488	987 (902,1075)	973	0.6238
CAM	1.0340	0.6396	196 (159,236)	184	0.7321
GHS	1.0037	0.4144	924 (842,1008)	916	0.5707
MHS	1.0061	0.5916	461 (403,523)	452	0.6219
Anxiety (N=2101)					
ANY	1.0115	0.8212	716 (644,792)	709	0.5775
CAM	1.0050	0.8796	154 (121,189)	143	0.7335
GHS	1.0540	0.7565	675 (604,747)	667	0.5814
MHS	1.001	0.6096	348 (298,400)	339	0.6287
Mood (N=1122)					
ANY	1.0196	0.6339	528 (466,594)	521	0.5884
CAM	1.041	0.7247	104 (78,134)	94	0.7642
GHS	1.018	0.7247	502 (441,565)	495	0.5886
MHS	1.001	0.6096	253 (211,298)	245	0.6397
Substance (N=514)					
ANY	1.009	0.8231	159 (125,195)	151	0.6722
CAM	1.003	0.931	34 (19,51)	24	0.8855
GHS	1.007	0.8963	151 (118,186)	143	0.6721
MHS	1.004	0.7004	97 (71,125)	88	0.7357
Serious (N=764)					
ANY	1.005	0.6937	401 (347,458)	394	0.5934
CAM	1.009	0.8018	87 (63,113)	77	0.7692
GHS	1.020	0.7601	387 (334,443)	380	0.5956
MHS	1.006	0.7939	231 (191,274)	224	0.6336

*Any service setting (ANY), complementary and alternative medicine (CAM), general health setting including primary (GHS), and mental health specialist services (MHS)

Multivariate Gelman-Rubin R and minimum Geweke are reported in the first two columns. The individual Gelman-Rubin R statistics are a ratio of between-chain to within-chain variation. The multivariate summary is the maximum univariate R statistic. The Geweke summary is the p-value for a t-test between the mean at the start of the analysis run and the mean at the end of the run.

Several models report a maximum R (MVR) that exceeds 1.02 threshold. However, upon further investigation the number of univariate R statistics that exceed that threshold are few. Thus, a decision has been made to retain the output from those models where the trace plots and posterior predictive performance appear to be satisfactory.

The remaining columns in table 6.1 show the posterior predictive distributions for the number of service use events and the probability that posterior predictive estimates (Yrep) was greater than the actual observed number (Yobs). All the models successfully predict the crude number of service events observed in the sample.

The worst performing models were for the smallest group of complementary and alternative medicine (CAM) services. Comparatively few people were seen by these services and the models were the worst in predicting the crude number of CAM service events. At worst, up to 89% of posterior predicted estimates were higher than the actual observed number. However, this is within the 95% credible region for the posterior estimates and as the other statistics performed satisfactorily the model was retained.

Cox regression models for disorder with competing risks

To evaluate the convergence and predictive ability of the Cox regression models used in this chapter, table 6.2 shows a predictive run for the cumulative observed events indicated by equation 10 in Chapter 3 section 3.5.1. The sum of those predicted events should include the actual number of events that are reported by the NZMHS dataset. Convergence is summarised in table 5.3 by the MVR and the minimum Geweke for all the parameters used in the Cox models.

Table 6.2 Diagnostic summary for models of cumulative lifetime incidence of disorder; treatment and recovery from disorder.

Disorder	MVR	Minimum Geweke	Yrep	Yobs	P(Yrep>
			% (95% CR)	%	Yobs)
Any mental disorder	1.0041	0.7247	5330 (5129,5532)	5337	0.5271
Treatment and recovery	1.0002	0.9552	3979 (3821,4173)	3996	0.5023
Any treatment	1.0051	0.9694	2256 (2131,2385)	2256	0.5001

Table 6.2 shows the location of the predictive distribution for the number of events is almost the same as the actual number. The widths of the 95th percentile credible regions for the predicted number are within one to two hundred.

The MVR and Geweke, alongside the trace plots (not shown) confirm that the parameter estimates have all converged satisfactorily.

6.2 Results

6.2.1 Twelve-month prevalence of use of services for the treatment of mental health problems by Cook Islanders in the NZMHS

Table 6.3 shows that in the previous year, just under three out of ten (29.3%) of Cook Islanders diagnosed with any 12-month mental disorder had seen someone in any service setting for their mental health problem. Most of those who sought treatment, 70%, had used a mental health specialist service, including mental health teams, psychiatric services or community mental health services. As reported in Te Rau Hinengaro (Oakley Browne et al., 2006a), 90% of people who used a service for their mental health problem also used a general health services. Table 6.3 shows that 80% of Cook Islanders had used the same services. Just under one in five people were seen in a complementary health setting, including religious or traditional services.

Also previously published in Te Rau Hinengaro for the total New Zealand adult population, Table 6.3 shows a small proportion of Cook Islands adults without any diagnosed disorder (4.3%) had sought treatment for their mental health problems. Compared to those with any mental disorders, fewer had used a mental health specialist service, with just over half of those who sought treatment seen compared with two thirds of those with any mental disorder. Conversely, proportionately more people with no disorder were seen in complementary and alternative medicines (CAM) setting, just under half of those who sought treatment were seen in this service setting.

Table 6.3 Twelve-month service use, among Cook Islanders with a diagnosed disorder, by service type

	Mental health specialist	Any health service	Complimentary services	Any service setting
	% (95% CR)	% (95% CR)	% (95% CR)	% (95% CR)
No disorder	2.5 (1.3-4.1)	3.9 (2.3-5.8)	2.0 (0.9-3.6)	4.3 (2.7-6.4)
Any mental disorder	20.7 (13.8-29.6)	23.2 (16.8-31.2)	5.7 (3.2-9.3)	29.3 (22.0-37.8)
Anxiety	24.5 (15.6-36.7)	29.7 (20.3-41.4)	8.8 (4.7-14.9)	30.9 (21.5-42.4)
Mood	27.0 (17.0-39.8)	29.9 (17.5-46.6)	11.6 (5.9-20.6)	30.3 (19.8-43.4)
Substance	20.8 (11.3-35.8)	26.0 (15.4-41.8)	8.4 (3.0-17.8)	26.0 (15.5-41.1)
Serious	31.5 (19.4-47.1)	33.0 (19.3-51.0)	11.6 (5.4-21.1)	33.3 (21.0-48.9)

Around one in three of the Cook Islands adults who were diagnosed with a mood or serious disorder saw someone for their mental health problem in the previous twelve months. Nearly all of those seen had visited to a health specialist including mental health services and nine out of ten people seen had visited a mental health specialty service. A few, one in nine Cook Islanders, with a mood disorder, and a similar proportion of those with a serious disorder, visited non-health (CAM) services. As a proportion of those seen in total, people with mood or serious disorders were more likely than those with other disorders, but less likely than those with no disorder, to visit a CAM service. Perhaps unsurprisingly, as they are not independent, Cook Islanders with a mood disorder were only slightly less likely to see someone in any setting as someone with a serious disorder. The difference between those with mood disorder and serious disorder visiting a mental health specialist service was negligible. However, people with mood disorders were slightly more likely to be treated in a CAM service than someone with a serious disorder.

Over a quarter of those who were diagnosed with a substance use disorder saw someone for their disorder. Nearly all of these visits included a visit to a health specialist. One in five saw a mental health/alcohol specialty service while just under one in three sought help from a CAM service.

6.2.2 Ethnic comparisons of twelve-months service use for any mental health problems in the NZMHS

Table 6.4 shows the 12-month prevalence of treatment, by service category, for Cook Islanders with no disorder and any mental disorder mental disorder along with comparative rate ratios for other ethnic groups. Compared with people of Māori and NMNP ethnic groups, Cook Islanders reported little difference in levels of treatment seeking for mental health problems even after controlling for age and sex differences. For example for those with no disorder, although the absolute RR's, compared with Maori and NMNP, for any service use are indicate 30% higher use of services overall, the PRR is less than 0.9. The exceptions to the above are that compared to Māori with any mental disorder, Cook Islanders have lower unadjusted

Table 6.4 Twelve month prevalence of service use by service type with ethnic comparisons

Service	Adj*	Cook Islands	Other Pacific	Māori	NMNP
		% (95% CR)	RR(P _{RR} [CI])	RR(P _{RR} [CI])	RR(P _{RR} [CI])
No disorder					
MHS	Unadj	2.5 (1.3-4.1)	0.6214 (0.0361)	1.5154 (0.8616)	1.1205 (0.6401)
	Adj	2.6 (1.3-4.5)	0.6065 (0.0275)	1.4234 (0.8278)	1.0755 (0.5859)
GHS	Unadj	3.9 (2.3-5.8)	0.7138 (0.0619)	1.3057 (0.8355)	1.3001 (0.8435)
	Adj	3.8 (2.2-5.8)	0.7171 (0.0645)	1.3026 (0.8331)	1.3623 (0.8623)
CAM	Unadj	2.0 (0.9-3.6)	0.8229 (0.2936)	0.9738 (0.4719)	0.8381 (0.2955)
	Adj	2.3 (1.0-4.4)	0.7915 (0.2524)	0.8694 (0.3450)	0.7119 (0.1404)
ANY	Unadj	4.3 (2.7-6.4)	0.7650 (0.1028)	1.2919 (0.8413)	1.2876 (0.8485)
	Adj	4.2 (2.5-6.3)	0.7613 (0.0982)	1.2773 (0.8295)	1.3370 (0.8592)
Any mental disorder					
MHS	Unadj	20.7 (13.8-29.6)	0.4824 (<.0001)	0.8898 (0.2435)	0.8614 (0.2002)
	Adj	20.5 (13.5-29.8)	0.4889 (<.0001)	0.9069 (0.2990)	0.8542 (0.1849)
GHS	Unadj	23.2 (16.8-31.2)	0.6024 (0.0001)	1.3588 (0.9660)	1.0590 (0.6425)
	Adj	25.3 (17.7-34.9)	0.6042 (0.0001)	1.2415 (0.8838)	1.0004 (0.5010)
CAM	Unadj	5.7 (3.2-9.3)	0.7057 (0.0737)	0.9727 (0.4563)	1.1459 (0.6849)
	Adj	7.2 (3.8-12.1)	0.7147 (0.0829)	0.7551 (0.1209)	1.0021 (0.5031)
ANY	Unadj	29.3 (22.0-37.8)	0.6258 (0.0001)	1.2198 (0.9197)	0.9990 (0.4970)
	Adj	33.2 (24.5-43.8)	0.6281 (0.0001)	1.0601 (0.6519)	0.9277 (0.2842)

* Unadjusted (unadj) or adjusted (Adj) for age and sex

use of health service (PRR=0.97) that is reduced further after adjusting for age and sex (PRR<0.9) in spite of similar levels of specialist mental health service use.

People of Other Pacific ethnic groups report consistently lower treatment seeking compared with people of Cook Islands ethnicity. Overall, treatment in any setting by people of Other Pacific ethnicity is 76% (PRR=0.98) or 62% (PRR=0.0001) for those with no mental disorder and any mental disorders respectively. Whether people had any mental disorder or not, Other Pacific peoples use of specialist mental health services was lower than that for Cook Islanders. Rates of treatment in a specialist mental health setting by Other Pacific peoples with any mental disorder was less than half of that for all other ethnic groups.

6.3 The effect of correlates on ethnic differences in twelve-month service use for those with any mental disorder

6.3.1 Treatment in any service settings

Table 6.5 reports the prevalence of any 12-month service use among Cook Islanders with any diagnosed disorder alongside comparative rate ratios by ethnicity, adjusted by individual covariates and an overall multi-variable adjustment model. The first thing to be seen from table 6.5 is that ethnic differences still remain between Cook Islanders and other groups after adjusting for other covariates. With the higher service use than Other Pacific peoples, slightly less use than NMNP and less use than Māori.

As one may expect, there is a comparatively small effect of adjusting for age and sex upon the rate ratio between Cook Islands and Other Pacific peoples prevalence of service use by someone with a diagnosed disorder. After adjusting for age and sex, the additional individual effects of each social or economic correlate there is a noticeable mediation of the ethnic group effect between Cook Islands and Other Pacific peoples prevalence of service use. The correlate with the greatest mediation effect on the differences between the two groups is from age at migration. The adjusted rate ratio increased from 63% ($P_{RR}=0.0001$) to 79% ($P_{RR}=0.05$), a 74% reduction in the attributable risk difference after taking into account age and sex.

Similarly, adjustment for most of the factors accounts for around 32-38% of the overall differences between Cook Islands and Other Pacific services use. While age at migration and other covariates were able to mediate the comparative risk between Cook Islanders and other groups, it did was unable to explain all the differences.

Although the unadjusted rate ratio between Cook Islands and NMNP 12-month service use is almost one, adjustment for all but one of the correlates increased the relative ratio in favour of NMNP over Cook Islanders. The largest increase came from age at migration which affected the rate of service use by NMNP to almost twice that of Cook Islanders ($P_{RR}=0.91$). However, while the differences for each of the other correlates were, while greater than one, none had a P_{RR} that exceeded the threshold for risk differences greater than zero.

In much the same way for each of the other ethnic group comparisons, comparative rates for Māori are also higher for Cook Islanders ($P_{RR}=0.92$). However, while the ethnic difference is almost entirely removed by age and sex adjustment, the rate ratios are further inflated by adjusting for other covariates. In particular,

Table 6.5 Prevalence of any 12-month service use adjusted by covariate, by itself and in addition to age and sex, with ethnic group comparisons

Correlate	Adj*	Cook Islands	Other Pacific	Māori**	NMNP
		% (95%CR)	RR (P_{RR} [CI])	RR (PRR[CI])	RR (PRR[CI])
No correlates	Unadj	29.3 (22.0-37.8)	0.6258 (0.0001)	1.2198 (0.9197)	0.9990 (0.4970)
Age and sex	Adj	33.2 (24.5-43.8)	0.6281 (0.0001)	1.0601 (0.6519)	0.9277 (0.2842)
Age at Migration[#]	Adj	19.5 (7.8-38.7)	0.7944 (0.0455)		1.9727 (0.9074)
Household/ Family type	Adj	24.4 (11.9-42.1)	0.7472 (0.0133)	1.8428 (0.8119)	1.3747 (0.7208)
Educational qualifications	Adj	23.6 (15.5-32.4)	0.7627 (0.0193)	1.6370 (0.9314)	1.2732 (0.8072)
Labourforce**	Adj	21.6 (9.3-38.3)	0.7620 (0.0190)	2.4906 (0.8164)	1.5440 (0.7565)
Household income	Adj	23.9 (16.7-32.5)	0.7532 (0.0132)	1.6007 (0.9426)	1.2371 (0.8236)
NZDEP 2001	Adj	24.2 (16.0-34.4)	0.7707 (0.0207)	1.6319 (0.9133)	1.2499 (0.7856)
Smoker	Adj	24.0 (15.4-34.6)	0.7517 (0.0133)	1.6766 (0.8982)	1.2833 (0.7862)

*Unadjusted (Unadj) and adjusted (Adj) for age and sex; [#] analysis excludes Māori; ** analysis excludes those aged 65 and older.

economic related indicators, educational qualifications ($P_{RR}=0.92$), household income ($P_{RR}=0.92$) and area deprivation ($P_{RR}=0.92$). Although the RR for Maori in the adjusted labourforce model increased to greater than two, the P_{RR} remained less than 0.9.

6.3.2 Treatment in a specialist mental health setting

Table 6.6 reports the prevalence of any 12-month use of specialist mental health services by Cook Islanders, with any diagnosed disorder alongside comparative rate ratios by ethnicity adjusted by individual correlates as reported in table 6.5. Like the previous section, differences between Cook Islanders compared with the lower group of Other Pacific peoples have been reduced by adjusting for other factors while the differences between Māori and to a lesser extent NMNP have increased.

However, none of the individual effects were able to explain more than 16% of the ethnic risk difference between Cook Islands and Other Pacific peoples' prevalence of mental health service use by someone with a diagnosed disorder. The covariate with the greatest effect was labourforce engagement, which mediated the

Table 6.6 Prevalence of 12-month mental health specialist service use adjusted by covariate, by itself and in addition to age and sex, with ethnic group comparisons

	Adjusted*	Cook Islands	Other Pacific	Māori	NMNP
		% (95%CR)	RR (P_{RR} [CI])	RR (PRR[CI])	RR (PRR[CI])
No correlates	Unadj	20.7 (13.8-29.6)	0.4824 (<.0001)	0.8898 (0.2435)	0.8614 (0.2002)
Age and sex	Adj	20.5 (13.5-29.8)	0.4889 (<.0001)	0.9069 (0.2990)	0.8542 (0.1849)
Age at Migration[#]	Adj	11.7 (2.9-28.1)	0.5517 (0.0001)		2.0413 (0.7159)
Household/ Family type	Adj	13.9 (5.4-28.8)	0.5637 (0.0003)	1.7948 (0.7331)	1.5182 (0.6245)
Educational qualification	Adj	13.4 (6.9-21.7)	0.5603 (0.0002)	1.4817 (0.7118)	1.2831 (0.6861)
Labourforce^{**}	Adj	11.4 (2.6-26.4)	0.5715 (0.0005)	3.7168 (0.6312)	2.2424 (0.6668)
Household income	Adj	13.2 (4.6-26.3)	0.5386 (0.0001)	1.6735 (0.6829)	1.4298 (0.6320)
NZDEP 2001	Adj	13.8 (8.1-21.6)	0.5549 (0.0002)	1.3672 (0.7850)	1.1872 (0.6802)
Smoker	Adj	13.5 (8.2-20.1)	0.5569 (0.0001)	1.4085 (0.8131)	1.2030 (0.7146)

*Unadjusted (Unadj) and adjusted (Adj) for age and sex; [#] analysis excludes Māori; ^{**} analysis excludes those aged 65 and older.

within Pacific ethnic difference by a modest 16% of the risk difference between the two groups. Note that labourforce is estimated for those aged under 65 years while the baseline, adjusted for age and sex, includes respondents at all ages.

The 12-month service use between Cook Islands compared with Māori or NMNP is low ($RR < 1$), with or without adjustment for age and sex. Further adjustment for each covariate increased the Māori and NMNP rate ratios to as much as almost three times in favour of Māori or NMNP over Cook Islanders. However, in spite of comparative risk increase for Māori and NMNP the P_{RR} remained in each case less than the threshold for observed difference.

6.4. Cumulative incidence of mental disorder, treatment and recovery

The previous section showed that as many as 20% of Cook Islanders with a 12-month mental disorder sought help from a specialist mental health service for their mental health or substance related problem; nearly three out of ten people (29%) sought treatment in any setting; and a small fraction (7%) sought treatment from CAM treatment services including religious leaders, healers or other non-mainstream health aligned practitioners. Though lower than Māori or NMNP, higher proportions of Cook Islanders received treatment than Pacific peoples from other Islands. Those Pacific peoples who were born in New Zealand, Cook Islanders as well as others, were also more likely to have received treatment.

Figure 6.1 shows the onset of any mental disorder overlaid with the cumulative incidence of the combined treatment and recovery from any mental disorder and then treatment alone. This gives rise to the cumulative incidence of recovery stacked upon that of treatment and the cumulative incidence of disorder with neither treatment nor recovery stacked on the two. The figure does not show such complexities as a person who was initially treated for one disorder, or recovered and has subsequently incurred a first treatment for another disorder at a later age. In the latter instance, that person would have been recorded as having received treatment for the episode at the younger age after which recovery is not taken into account.

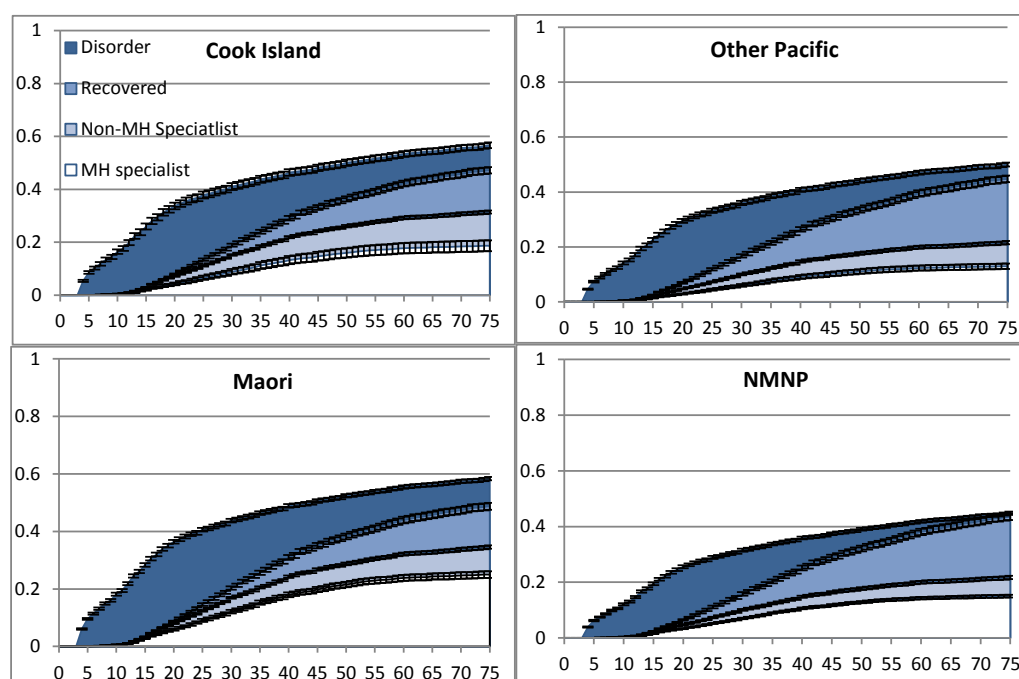


Figure 6.1 Age of onset of any mental disorder, recovery and treatment (any and mental health specialist) by ethnic group

By 50 years of age, the lifetime risk (i.e. the probability of disorder by that age), for Cook Islanders is estimated to be 52.4% (47.7,57.0). Around half had received treatment and an additional one in three had recovered without requiring treatment. A small proportion, 11% of Cook Islanders, at that age still had some level of unresolved disorder that required treatment but had not received any.

An estimated half of onset of any mental disorder among Cook Islanders had occurred by 15 years of age. By 15 years, the cumulative incidence of treatment was only around 3.9% (3.1, 4.8), while the incidence of recovery was too small to estimate¹. Around half of all people treated had seen someone for the first time by 31 years of age. By 30 years of age, the cumulative incidence of mental disorder among Cook Islanders was 43.6%, (39.4, 47.8) treatment was 14.8% (12.0, 17.7) and recovery without treatment 5.7% (2.7, 8.6). The proportion of people still requiring treatment at age 30 was still around 23%.

¹ That is to say the estimate for recovery, taken as the difference between recovery and treatment and treatment alone is zero. However, a non-zero value for recovery may exist in the upper and lower limits of the two cumulative incidence estimates.

By 50 years of age, the lifetime risk of any mental disorder for Māori is estimated to be 53.4% (51.2, 55.6), 42.2 (39.8, 44.7) for Other Pacific and 36.9% (35.7, 38.0) for NMNP. Also by that age, and similar to that shown for Cook Islanders above, over half had received treatment and less than half had recovered without requiring treatment. A small proportion at that age still required treatment but had not received any. This was 8.6% (7.4, 9.7) for NMNP but over 11% for others, as much as 12.6% (10.2, 15.1) of people from Other Pacific nations.

6.4.1 Time to first treatment or recovery

Half of all first treatment contact was within 11 years from the onset of symptoms of any mental disorder. Figure 6.2 shows, that within 15 years from the time of disorder onset, over one in four Cook Islanders, 26.2% (20.6, 31.8), had sought some form of treatment for their mental health problem while another 17.8% (11.3, 24.4) had recovered without any treatment. The remainder comprising over half, (56%) of Cook Islanders with a disorder represent those who still required treatment 15 years after onset. By 45 years, after onset of the disorder among Cook Islanders, the 43.9% (34.1, 53.8) had sought treatment and 30.0% (22.8, 37.2) had recovered

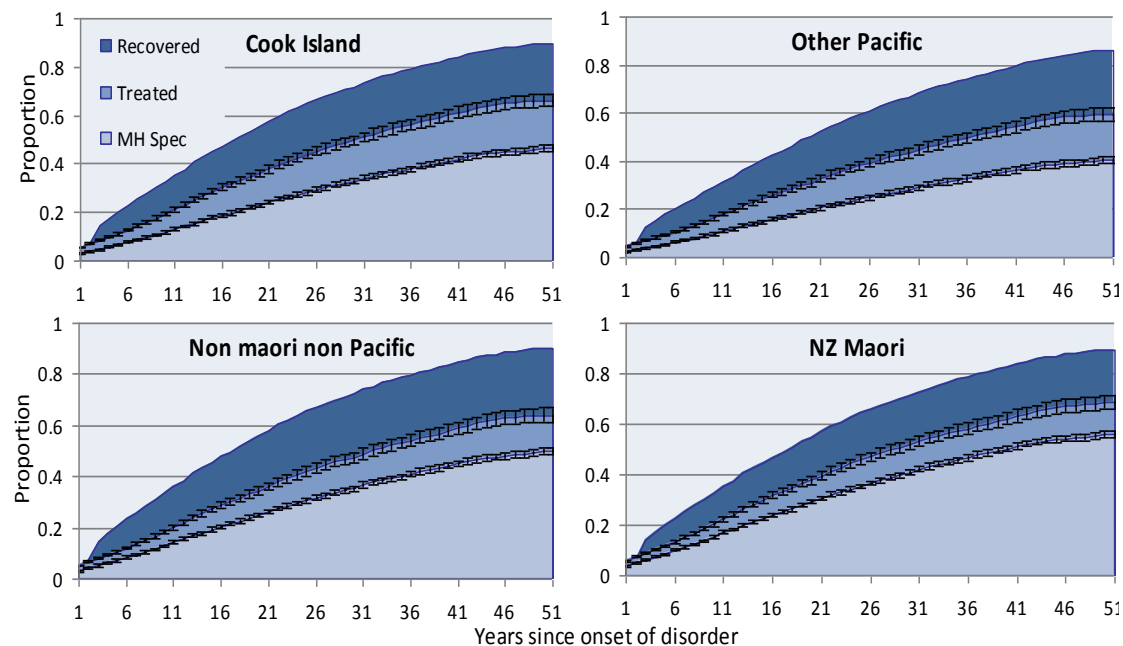


Figure 6.2 Time to treatment and recovery from onset of any mental disorder by ethnic group (N= 4910)

without treatment. The remainder, 26%, of Cook Islanders with a disorder, still required treatment 45 years after the onset of their disorder.

Fifteen years after the onset of any diagnosed disorder, Cook Islanders were slightly less (9%) likely to be treated but more likely (15%) to have recovered than NMNP peoples. Overall, NMNP peoples were just as likely as Cook Islanders to have unresolved disorder after 15 years. For those with disorder whose onset was 15 years prior, Māori had similar levels of disorder, recovery and unresolved disorder as Cook Islanders. People from other parts of the Pacific were 22% less likely to be treated than Cook Islanders, but with similar levels of recovery. As a consequence of less treatment, they were most likely to have residual untreated disorder after 15 years.

After 3 years from the time of onset of disorder, Other Pacific peoples remained 14% less likely than Cook Islanders to be treated, but also proportionately fewer had recovered. Thus, while the proportion of people with untreated disorder reduced, the difference between the two groups increased. By 45 years, NMNP remained more likely to be treated and less likely to have recovered than Cook Islanders, while Māori were only slightly more likely to be treated but 17% more likely to have recovered.

6.4.2 Treatment or recovery by place of birth and gender

Table 6.7 shows that 10 years after onset of any disorder 21% of Cook Island men born in New Zealand and 16% born overseas remained untreated. This compares with 25.5% for New Zealand born women and 19% for other women respectively. After 30 years after the onset of disorder the proportions who had received treatment ranged from a high of 57% for New Zealand born women to a low of 39% for Island born men.

Irrespective of their place of birth, ten years after onset of a mental disorder, Cook Island women were 24% more likely to have received treatment than men. That

Table 6.3 The cumulative proportion at time since onset of any mental disorder by place of birth among Cook Islanders.

Sex	years	MH specialist	Treatment*	Recovery	Untreated
Migrant Cook Islanders					
Female	10	10.6 (7.8,13.5)	19.4 (15.7,23.2)	14.2 (9.8,18.5)	66.4 (62,70.8)
	20	19.8 (14.9,24.7)	34.1 (28.4,39.8)	19.7 (14.1,25.3)	46.2 (40.6,51.8)
	30	28.5 (21.9,35.2)	46.5 (39.6,53.5)	23.2 (17.6,28.8)	30.3 (24.6,35.9)
Male	10	8.5 (6.1,10.9)	15.6 (12.3,18.9)	17.5 (13,22)	66.9 (62.4,71.4)
	20	16.1 (11.9,20.3)	27.9 (22.7,33.2)	25.2 (19.4,31)	46.8 (41,52.6)
	30	23.4 (17.6,29.2)	38.9 (32.2,45.6)	30.3 (24.4,36.1)	30.9 (25,36.7)
New Zealand born					
Female	10	17.2 (12.9,21.5)	25.5 (20.9,30)	13.2 (8.8,17.6)	61.4 (57,65.8)
	20	31.0 (24.1,37.9)	43.3 (36.8,49.7)	16.9 (11.7,22.1)	39.8 (34.6,45.1)
	30	43.1 (34.5,51.7)	57.3 (50,64.6)	18.7 (13.8,23.5)	24.0 (19.2,28.9)
Male	10	13.9 (10.2,17.6)	20.6 (16.5,24.8)	17.5 (12.9,22.1)	61.9 (57.3,66.5)
	20	25.5 (19.4,31.7)	36.0 (29.7,42.2)	23.6 (18.1,29.1)	40.5 (34.9,46)
	30	36.1 (28.1,44.1)	48.8 (41.3,56.3)	26.6 (21.5,31.8)	24.6 (19.5,29.8)

* Treatment services include specialist mental health services

difference is also the same for mental health specialist services. However, women were 19-25% less likely than men to have recovered without treatment. These gender differences changed little over time since onset of disorder. Overall the difference between men and women with untreated disorder was only about 1-2%.

In addition to the gender differences there was also a consistent pattern that arose from the effect of place of birth. Those born in New Zealand were 51-62% more likely to use a mental health specialist service and 23-31% more likely to have sought treatment in any setting than their migrant counterparts. Generally, the proportions who recovered without any treatment increased with time but so too did the difference between Migrant and New Zealand-born Cook Islanders. Initially similar proportions had recovered within 10 years of disorder onset, but by 30 years migrant Cook Islanders were as much as 24% more likely to have recovered without treatment.

Largely due to their low service use, migrant Cook Islanders were also 26% more likely to have untreated disorder 30 years after onset.

As with other disorders, those who were more likely to seek treatment had a smaller gap between treatment and recovery. Men who were not born in New Zealand were most likely to have untreated disorder without recovery.

6.5 Discussion

6.5.1 Background

Published in 2009, Kokaua and Wells (Kokaua & Wells, 2009) reported the general proportions seeking help for their mental health problems with estimates calculated using classical statistical methods in SUDAAN (Research Triangle Institute, 1999). They showed Other Pacific peoples and Cook Islanders had the lowest proportions of people with a 12-month disorder to use any health service for their mental health problem compared to both Māori and NMNP. Even after adjustment for different age and sex structure of each population Other Pacific people remained significantly less likely to have seen anyone for their mental health problem. They specifically reported that 26.4% of Māori, 23.7% of NMNP, 17.2% of Cook Islanders, and 15.6% of Other Pacific peoples had used any mental health specialist service for their mental health problem. This was consistent with earlier findings (Oakley Browne et al., 2006c) that reported low rates of service use among Pacific peoples overall.

Kokaua and Wells summarised that Cook Islands people were more likely than Other Pacific peoples to see someone for their mental health problem but both groups are less likely than NMNP and Māori to visit mental health specialist services.

There has long been a concern that Pacific peoples seem to be over represented in services that deal with extreme levels of mental health care (Gaines et al., 2003; Ministry of Health, 2005). Generally, there has been an impression that Pacific people's use of mental health services, while generally lower than people from other ethnicities, generally required a level of treatment that was longer in duration and more costly. These results seem to confirm that pattern for Cook Islands clients.

Conclusions from Kokaua and Wells (2009) left a note of caution for the Cook Islands population resident in New Zealand as well as those who plan for and work in services that treat people with problems related to mental disorder. They pointed to relative high levels of need, particularly high rates of substance use, alongside low access of specialist mental health services for treatment by those who need it.

6.5.2 Method

Sections 6.2 and 6.3 of this chapter extends the analyses used in the 2009 publication by including fixed effects models and using hierarchical Bayes models. Sections 6.4 and 6.5 added a Bayesian Cox regression analysis of onset and first service use, with competing risks, reporting the cumulative incidence at age to first treatment or subsequent recovery without treatment from disorder.

Each cumulated level, from firstly mental health specialist treatment to treatment in any service setting to aggregated treatment and on-going recovery, were analysed separately and overlaid on age at onset (onset) of any mental disorder. This made the application of the model easier to apply as each level's model is the same as for a Cox model for a single event. Thus, the specification of the independent variable expression has fewer levels to compute. Also, the number of observations was increased by combining treatment and recovery events. As shown in figure 6.1, the cumulative incidence for each individual level is obtained by taking the difference between the cumulated level and the preceding level. To simplify the model the event of a relapse occurring has been ignored.

Second, the same method has been applied to an analysis of the time to treatment and recovery since the onset of disorder. The principle of the application is the same as that described above except the levels exclude an analysis of any mental disorder and the population is restricted to those who had a lifetime disorder.

In the case of time to onset, treatment and recovery from birth we are also interested in probability of onset curves that are:

1. adjusted for complex survey design; and
2. reported for the four ethnic groups of interest

Very few (if any) Bayesian survival analyses have been applied to complex survey data and even fewer to the analysis by ethnic groups

6.5.3 Summary of results

It has been previously reported that Cook Islands people were more likely than Other Pacific peoples to see someone for their mental health problem, but both groups are less likely than NMNP and Māori to visit any service, and specifically mental health specialist services, in any given twelve months. There has also been a long concern that Pacific peoples seem to be over represented in services that deal with extreme levels of mental health care (Gaines et al., 2003; Ministry of Health, 2005). There has been an impression that combined Pacific peoples' use of mental health services in any given year, while generally lower than people from other ethnicities, required a level of treatment that was longer in duration and more costly.

These results seem to confirm that pattern, as combined Pacific overall 12 month use of services for their mental disorder is lower than people from other ethnic groups. However, while this holds true for Cook Islanders for any service use, there appears to be less of a difference between Cook Islanders and NMNP use of mental health specialist services.

Over the course of a lifetime there is a comparatively small group of Cook Islanders who remain without either treatment or recovery from their mental disorder. Section 6.4 showed that prior to 45 years of age there appears to be a considerable group of people that are neither treated nor recovered. In fact only half of people with any mental disorder were treated or recovered within 15-20 years of onset of their disorder. This is true for all ethnic groups.

Very few ethnic differences were explained by any external correlates. This confirmed the results reported in Te Rau Hinengaro (Oakley Browne et al., 2006a) and confirms the demand-driven nature of treatment services as a response to an individual's need, perceived or otherwise. One exception was for the variable age at migration. As it is a variable that is not time dependent, a migration type variable (place of birth) was included in the analyses of section 6.5. Those analyses showed

that within Cook Islanders, migrant New Zealanders were less likely to use treatment services, especially specialist mental health services. Perhaps as a consequence of their under utilisation of treatment services they were both more likely to recover but also more likely to have untreated disorder as time elapsed since the onset of any mental disorder.

The other key result is for Other Pacific, a group with a comparatively low risk of disorder, who have low use of treatment services. However over time they also have the greatest risk of non-treated disorders or recovery. Other Pacific peoples have greater numbers of first generation migrants who, even among Cook Islanders, use services less often. However, overall place of birth only explained a comparatively small fraction of the differences between Cook Islands and Other Pacific service use. Other reasons that may lead to avoiding treatment include: understanding of mental illness; cultural background; knowledge and availability of services or perceived cost; to name a few. The evidence would point to, whatever the reasons, Cook Islanders and Other Pacific peoples appear to only receive treatment when it is extremely severe or under compulsion (Kokaua & Wells, 2009; Ministry of Health, 2005).

6.5.4 Conclusions

These results confirm concerns raised in previous analyses (Kokaua & Wells, 2009) for the Cook Islands population resident in New Zealand as well as by those who plan for and work in services that treat people with problems related to mental disorder. While Cook Islanders use of health services, and in particular for use by those with any mental disorder, is as high as Māori and NMNP their patterns of use are similar to those of NMNP peoples yet their prevalence is comparable to Māori. There other key result is for Other Pacific who, in spite of comparatively low risk of disorder, and service use, have the greatest risk of non-treated disorders or recovery over time.

7 Background to National Mental Health service use data in the MHINC

<i>7.0. Abstract</i>	<i>155</i>
<i>7.1. Introduction to the MHINC</i>	<i>155</i>
<i>7.2. Ethnicity in the MHINC</i>	<i>159</i>
<i>7.3. Discussion</i>	<i>162</i>

7.0. Abstract

The aim of this chapter is to identify a method of establishing the level of mental health service use by Cook Islanders compared with people from other ethnic groups in New Zealand and accounting for missing ethnic group data. Section 7.1 is an overview of the MHINC/PRIMHD data extract provided by the New Zealand Ministry of Health and is used in the analyses of mental health service use. Section 7.2 gives an overview of how ethnicity is recorded in MHINC and subsequently reported in analyses of MHINC data.

7.1. Introduction to the MHINC

This study uses a data extract from the live in-house mental health dataset called the Mental Health Information National Collection (MHINC). This dataset is key to analysing national mental health service use between 2000/01 and 2007/08. Therefore it is essential to understand how it is comprised as well as some of its weaknesses.

The stated purpose of the MHINC as given in the MHINC Data dictionary (New Zealand Health Information Service, 2006) is to form “a national database of information collected by the Ministry of Health to support policy, monitoring and research”. The MHINC data dictionary describes the type of mental health and alcohol and other drug treatment services that report to the MHINC. Specifically, the MHINC does not include mental health services provided by general practitioners in GP clinics and excludes some psycho-geriatric services. The latter are not funded by the

government mental health funding stream in services located in the lower part of the North Island and the South Island and as such are not required to report to the MHINC.

All hospitals and non-government organisations (NGOs) that receive government funding to provide mental health and alcohol and other drug treatment services are contractually obligated to send data to the MHINC. However, in practice, not all NGOs report to the MHINC (New Zealand Health Information Service, 2006).

Table 7.1 shows the number of agencies that reported to the MHINC categorised as DHBs or NGOs and the client numbers seen by each group of agencies in each year. Unsurprisingly, there were 21 DHB-owned agencies that provided services to 99% of all clients seen by all services reporting to the database. Note that clients could and did attend both DHB and NGO agencies. Hence the total number of clients was less than the sum of DHB clients and NGO clients.

Apart from 2000/01, the number of NGO agencies reporting to the MHINC was in excess of 30. This represented less than 10% of NGO agencies contracted to provide mental health services in New Zealand. However, these agencies received 18% (\$45M/\$247M) of funding to NGOs. It cannot be ascertained what proportion of the total number of clients seen by NGOs was represented by those who reported to the MHINC.

Appendix D of the MHINC data dictionary describes the eight tables that comprise the MHINC database. The tables listed in the relationship diagram of Appendix D of the data dictionary are essentially the same as the tables that were extracted for this piece of work, with the omission of supplementary details reported

Table 7.1 Total number of agencies and clients reporting to MHINC 2000/01 to 2005/06.

		2000/01	2001/02	2002/03	2003/04	2004/05	2005/06
TOTAL	agencies	47	53	55	57	56	55
	clients	82084	87930	87931	88428	89772	92249
DHB	agencies	21	21	21	21	21	21
	clients	81079	86810	87442	87741	89187	91406
NGOs	agencies	26	32	34	36	35	34
	clients	1772	2485	2334	3229	3631	4049

by organisations that send inpatient data to the National Minimum dataset via MHINC, and the removal of client system identifier from each table.

For privacy reasons, NZHIS does not receive from service providers any individual names or addresses of individuals in mental health services. It receives only a national health index (NHI) number which is then routinely encrypted for further protection. This encrypted version (encrypted_hcu_id) is used here.

The other substantial difference is that the extract used in this study is not a single database but is made up of a snapshot of MHINC tables for clients seen in each year. Thus, there are eight separate sets of tables, one for each year.

Figure 7.1 shows the fields included in the tables provided for this MHINC extract. As shown in Appendix D of the MHINC data dictionary, the actual MHINC tables are:

Usersyr<year>_suffix – Healthcare user (client) table

Referralsyr<year>_suffix

Serviceyr<year>_suffix – services provided

Accessyr<year>_suffix – access to services

Diagnosisyr<year>_suffix

Legalyr<year>_suffix – legal status

Dischargesyr<year>_suffix

Two additional tables are included in the extract:

Pre-MHINC – identifies users from previous years

Geo – provides more recent definitions for geographic detail. In past years domicile code, a census area unit defined variable, has been used as defined in this table. Subsequent geographic applications for health data use more up to date location specifications. Alongside domicile code this table also includes DHB and NZDEP2001 mappings. The latter is the same variable used in Chapters 4 and 6 to

measure the level socio-economic deprivation for local communities where people reside.

In practice, the information from these tables is almost always incorporated immediately into the respective linked tables. Thus, the “USERS” tables will have a flag indicating a client of mental health services from previous years from the “Pre-MHINC” table. These will only be users of inpatient services and psychiatric hospital clients, as those were the only institutions from which data was collected prior to 2000/2001.

Information taken from the “GEO”; DHB of clients domicile, area NZDEP2001 decile code (Crampton & Davis, 1998) and region, is incorporated into the “ACCESS” table. Finally, as a practical measure the “service_end_date” and “service_setting” fields are taken from the SERVICE tables and attached to the respective link in the ACCESS table. Therefore in further analyses only this appended ACCESS table is used and the SERVICE and GEO tables are disregarded.

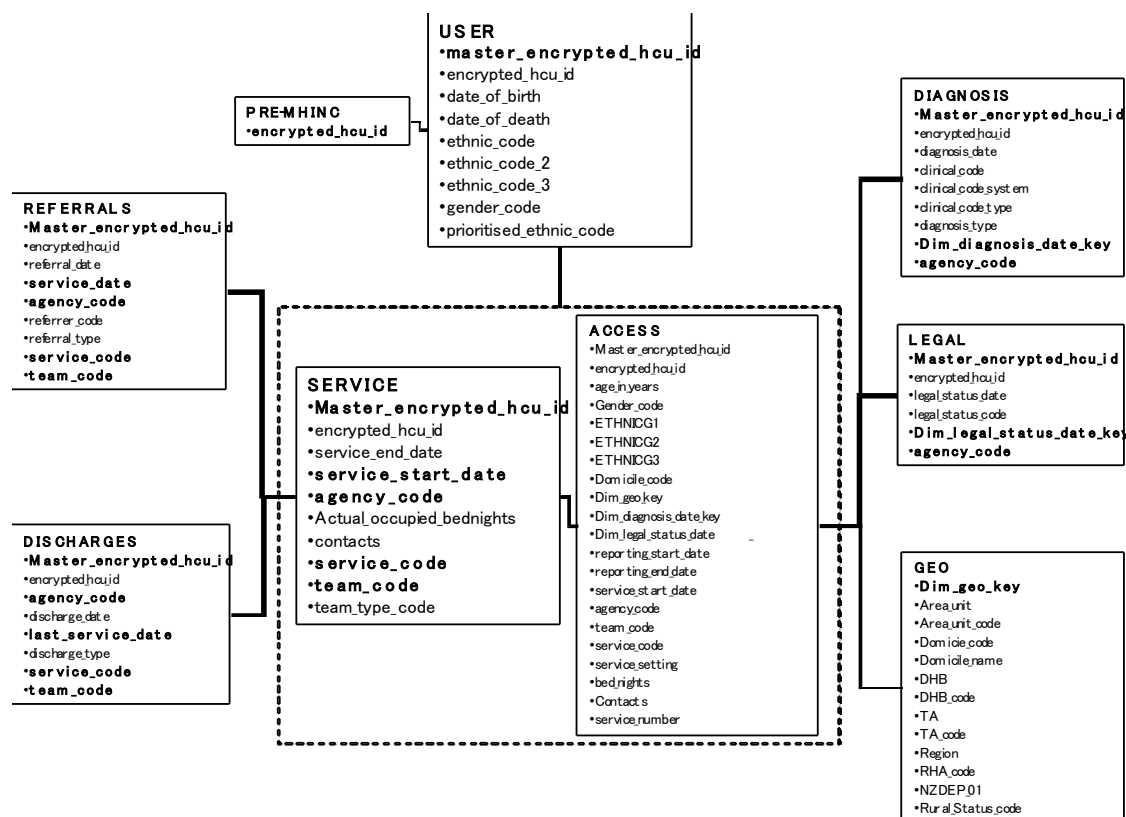


Figure 7.1 MHINC tables extracted annually from 00/01 to 07/08.

In terms of data collection, this dataset is twice removed from the point of actual data collection and represents a series of annual snapshots of the raw MHINC database. The record data is collected and collated by a variety of teams within a variety of agencies contracted to or owned as a subsidiary to District Health Boards (DHBs) in New Zealand. These services are provided through government funding.

7.2. Ethnicity in the MHINC

Historically there has been a large discrepancy in the way ethnicity is gathered and reported to different health administrative databases and the five yearly census counts. The significance of the latter is that it is the primary source of data used for population denominators when calculating prevalence rates of occurrence of many observed health indicators and other key statistics. This difference, usually undercounting of ethnic minorities, has been much reported, especially for Māori whose undercount in official health data was reported as recently as 2006 (Harris et al., 2007). Several commentaries on addressing this undercount in health statistics have led to approaches such as probability linking to census ethnicity and creating adjustment weights (Harris et al., 1997; Ajwaniet al., 2003a; Ajwani et al., 2003b; Curtis, Wright, & Wall, 2005). Since the late 1990s there have been considerable health sector-wide improvements in the general collection. In spite of this data collection, practices still vary considerably around the country in different DHBs.

In the MHINC, ethnicity data, in theory at least, are captured by all services at the point of entry to that service and are reported by all DHBs. That is, on entry to a mental health service a person is asked with which ethnic groups(s) they identify, and up to three different ethnic groups are entered. These are the ethnicity fields that are shown in figure 1 in the ACCESS table. The data collections, in New Zealand's Ministry of Health, allowed for up to three different ethnic groups per person to be reported.

Alternatively, it is reported in the MHINC as part of the NHI descriptors and is shown in figure 1 in the USERS table. This set of data is standard for all data sets used by the Ministry of Health. In this case, upon entry to any health service in New Zealand their demographic details including ethnicity are updated and reported to the NHI

Table 7.2 Client numbers by ethnicity recorded in the Users and Access tables.

Code	2000_01	2001_02	2002_03	2003_04	2004_05	2005_06
All clients	82084	87930	87931	88428	89777	92253
Pacific ethnicity						
ACCESS table	2210	2713	2974	3194	3584	4131
USERS table	2455	2955	3118	3371	3776	4282
Code in either table	2741	3237	3447	3654	4007	4494
Coded in any year	2858	3375	3557	3789	4148	4651
Cook Islands ethnicity						
ACCESS table	459	540	610	666	779	904
USERS table	569	654	701	734	827	949
Coded in either table	652	737	786	816	905	1016
Coded in any year	695	783	823	857	949	1066
Any missing ethnicity						
ACCESS table	4818	4681	4138	3447	4420	4273
USERS table	3199	3294	3003	2777	2902	3005
Code in either table	1510	1569	1438	1268	1850	2189
Coded in any year	1178	1235	1125	1051	1256	1472
Cook Islands missing and unspecified Pacific ethnicity [†]						
ACCESS table	5018	4881	4269	3546	4526	4382
USERS table	3258	3370	3081	2834	2971	3083
Code in either table	1560	1623	1487	1298	1896	2249
Coded in any year	1220	1280	1165	1076	1293	1518

[†] Cook Islands missing also includes those with missing ethnicity and those that indicated general "Pacific" ethnicity without indicating their island ethnic group.

data set. This means that ethnicity in the ACCESS table may differ from year to year but in the USERS table it should be as at the date the data was extracted.

Table 7.2 shows the numbers of clients reporting Pacific and Cook Islands ethnicity in the USERS and ACCESS tables. Although the numbers in each ethnic group reported in the USERS table were consistently higher than those reported in the ACCESS table, the difference was usually less than 10% and was around 3-5% in 2006/07. In addition, the proportion of clients with no known ethnic group was 3-4% in the USERS table and 4-5% in the ACCESS table.

The similar magnitudes in the numbers attributed to each ethnic group has led to the misleading impression that one group, reported in the ACCESS tables, was a subset of the other. However, in their analysis of mortality data, Curtis et al. (2005) used the ethnic groups as collected from the union of both a mortality sourced and NHI sourced ethnicity codes to identify a group which they labelled "ever Māori". This

meant that if, in either set of data, an individual had indicated they were Maori then they would be classed as “ever Māori”.

In a similar approach, clients attributed to each ethnic group in either the USERS or ACCESS tables as well as in past or subsequent years have been collated in table 7.3. It shows that the numbers of Māori and Pacific increased by around 10 to 20% while Cook Islands numbers have increased by as much as 46% in the first two years. These proportions represent the proportion of clients identified as a particular ethnic group in the USERS table that was not identified as that ethnic group in the ACCESS table.

Also of importance was the dramatic reduction, by as much as 50%, in the number of clients who had no ethnicity. Thus the range of proportions of clients with an ethnic group that was effectively missing from year to year is 1.4% to 2.4%. In the past the standard practice for analysis of this dataset would be to place the missing codes with the NMNP ethnic groups.

The extent of missing data is dramatically reduced by using this “combined” ethnic group even within different tables in the MHINC dataset. However, by using this method the distribution of clients with no identified ethnicity does not necessarily disproportionately over-represent Pacific or Cook Islands. Three percent of clients with no reported ethnic group from the ACCESS table are recoded as Pacific and 71% are recoded as non-Pacific. The 26% left over remain with no identified ethnic group. The bulk of the increased Pacific numbers result from the 1% of clients coded as non-Pacific who were coded as Pacific in the USERS table.

Table 7.3 Client numbers by combined ethnicity (either NHI- or access- reported).

Code		2000_01	2001_02	2002_03	2003_04	2004_05	2005_06
Total	Total	82084	87930	87931	88428	89777	92253
Total	Missing	1510	1569	1438	1268	1850	2189
ethnicity	Māori	15471	16863	17194	17371	17448	18274
	Pacific	2741	3237	3447	3654	4007	4494
Within	Missing	1560	1623	1487	1298	1896	2249
Pacific	Cook	652	737	786	816	905	1016
	Islands						

The final step reported in table 7.3 is to recode clients that have previously or subsequently been identified as either Cook Islands or Pacific. This increased the number of Cook Islands and Pacific by 5%-6% and 4%-5%, respectively. Even more dramatic is the 17%-33% decrease in the number of clients with no coded ethnic group.

7.3. Discussion

In any report dealing with the analysis of mental health service use among a specific ethnic group and using MHINC data we will inevitably encounter the issue of missing data. A variable of key interest in this report is ethnicity. As shown above, missing ethnic group codes can be somewhat alleviated by historical tracking but that relies on an assumption that past observed ethnicity has not been reported incorrectly. In the following chapter a model is developed to provide estimates as if there were no missing data.

8 A hierarchical Bayes model for analysing aggregate ethnic group data with missing entries in the MHINC

<i>8.0. Abstract</i>	163
<i>8.1. Background to analyses of missing data</i>	164
8.1.1. Mechanisms for unintentional missing item data	165
<i>8.2. Models for addressing missingness</i>	167
8.2.1. Complete case	167
8.2.2. Imputation	168
8.2.3. Single imputation	171
8.2.4. Multiple imputation	171
<i>8.3. Missing data methods applied to ethnicity in MHINC</i>	173
8.3.1. Simple “imputation” methods.....	173
8.3.2. Multiple imputation method.....	174
8.3.3. Hierarchical Bayes models.....	175
<i>8.4. Comparison of several different models</i>	179
8.4.1. Estimates for η , number of actual clients seen per year	180
8.4.2. Estimates for π , annual proportion of the population who were mental health clients, per 10,000.....	182
8.4.3. Processing times.....	184
<i>8.5. Discussion</i>	185

8.0. Abstract

The objective of this chapter is to identify a method of establishing the level of mental health service use by Cook Islanders compared with people from other ethnic groups in New Zealand, accounting for missing ethnic group data. Section 8.1 reviews the nature and background to missing data and analyzing data with missing values. It covers the various models and approaches to analyzing data with imputed values.

Section 8.2 introduces the models chosen for the comparison but also introduces a hierarchical Bayes model as an alternative to multiple imputation. This model is different from the usual approach of imputed models in that it is applied to aggregate tables as opposed to the record data itself. This is because the denominator population data is only available in grouped form. Thus, the numerator data is also ultimately grouped into at least the smallest level of groups reported for the denominator.

Section 8.3 shows some results for two key parameters and section 8.4 discusses advantages of each model. The hierarchical Bayes model with non-informative priors produced similar results to the multiple imputation models. Both seemed to provide more realistic results than simpler models.

In the face of no further information to introduce, and if the analyst had an entire dataset, then a multiple imputation model is adequate. If the analyst is limited to tabulated data with some “not specified” field or the analyst may have some other expert opinion to include with the observed data, the hierarchical Bayes model introduced in Section 8.3 is able to work in both cases.

8.1. Background to analyses of missing data

The issue of handling missing data has been around for many years and had increased interest since the 1990s with a concerted focus on imputation methods and the introduction of a multiple imputation method by Rubin (Congdon, 2005; Gelman et al, 2004; Rubin, 1987; Rubin & Little, 2002; Schafer, 1999).

There are many ways that missing data in datasets can arise that have been identified in statistical literature. Some of these arise as a result of sampling design or non-response like the examples addressed in the NZMHS chapters. In the case of MHINC, missing data is considered unintentional and arise in two ways (Congdon, 2005; Gelman et al., 2004):

- Unit non-response – complete missing records
 - Incomplete service providers
- Item non-response – non response to certain items
 - Ethnicity and diagnosis
 - Other not responded fields

Both types of missing data are represented in this study. Nearly all of the missing ethnicity data are item non-response in that they represent a non-answer to certain items. Unit non-response arises from individuals records not reported for individuals who used service providers who did not report to MHINC (Congdon, 2005).

Some partial left and right censoring is present. There is an indicator of clients who had previous visits to a mental health service but there is no detail about those visits prior to 2000. There will also be no discharge records for clients who had not been discharged from a clinical service, by the last year of data.

8.1.1. Mechanisms for unintentional missing item data

Notation for missing data models

Given a set of observations:

$$\{\mathbf{Z}_{\text{missing}}, \mathbf{Z}_{\text{observed}}\} = \{(\mathbf{Y}_{\text{missing}}, \mathbf{X}_{\text{missing}}), (\mathbf{Y}_{\text{observed}}, \mathbf{X}_{\text{observed}})\};$$

an inclusion indicator, \mathbf{R} , representing the response mechanism and is denoted by:

$$\mathbf{R} = \begin{cases} 1, \mathbf{Z}_{\text{missing}} \\ 0, \mathbf{Z}_{\text{observed}} \end{cases}$$

Where \mathbf{Z} is the set of variables in a dataset and \mathbf{Y} is the variable of interest (dependent variable) while \mathbf{X} is the set of correlates.

Let the joint distribution of the data and response indicators be given by:

$$p(\mathbf{R}, \mathbf{Z} | \phi, \theta) = p(\mathbf{R} | \mathbf{Z}, \phi) p(\mathbf{Z} | \theta), \quad (8.1)$$

where ϕ and θ are the parameters for response mechanism and observed data, respectively. Furthermore, assume the data and response mechanism depend upon separate parameters, ϕ and θ , that are apriori independent so that $p(\phi, \theta) = p(\phi)p(\theta)$.

Three main classifications for the type of “missingness” in data have been defined by the base assumption about the way the missing data has been determined (Little & Rubin, 1987). Firstly, if probability of response does not depend on the observed or missing data, i.e. $p(\mathbf{R} | \mathbf{Z}, \phi) = p(\mathbf{R} | \phi)$ the response mechanism is said to be missing completely at random (**MCAR**). That is to say, if there is no apparent pattern in the missing values in the data to the extent that it cannot be informed in any way by other variables in the dataset. This assumption must hold for any analyses

to use complete cases only where missing data is ignored, since it is assumed that the missing data holds no information content of value to the analysis or biases.

Secondly, if the response mechanism depends on the observed data but not the missing data, i.e. $p(\mathbf{R}|\mathbf{Z}, \phi) = p(\mathbf{R}|\mathbf{Z}_{observed}, \phi)$ the response mechanism is said to be missing at random (**MAR**). In this case, there is a pattern in the missing values in the data that can be informed only by observed variables in the dataset.

Finally, if the response mechanism does depend on the missing data, i.e. $p(\mathbf{R}|\mathbf{Z}, \phi) \neq p(\mathbf{R}|\mathbf{Z}_{observed}, \phi)$ the response mechanism is said to be missing not at random (**MNAR**).

Principally, the parameters of interest in this thesis are those of the data model, θ . An expression for the posterior probability of θ can be found by integrating the joint probability distribution for θ and ϕ given the data that has been observed, \mathbf{R} and $\mathbf{Z}_{observed}$, over the latter. This posterior distribution can be written as:

$$\begin{aligned} p(\theta|\mathbf{R}, \mathbf{Z}_{observed}) &= \int p(\theta, \phi|\mathbf{R}, \mathbf{Z}_{observed})d\phi \\ &\propto \int p(\mathbf{R}, \mathbf{Z}_{observed}|\theta, \phi)p(\theta, \phi)d\phi \\ &= \iint p(\mathbf{R}, \mathbf{Z}|\theta, \phi)p(\theta, \phi)d\mathbf{Z}_{missing}d\phi \\ &= \iint p(\mathbf{R}, |\mathbf{Z}, \phi)p(\mathbf{Z}|\theta)p(\theta)p(\phi)d\mathbf{Z}_{missing}d\phi \end{aligned}$$

Under the assumption that the response mechanism is MCAR the posterior reduces to:

$$p(\theta|\mathbf{R}, \mathbf{Z}_{observed}) \propto \int p(\mathbf{R}, |\phi)p(\phi)d\phi \int p(\mathbf{Z}|\theta)p(\theta)d\mathbf{Z}_{missing}$$

Under MAR the posterior reduces to:

$$p(\theta|\mathbf{R}, \mathbf{Z}_{observed}) \propto \int p(\mathbf{R}, |\mathbf{Z}_{observed}, \phi)p(\phi)d\phi \int p(\mathbf{Z}|\theta)p(\theta)d\mathbf{Z}_{missing}$$

In both cases the first integral reduces to a constant term for MCAR and factor that is dependent upon $\mathbf{Z}_{observed}$ for MAR. Since the second integral is on the missing

portion of \mathbf{Z} it reduces to $p(\mathbf{Z}_{observed}|\theta)p(\theta)$. Thus both expressions reduce further to:

$$\begin{aligned} p(\theta|\mathbf{R}, \mathbf{Z}_{observed}) &\propto p(\mathbf{Z}_{observed}|\theta)p(\theta) \\ &\propto p(\theta|\mathbf{Z}_{observed}) \end{aligned}$$

Thus, under MCAR or MAR, inference can follow directly from the observed data without the need to explicitly model the response mechanism (beyond the MAR imputation). The response mechanism is therefore ignorable.

However when the response mechanism is MNAR, the posterior for θ is not proportional to the posterior given just the observed data and the response mechanism must be explicitly modelled, i.e. it is non-ignorable. The posterior must therefore be expressed as:

$$p(\theta|\mathbf{R}, \mathbf{Z}_{observed}) \propto \iint p(\mathbf{R}, \mathbf{Z}, \phi)p(\mathbf{Z}|\theta)p(\theta)p(\phi)d\mathbf{Z}_{missing}d\phi$$

A full expression for $p(\mathbf{R}, \mathbf{Z}_{missing}, \mathbf{Z}_{observed}, \phi)$ must be stated.

8.2. Models for addressing missingness

8.2.1. Complete case

In this case, the missing data can be assumed to be dispersed randomly across the outcomes of the missing field. Under MCAR assumptions, it is reasonable to employ a complete case-only method of analysis. As the name suggests, any records with missing data fields are discarded and parameters are calculated using complete records only. This method is only valid if there is no predictable pattern in the missing data. Otherwise some bias is introduced.

However, in the case of the population database the complete case method only serves to understate the incidence of a given event. Alternatively, under MCAR assumptions, one can simply randomly assign a value/category, from the observed distribution for that variable to the missing item.

8.2.2. Imputation

The concern with having missing data is that the methods of analysing datasets with missing data, except in the case of only analysing complete cases, can be excessively complicated. In addition, there may be a loss of information value contained in those missing data. Finally, some bias may be introduced due to differences in observed and missing data.

Imputation is a reasonably applicable approach to analysing datasets with missing data. Many analysts have been attracted to this method that has a rather simple strategy of:

replacing the missing fields with plausible “estimates”; and

analysing the data as if it were a complete set.

Thus the analyst is able to proceed with their analysis using the tools designed for analyses of complete data.

While much has been published about the use of imputation or more frequently multiple imputation for analyses that have some missing data, most involve sample survey datasets (Harel & Zhou, 2007; Horton & Lipsitz, 2001). Relatively few have involved large population datasets (Zhou, Eckert, & Tierney, 2001; Park & Lee, 1999; Schenker, Treiman, & Weidman, 1993). Nearly all follow the process prescribed by Rubin (1993b) or Little and Rubin (1987).

Imputation models for missing data are grouped into two general classifications; “selection” or “pattern mixture” (Little, 1993a). The two groups differ according to the models specification of the joint probability for the data and response mechanism. As stated above in equation 8.1 the joint distribution is composed of a conditional likelihood and a marginal prior distribution. Selection models require estimating a conditional distribution for \mathbf{R} given the data \mathbf{Z} , as stated in equation 8.1:

$$p(\mathbf{R}, \mathbf{Z} | \phi, \theta) = p(\mathbf{R} | \mathbf{Z}, \phi) p(\mathbf{Z} | \theta),$$

Pattern mixture models require establishing a pattern within the data, \mathbf{Z} , given the missing data \mathbf{R} . The expression for these models require rearranging equation 8.1 into a likelihood for \mathbf{Z} , given \mathbf{R} , and a likelihood for \mathbf{R} , thus:

$$p(\mathbf{R}, \mathbf{Z} | \phi, \theta) = p(\mathbf{Z} | \mathbf{R}, \pi) p(\mathbf{R} | \tau),$$

Under MCAR, where \mathbf{R} is independent of \mathbf{Z} , by letting $\pi = \theta$ and $\tau = \phi$ the two methods are equivalent. Assuming firstly that the data is MAR, this method simplifies patterns of missingness within distinct groups (Little, 1993a). Then the method employs a model to estimate the missing values within each group. The appeal of this method is threefold in that it uses existing software commands, is flexible and uses assumptions that are clearly stated.

“Naïve” methods of imputation

Although ease of analysis is the main appeal of imputation, Rubin (1987) issued a caveat around using many “naïve” or simple approaches to creating missing data estimates as they tend to underestimate the variances of the resulting parameters. A major concern is that naïve models, although apparently simple, can rely upon a number of hidden unstated assumptions. A good model is said to be one where the assumptions are as clearly stated as possible.

Cases assigned to the largest group

As the name suggests, missing values take on the value of the most common group. It is applied to categorical variables and is the most common method applied to ethnic group analyses in New Zealand government analyses. This method has little impact on the largest group but can have a greater impact on the smaller groups in the analyses.

Last value carried forward

Applies to situations where missing values take on the most recent observed values by the same individual. It is applied to sample designs that contain repeated measure techniques and most often has been applied to analyses of longitudinal data where individuals that have dropped out. In many samples, cases can assume an

unrealistic pattern in the data as this method forces the missing values to take on previously observed values.

The “Ever Māori” or “Ever Pacific”, as exemplified in section 7.2, is an example of this approach that has an intuitive appeal, since ethnicity is a field in MHINC that is often “mis-” or “non-” reported over time. As such, subsequent and previous observations in this field are replaced if at some time an event has been reported, in this case an ethnic group has been indicated.

This method has the potential to overstate the ethnic groups that have been identified, especially with respect to the New Zealand census of population and dwellings. The latter, although recognised as having greater accuracy with ethnic group reported, does not report inter-censal “Ever Māori” or “Ever Pacific” estimates.

Mean imputation

Here, missing values are imputed/replaced with the overall mean for the observed values. Since replaced data is equal to the mean, this method, while maintaining the overall average, constrains the mean to that observed, and overstates the precision of parameter estimates as all missing values are assigned the same value, hence reducing the variance and ignoring the uncertainty in the imputation.

“Other” methods of imputation

Hot/Cold deck imputation

These are methods where missing values are replaced by observed values from selected records from another data source (cold) or selected observed values made by other individuals with similar covariates in the same data source (hot). Two main ways of identifying sources for replacement data are to randomly select observations from a pool of respondents or choose a response from an identified nearest neighbor. The latter deterministic, nearest neighbor, method uses a metric to determine the distance between the non-respondent and other respondents (Andridge & Little, 2010).

The main concern raised about this method is that it distorts correlations. The nearest neighbour, in particular, would increase the correlations within groups with similar covariates (Rubin, 1987).

Regression imputation

This is a method where missing values are predicted using an appropriate multiple regression method. This method understates marginal variance and overstates correlations with covariates (Rubin, 1987).

8.2.3. Single imputation

Imputation is an easy to apply method of replacing the missing fields with plausible “estimates”. An analyst is then able to proceed with their analysis using the tools designed for the analyses of complete data.

Schafer (1999) stated that for datasets with fewer than 5% missing values, a single imputation might be appropriate without any need for corrective method. This is the case for missing ethnicity data in MHINC. However, diagnosis has many more missing items. In the latter case a single imputation is less effective.

8.2.4. Multiple imputation

Rubin (Rubin, 1987) proposed a method of analysing datasets with item missing data that:

- used software that was limited to analyses of whole datasets; but
- was statistically valid in that it:
- produced point estimates that were approximately unbiased; and
- intervals that did not use underestimated variances.

Imputation algorithm

The overall approach is reasonably straightforward and has been widely documented (Rubin, 1987, 1996; Schafer, 1999; Horton & Lipsitz, 2001). It usually involves three steps as follows:

1. Impute

Create a m sets of plausible values as in the last section. That is draw m samples from:

$$P(Z_{miss} | Z_{obs}) = \int P(Z_{miss} | Z_{obs}, \gamma) P(\gamma | Z_{obs}) d\gamma$$

2. Analyse

Then do m separate analyses and calculate m versions of the desired parameters, say $\Pi = \{\pi_1, \pi_2, \dots\}$ in this case.

3. Combine

The parameters are combined using the following formulae:

$$\bar{\pi}_i = \frac{\sum_{j=1}^m \pi_{i,j}}{m}$$

$$T_i = (1 - m^{-1})B_i + \bar{U}_i$$

Where $B_i = \frac{\sum_{j=1}^m (\pi_{i,j} - \bar{\pi}_i)^2}{m}$, $\bar{U}_i = \frac{\sum_{j=1}^m U_{i,j}}{m} = \text{var}(\bar{\pi}_i)$, and

$$U_{i,j} = \text{var}(\pi_{i,j})$$

Also, $\bar{\pi}_i$ and T_i are approximations to the posterior mean and variance and can therefore be used to construct approximate credible intervals, based on the normal or t- distributions

Unless the proportion of missing data were high there was little improvement in precision from computing more than ten (Rubin, 1987; Schafer, 1999). In the example given below by the method described in section 8.3.2 only 10 iterations were used.

Propensity score method

A popular variant of multiple imputation is the propensity score method which starts with calculating a score $e_i = P(R_i=1 | \mathbf{X}, \mathbf{Y}_{\text{obs}})$. In most other approaches to analyzing data with missing items that is MAR it is not necessary to model the missingness indicator. This method models it directly then proceeds as follows:

- stratify records on the basis of e_i , eg into q quantiles of e_i
- suppose there are R_q observed values and Q_q missing in each quantile. Randomly select Q_q observed values from the R_q observed values to replace the missing in the same group
- Calculate m separate replicates of step 2 then analyse each replicate and analyse in the usual way for multiple imputation.

8.3. Missing data methods applied to ethnicity in MHINC

The results from five different missing data models, have been compared to look at how well they address a missing data problem. In each case the models provide estimates for η_i , the total count in each i th ethnic group, and π_i , the probability of observing an event in the total ethnic population. Each model has been applied to the unaltered ethnic group (assigned the shorthand notation “unmodified” in the model below) observed in the users table (NHI) as well as the amended “ever-” observed ethnic groups (labelled “combined”) described in section 7.2. This is where individuals have identified themselves as belonging to any of the ethnic group fields in either of two separate data sets in MHINC (the ACCESS and USER tables). The result is to produce two sets of output, one for each ethnic group definition, for each imputation method.

8.3.1. Simple “imputation” methods

Two commonly used methods have been incorporated for comparison because of their widespread use on ethnic group data. They are:

complete case only (MCAR), and

missing cases assigned to the largest group.

In each case, missing values are assigned or left out, depending on the method, and the analyses are undertaken as if the resulting set of data were fully observed.

In both cases a Poisson regression model has been used to generate maximum likelihood estimates for η_i , the total count and the probability, π_i , the proportion.

8.3.2. Multiple imputation method

A multiple imputation method has been used. In this case a logistic regression method is used to generate 10 versions of the dataset. Missing values are generated for each ethnic group (eth_i) in the analysis (Cook Islands, non-Cook Islands Pacific, Māori and Others), each is treated individually as a binary variable. That is a separate indicator is created for Cook Islands vs non-Cook Islands, another for non-Cook Islands Pacific versus the rest and so on. Then a logistic regression model for $\lambda_i = P(\text{eth}_i=1)$ is fitted against the other demographic covariates, eg. $X = \{1, \text{age}, \text{sex and NZDEP}\}$ as follows:

$$\text{Logit}(\lambda_i) = \mathbf{X} * \boldsymbol{\beta}$$

where $\text{logit}(\lambda_i) = \log(\lambda_i)/(1-\log(\lambda_i))$. The fitted model yields the estimate for the coefficient vector $\bar{\boldsymbol{\beta}}$ and an associated covariance matrix \mathbf{V}_i .

A set of new parameter estimates for $\boldsymbol{\beta}^*$ are given by:

$$\boldsymbol{\beta}^* = \bar{\boldsymbol{\beta}} + \mathbf{V}_{h,i}^T \mathbf{z}$$

Where \mathbf{z} is a vector of $k+1$ independent normal random variates and $\mathbf{V}_{h,i}$ is given by $\mathbf{V}_i = \mathbf{V}_{h,i}^T * \mathbf{V}_{h,i}$.

An expected probability that $\text{eth}_i=1$ is then computed by:

$$\lambda_i^* = \exp(\mathbf{x}_i * \boldsymbol{\beta}^*) / (1 + \exp(\mathbf{x}_i * \boldsymbol{\beta}^*))$$

A random number, u , is drawn from $U(0,1)$. The missing value of eth_i is assigned the following value:

$$eth_i = \begin{cases} 1, \lambda^* < u) \\ 0, otherwise \end{cases}$$

As in the previous two methods, a Poisson regression model has been used to estimate incidence rates, $\pi_{i,j}$ for $j=1$ to 10. These 10 estimates are then combined using the imputation algorithm outlined in section 8.2.4.

8.3.3. Hierarchical Bayes models

In this section a hierarchical Bayes model is introduced that is a departure from usual method of imputing missing values on individual record item missing values. Here we have undertaken to develop a model for an aggregate table of categorical data. This is done for three main reasons:

- to avoid the need for imputing data in millions of records;

Table 8.1 Data layout for aggregate MHINC data for 12 age groups over T years.

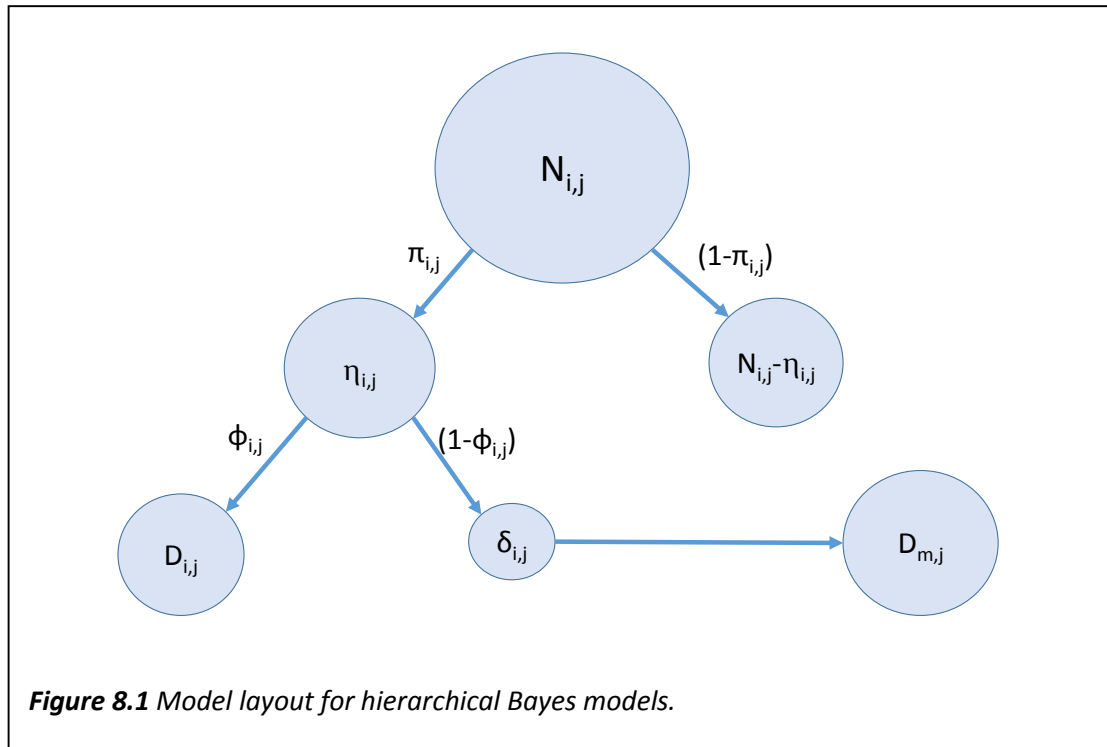
Eg.	Covariate					age = 12, sex = M, year =T
	age = 1, sex = F, year =1	age = 1, sex = M, year =1	...	...	...
j =	1	2	...	...	...	J
Population totals						
1-Cook Islands	$N_{1,1}$	$N_{1,2}$	...	...	...	$N_{1,J}$
2-NCI Pacific	$N_{2,1}$	$N_{2,2}$	...	...	...	$N_{2,J}$
3-NZ Māori	$N_{3,1}$	$N_{3,2}$	...	...	...	$N_{3,J}$
4-Other	$N_{4,1}$	$N_{4,2}$	...	...	...	$N_{4,J}$
Desired unknown number of events						
1-Cook Islands	$\eta_{1,1}$	$\eta_{1,2}$	...	...	...	$\eta_{1,J}$
2-NCI Pacific	$\eta_{2,1}$	$\eta_{2,2}$	...	...	...	$\eta_{2,J}$
3-NZ Māori	$\eta_{3,1}$	$\eta_{3,2}$	...	...	...	$\eta_{3,J}$
4-Other	$\eta_{4,1}$	$\eta_{4,2}$	...	...	...	$\eta_{4,J}$
Observed frequencies						
1-Cook Islands	$D_{1,1}$	$D_{1,2}$	...	...	...	$D_{1,J}$
2-NCI Pacific	$D_{2,1}$	$D_{2,2}$	...	...	...	$D_{2,J}$
3-NZ Māori	$D_{3,1}$	$D_{3,2}$	...	...	...	$D_{3,J}$
4-Other	$D_{4,1}$	$D_{4,2}$	...	...	...	$D_{4,J}$
5-Missing	$D_{m,1}$	$D_{m,2}$	...	...	...	$D_{m,J}$

- sometimes aggregate data, with a “not specified” field, is all that is made available to a researcher;
- it incorporates the imputation and the data analysis into the same step; and
- the model allows for incorporation of additional expert opinion.

As such, we also introduce a different notation. If we assume the complete MHINC data that would be observed if there was no missing ethnicity information could be represented by $\boldsymbol{\eta} = \{\eta_{i,j}\}$, where $\eta_{i,j}$ is the true count for the i th ethnic group and the j th cell of the cross-classification of categorical covariate.

On the other hand, the observed data, denoted by $\mathbf{D} = \{D_{i,j}, D_{m,j}\}$, contains individuals with unclassified ethnicity, thus creating an additional “missing data” category denoted by $\{D_{m,j}\}$. Assume for this example that there is no misclassification of ethnicity in the group with ethnicity recorded and that there are no missing data in $N_{i,j}$ the population totals. Thus all the raw data of interest are shown in Table 8.1.

This means that, in the i th ethnic and j th covariate stratum, the observed $D_{i,j}$ people are a subset of the $\eta_{i,j}$ people in the complete data that would be observed if



ethnicity were not missing. Although we observe \mathbf{D} our interest is really in the true counts, $\boldsymbol{\eta}$, but we have to acknowledge that the true counts are unknowns. To a Bayesian the problem is to compute $p(\boldsymbol{\eta} | \mathbf{D})$, a posterior probability distribution for $\boldsymbol{\eta}$ conditional on the observed \mathbf{D} . Simply using a point estimate $\widehat{\eta_{i,j}}$ for each η_{ij} , does not turn the unknown count into a known count, since an estimate of a count is not the same thing as the count. Hence, since we do not observe the true counts there will always be uncertainty surrounding them. In Bayesian statistics this uncertainty is expressed in terms of a probability distribution. Furthermore, we can also use the observed counts to learn something about the true counts. So while intuitively $\boldsymbol{\eta}$ can be thought of as a count, in terms of this model it has now become one of the parameters that we wish to know something about.

In the MHINC example we are looking for the true value for $\eta_{i,j}$ that exists in the total New Zealand population with an unknown proportion. Figure 8.1 shows that within the j th covariate subgroup and i th ethnic group $\eta_{i,j}$, the true count, would be selected from the total population in that subgroup, $N_{i,j}$, with proportion $\pi_{i,j}$. Thus, a complete data model for $\eta_{i,j}$ could be described as follows:

$$\eta_{i,j} | \pi_{i,j} * N_{i,j} \sim \text{Poisson}(\pi_{i,j} * N_{i,j}) \quad \text{or} \quad \eta_{i,j} | \pi_{i,j} * N_{i,j} \sim \text{Binomial}(\pi_{i,j}, N_{i,j}) \quad (1)$$

Similarly, $D_{i,j}$, the observed count, would be taken/sampled from $\eta_{i,j}$ with proportion $\phi_{i,j}$. Incidentally, it is common to view $D_{i,j}$, as if it had been taken from the total population in the way we have treated $\eta_{i,j}$ above. We have chosen the flow described in figure 8.1 as it is conceptually clearer, though not necessarily computationally easier. Thus, the first level of the model asserts that:

$$p(\mathbf{D} | \boldsymbol{\eta}, \boldsymbol{\pi}, \boldsymbol{\phi}) = \prod_{i,j} p(D_{i,j} | \phi_{i,j}, \eta_{i,j}) \quad (2)$$

where $D_{i,j}$ is independently distributed:

$$D_{i,j} | \phi_{i,j}, \eta_{i,j} \sim \text{Binomial}(\phi_{i,j}, \eta_{i,j}), \quad i = 1 \dots I; j = 1 \dots J \quad (3)$$

A joint prior distribution for $\boldsymbol{\eta}$, and $\boldsymbol{\phi}$ can be given by:

$$p(\boldsymbol{\eta}, \boldsymbol{\phi} | N) = p(\boldsymbol{\phi})p(\boldsymbol{\eta} | N) \quad (4)$$

$$= \prod_{i,j} p(\phi_{i,j}) \int \prod_{i,j} p(\eta_{i,j} | \pi_{i,j}, N_{i,j}) p(\pi_{i,j}) d\pi$$

Where $p(\eta_{i,j} / \mathbf{N}, \pi_{i,j})$ is stated in equation (1) while $p(\pi_{i,j})$ and $p(\phi_{i,j})$ will be described in the subsequent section. In this proposition there is an assumption of independence between $\pi_{i,j}$ and $\phi_{i,j}$. In practice this may not be true.

Prior distributions for π and ϕ

Two types of models have been defined in the previous section: a Poisson model where $p(\eta_{i,j} / N, \pi_{i,j})$ as shown earlier is determined to be Poisson, and a logistic model where $p(\eta_{i,j} / N, \pi_{i,j})$ is determined to be binomial. The distribution for the observed data incorporating MAR missing data assumptions is given by $p(\mathbf{D} / \eta_{i,j}, \phi_{i,j})$ as in equation (2) is asserted to be binomial.

In the application of these models, each type of model is further extended to two separate models that differ only by each model's definition of their prior distributions for the remaining parameters $\phi_{i,j}$, the probability that $D_{i,j}$ has been observed from $\eta_{i,j}$ and $\pi_{i,j}$ the probability that $\eta_{i,j}$ has been observed in $N_{i,j}$.

Whether a Poisson or binomial model, $\phi_{i,j}$ will be said to be distributed Beta as follows:

$$\phi_{i,j} \sim \text{Beta}\left(\sum_i D_{i,j}, D_{m,j}\right)$$

This distribution is a natural conjugate distribution for $\phi_{i,j}$ given (3) with the expectation that the probability that $D_{i,j}$ has been observed from $\eta_{i,j}$ is proportional to the probability that data has been observed for all ethnic groups combined. Or equivalently proportional to the probability that $D_{.,j}$ has been observed from $\eta_{.,j}$. In a formal sense the prior for the $\phi_{i,j}$ dependent upon the data. However, the dependence is considered mild since it depends only on totals summed over all ethnic group categories and not on individual ethnic group counts.

The prior for the probability parameter, $\pi_{i,j}$ will be in terms of a link function $g(\pi_{i,j})$: the logit ($\log(\pi_{i,j} / (1 - \pi_{i,j}))$) for a binomial distributed $\eta_{i,j}$ or the log($\pi_{i,j}$) function for $\eta_{i,j}$ distributed Poisson. The prior for $g(\pi_{i,j})$ has been expressed in two ways:

$$g(\pi_{i,j}) = \mathbf{x}_{i,j}^T \boldsymbol{\beta}, \text{ and} \quad (5)$$

As for Section 3.3, $\mathbf{x}_{i,j}$ is a vector of indicators for the i th ethnicity and the j th observed covariates. In some models, the latter may contain indicators for year and ethnicity. Other models, if adjusting for or describing, age, sex and NZDEP will contain indicators for those. Likewise, $\boldsymbol{\beta}$ is the vector of coefficients that correspond to the elements of $\mathbf{x}_{i,j}$.

Priors for $\boldsymbol{\beta}$ are stated in a similar way to those described in Section 3.3 for the analyses of the NZMHS. The main difference is the priors in this instance are designed to be non-informative or vague. Unlike the examples in earlier chapters, where prior knowledge about age, sex, ethnicity or NZDEP were elicited from other sources, including MHINC, much less prior knowledge existed back in 2000. Thus, for each element of $\boldsymbol{\beta}$ a prior distribution is given by an independent Normal distribution with mean of zero and a comparatively small precision of 0.01.

Marginal posterior distributions for η and π

Inference follows from the conditional joint posterior distribution for η , π and ϕ which is be given by:

$$p(\eta, \pi, \phi | \mathbf{D}, \mathbf{N}) \propto p(\eta | \mathbf{N}, \pi) p(\pi) p(\mathbf{D} | \eta, \phi) p(\phi) \quad (6)$$

Using (6), the Gibbs sampling proceeds by sampling in turn from the following full conditional distributions

$$1. p(\eta | \phi, \pi, \mathbf{D}, \mathbf{N}) \propto \prod_{i,j} p(D_{i,j} | \phi_{i,j}, \eta_{i,j}) p(\eta_{i,j} | \pi_{i,j}, N_{i,j}) \quad (7)$$

$$2. p(\phi | \eta, \pi, \mathbf{D}, \mathbf{N}) \propto \prod_{i,j} p(D_{i,j} | \phi_{i,j}, \eta_{i,j}) p(\phi_{i,j}) \quad (8)$$

$$3. p(\pi | \eta, \phi, \mathbf{D}, \mathbf{N}) \propto \prod_{i,j} p(\eta_{i,j} | \pi_{i,j}, N_{i,j}) p(\pi_{i,j}) \quad (9)$$

8.4. Comparison of several different models

In brief, this section compares five models. First, the two most commonly used “naïve” approaches to handling missing data are:

- Method 1: Ignoring missing data, assuming data are MCAR, and

- Method 2: Subsuming all missing data into the most common value.
- Method 3: Multiple imputation under MAR assumptions using PROC MI and MIANALYSE in SAS with monotone missingness and a logistic model predicting the missing values.

The two Bayesian models are

- Method 4: A Poisson regression model, for aggregate data assuming $\eta_{i,j}$ distributed Poisson, and
- Method 5: A logistic regression model for aggregate data, assuming $\eta_{i,j}$ distributed binomial.

8.4.1. Estimates for η , number of actual clients seen per year

Table 8.2 shows estimates for the parameter η , the average annual number of clients seen by mental health services, from the different imputation methods presented above. Each imputation method is applied to two separate ethnic subgroups. The first is the unmodified ethnic method of classification and the second combined method, those labelled in section 7.2 with the prefix “ever-”. The first two imputation methods show the distribution of MHINC clients reported by two naïve but standard methods of analyses. Method 2 applied to the unmodified method of assigning ethnicity is the most common method of ascertaining the ethnic group distribution in reports of MHINC data. The confidence intervals in models 1 and 2 are derived from the variation across eight years of data. In any given year they would report a single observed count.

As shown in chapter 7, the combined method of assigning ethnicity reduced the number of uncoded ethnicity fields by as much as three quarters in some years. So the combined ethnic classification total that is observed in imputation method 1 was higher than the unmodified classification for all ethnic groups combined.

Methods 1 and 2 are identical except for the numbers of NMNP, non-Māori-non-Pacific clients. In methods 2 all missing values are coded to NMNP, resulting in a 6% increase in the number of clients using the unmodified ethnic classification or a 2% increase using the ethnic classification.

Table 8.2 Comparisons of estimated mean annual client number; by imputation method and ethnicity.

Imputation method	Ethnicity method	Adjust	Cook Islands	Other Pacific	Māori	NMNP	All ethnic groups
Method 1 Complete case	Unmodified	η	624	2399	14576	67191	84790
		(95% CR)	(492, 756)	(2000, 2797)	(13636, 15515)	(65558, 68824)	(81686,87892)
	Combined	η	867	2868	16946	66820	87501
		(95% CR)	(756, 978)	(2472, 3263)	(16202, 17690)	(65135, 68504)	(84565,90435)
Method 2 Highest frequency	Unmodified	η	624	2399	14576	71258	88857
		(95% CR)	(492, 756)	(2000, 2797)	(13636, 15515)	(69628, 72887)	(85756,91955)
	Combined	η	867	2868	16946	68046	88727
		(95% CR)	(756, 978)	(2472, 3263)	(16202, 17690)	(66315, 69776)	(85745,91707)
Method 3 Multiple Imputation	Unmodified	η	654	2518	15229	69892	88293
		(95% CR)	(527,781)	(2125,2911)	(14315,16142)	(68560,71224)	(86626,89961)
	Combined	η	884	2934	17158	67317	88293
		(95% CR)	(779,988)	(2540,3328)	(16434,17883)	(65840,68794)	(86598,89988)
Method 4 Bayes Poisson	Unmodified	η	656	2527	15253	69856	88292
		(95% CR)	(462, 904)	(1844, 3267)	(13460, 16860)	(66510, 71490)	(82276,92521)
	Combined	η	885	2936	17162	67311	88294
		(95% CR)	(717, 1092)	(2230, 3662)	(15580, 18380)	(63820, 69330)	(82350,92455)
Method 5 Bayes logistic	Unmodified	η	656	2527	15252	69852	88292
		(95% CR)	(462, 905)	(1844, 3267)	(13460, 16860)	(66510, 71490)	(82276,92521)
	Combined	η	885	2936	17162	67311	88294
		(95% CR)	(717, 1092)	(2230, 3662)	(15580, 18380)	(63820, 69330)	(82347,91481)

For methods 2 - 5 the unmodified and combined “all ethnic group” totals were almost the same, as they use all the records available with the differences resulting from the distribution of clients across the ethnic groups.

These models have resulted in a 4% increase for the NMNP group, compared to the 6% for model 2, but a 4.5-5% increase for the unmodified method of identifying Cook Islands, other Pacific and Māori. Using the combined method for classifying ethnic groups, these models have resulted in less than 1% increase for NMNP, compared to the 2% for model 2, but a 1.2-2.3% increase for Cook Islands, other Pacific and Māori.

Methods 3, 4 and 5 are variations of multiple imputations and as such have very similar results for η . The Poisson and logistic model estimates were almost identical. While this is not always the case the two estimates are likely to be similar as the numbers of observations increases.

Methods 3, 4 and 5 also yield considerably wider credible intervals than methods 1 and 2 which is consistent with the latter methods uncertainty due largely to annual variation while the former include further uncertainty due to missing data. Methods 4 and 5, the hierarchical Bayes model estimates, yielded estimates with wider credible intervals than those produced by method 3, 50% and 2.5 times wider for Cook Islands and NMNP estimates respectively. This may be a result of some information loss in moving from individual to categorical data; or possibly uncertainty due to missing data that is not fully accounted for by the MI approach.

8.4.2. Estimates for π , annual proportion of the population who were mental health clients, per 10,000

Table 8.3 shows estimates for the parameter π , the average annual number of clients per 10,000 head of population seen by mental health services, from the seven different methods described above. As in section 3.6.1, methods 1 and 2 show the values that would be shown in standard analyses of unmodified and combined methods of classifying ethnic group. Method 2 applied to the unmodified method of classifying ethnicity represents a common method of estimating π in reports of MHINC data.

Table 8.3 Comparisons of estimated rates per 10,000 that a person will be a mental health service client by imputation method and ethnicity.

Imputation method	Ethnicity method	Rate (π (95% CR))	Cook Islands	Other Pacific	Māori	NMNP	All ethnic groups
Method 1 Complete case	Unmodified	π	101.7	104.6	213.3	184.5	151.0
		(95% CR)	(89.7, 113.6)	(94.0, 115.1)	(199.5, 227.1)	(180.9, 188.1)	(130.4, 171.6)
	Comb	π	139.0	123.4	245.5	182.9	172.7
		(95% CR)	(132.6, 145.4)	(113.1, 133.7)	(232.9, 258.2)	(179.7, 186.1)	(152.9, 192.5)
Method 2 Highest frequency	Unmodified	π	101.7	104.6	213.3	194.6	153.5
		(95% CR)	(89.7, 113.6)	(94.0, 115.1)	(199.5, 227.1)	(191.1, 198.1)	(132.1, 174.9)
	Comb	π	139.0	123.4	245.5	186.0	173.5
		(95% CR)	(132.6, 145.4)	(113.1, 133.7)	(232.9, 258.2)	(182.8, 189.2)	(153.6, 193.4)
Method 3 Multiple Imputation	Unmodified	π	122.7	129.3	298.4	223.9	193.6
		(95% CR)	(103.8,141.7)	(114.7,143.8)	(285.6,311.3)	(220.6,227.3)	(163.3,223.9)
	Comb	π	162.2	150.7	336.4	215.6	216.2
		(95% CR)	(147.9,176.5)	(137.1,164.4)	(327.3,345.5)	(212.9,218.4)	(185.7,246.7)
Method 4 Bayes Poisson	Unmodified	π	118.6	130.4	299.1	223.7	227.6
		(95% CR)	(113.6, 123.0)	(125.7, 134.0)	(288.8, 306.3)	(216.1, 228.9)	(219.8,233)
	Comb	π	160.0	151.5	336.6	215.6	228.0
		(95% CR)	(153.7, 165.3)	(146.1, 155.5)	(325.2, 344.6)	(208.4, 220.6)	(220,237.2)
Method 5 Bayes Logistic	Unmodified	π	118.5	130.4	299.2	223.7	227.6
		(95% CR)	(113.6, 122.9)	(125.7, 134.0)	(289.1, 306.2)	(216.2, 228.9)	(220,233)
	Comb	π	159.9	151.5	336.5	215.6	228.0
		(95% CR)	(153.6, 165.2)	(146.1, 155.6)	(325.2, 344.4)	(208.4, 220.6)	(220.3,233.4)

As shown above, the combined method of assigning ethnicity that greatly reduced the number of uncoded ethnicity fields had the greatest impact on the marginal differences between the rates. However, for all the ethnic groups apart from non-Māori/non-Pacific, there is another large increase caused by allocating the missing ethnic groups across the three other ethnic groups as well as the largest.

As expected, the rates for all but NMNP in methods 1 and 2 are identical in their estimates of π with the only difference being that the Others' rates are higher in method 2. Consequently, the overall totals are also increased for method 2. For methods 2 – 5 estimates of π using the unmodified method of ethnicity are very similar as are the estimates using the combined definition of ethnicity. Also observed in the previous section for estimates of η , estimates of π for combined ethnicity are higher than those using the unmodified definition.

8.4.3. Processing times

Table 8.4 shows runtimes for each method. Methods 1 to 4 were performed on a IBM ThinkPad and a Dell desktop with a Core2 Quad processor was used for method 5. Note that these times exclude the processing times required to set up the data in preparation for each procedure. They represent the time to process the procedure required to perform the analyses that make each method differ from the others.

Clearly, the first four methods were processed in very short time while method 5 took more than 12 hours to process. The Winbugs website does warn that it can use

Table 8.4 Comparison of run times for each model.

Method ¹	Description	Run times
Method 1 Complete case		<60s
Method 2 Highest frequency		<60s
Method 3 Multiple imputation	Multiple imputation	280s
	Processing results	<60s
Method 4 Bayes Poisson	10,000 updates	188s
Method 5 Bayes logistic	10,000 updates	>12 hrs

¹ Method 1-4 are run on an IBM ThinkPad with an Intel Pentium processor 1.7 GHz while method 5 was run on a Dell desktop with a Core2 Quad processor.

a large amount of processing resources. However, although it took long time to process, the results shown above were similar to those produced by the same methods that used a Poisson instead of a binomial distribution.

In fact, the only difference between the methods was the use of a different distribution as a prior for the mean count parameter, η .

8.5. Discussion

This chapter summarises the results from five different imputation methods, each with different approaches to handling data fields that have not been fully coded. As can be seen above, the methods present some varied results, yet some methods show similarities. A desired method will be one that represents the information available in as much of the available data as is possible and try to represent as much of the uncertainty associated with the data as possible. In routine government reporting practice both of these are ignored, as they purport to show retrospective counts as observed in each year. In this report I am interested in an estimate of what would have been seen if there were no missing data.

The imputation methods add an additional layer of complexity to the analyses and are therefore slightly more difficult to employ and explain to a non-technical audience. The hierarchical Bayes models used WinBugs which, although a freely available piece of software, did not work naturally with SAS 9.2. While SAS 9.2 was the version available for this piece of research the subsequent version, 9.3, had other options for Bayesian analyses with Gibbs sampling and MCMC that didn't require calling WinBUGS.

In this analysis we are interested in identifying people who have not identified one or more ethnic groups in MHINC. As has been stated earlier there are no missing age groups and very few uncoded gender and NZDEP fields. In addition to modelling the missing observations another approach was to update an individual's ethnic group if it was identified in either previous or subsequent years or either of the two places it is recorded in the database. This has the effect of dramatically reducing the number

of missing ethnic group entries and reducing the number of estimated values in turn reducing the variance associated with imputing these values.

Table 8.5 compares some of the advantages and disadvantages of each method. The simple methods, as reported by methods 1 and 2, are easy to perform and also easy to explain to a non-technical audience. However they mis-report either frequencies or rates and associated variances. On the other hand, the imputation methods 3, 4, and 5 are clearer about their handling of the missing data and provide more appropriate estimates of frequencies and rates. Furthermore, since the true value is unknown, they express uncertainty about the estimates in terms of a probability distribution.

Table 8.5 Comparison of run times for each method

Method	Advantages	Disadvantages
1	Easy to analyse Quick to run Reports actual frequencies Easier to understand by lay readers	Under-reports actual frequencies Missing data assumptions are vague Understates variances
2	Uses all the data Easy to analyse Quick to run Reports actual frequencies Easier to understand by lay readers Missing data applied to the group where it has least impact	Over-reports rates for the largest group and under-reports the rates of others Missing data assumptions are vague Understates variances
3	Uses all the data Uses SAS and is available in most other statistical software Quick to run Missing data applied to all groups with clear assumptions Variances incorporate missing data as well as other factors/covariates	A bit more difficult to analyse The approach may be difficult to understand by lay readers Estimated frequencies are no longer actual observations
4	Uses all the data, in tabulated form Quick to run A single model incorporating analysis and missing data adjustments Missing data applied to all groups with clearer assumptions Variances incorporate missing data as well as other factors/covariates	A bit more difficult to analyse Uses WinBugs externally from the data processing stage The approach may be difficult to understand by lay readers Estimated frequencies are no longer actual observations
5	As for method 4 except for speed	As for method 4 Is very slow to run

For Pacific and Māori, important indicators in this thesis, both simple methods under-report the frequencies and rates observed. The combined ethnicity dramatically increased the frequencies and rates in the naïve methods. All the imputation methods further increased the frequencies and rates for Māori and Pacific.

The multiple imputation procedure used in SAS is appealing because it is relatively easy to employ, uses standard analysis tools that are known to the SAS user which is a widely used software package.

The hierarchical Bayes model was developed to enable the incorporation of prior knowledge about the data observed as well as establishing a clear model hierarchy, making it easier to be explicit about the assumptions that underpin its design. This structure allows the single model to show parametric expectations and variances that incorporate correction for missing values into the desired analysis. It also provides additional potential to incorporate a predictive element into the same model structure as well as be used in survival models for age at first use in MHINC data.

This hierarchical Bayesian framework is able to develop a model that uses aggregate data tables rather than imputing the individual record missing item data. The advantage of this method is that, in many instances, data is not available to researchers in individual record form or sometimes the number of records is simply too large. In this analysis, population incidence or prevalence rates are calculated using New Zealand 2006 census populations and projections as a denominator. These are supplied in grouped form by Statistics New Zealand.

While the Poisson model performed well the logistic model was too slow to be useful in a real world situation where deadlines are an issue. However, it should not be ruled out entirely as many projects allow for the time required to run such models if deemed appropriate. In this case the Poisson and logistic regression models produced very similar results, making the Poisson regression model more appealing in this particular case.

As stated previously, the hierarchical Bayes framework has provided us with the ability to develop a model that:

works with aggregate data;

incorporates the imputation and the data analysis into the same step; and

allows us to incorporate additional knowledge that we may have about the statistics we are reporting by way of priors.

Subsequent analyses in this thesis will use the hierarchical Bayes model with either Poisson or Gaussian distributions applied to the “combined” ethnic groups definition.

9 Use of New Zealand government funded mental health services between 2000 and 2008 by Cook Islanders

<i>9.0. Abstract</i>	189
<i>9.1. Method</i>	190
9.1.1. Diagnosis of Bayesian model performance	191
<i>9.2. Results</i>	193
9.2.1. Prevalence among Cook Islanders.....	193
9.2.2. Ethnic comparisons	197
<i>9.3. Discussion</i>	202
9.3.1. Background.....	202
9.3.2. The hierarchical Bayes model.....	202
9.3.3. Summary of results.....	203
9.3.4. Conclusions.....	205

9.0. Abstract

Aims and objectives

The aim of this chapter is to describe patterns of treatment services received for mental disorder among New Zealand's Cook Islands residents compared with other ethnic groups.

Overview

It is not often that mental health service utilization has been reported for Cook Islanders in any publication. The standard practice for any publication or reports about mental health service use, is to report rates for Pacific groups as a whole. In 2009, I published a paper showing, for the first time, a brief summary of mental health service use among a within-Pacific ethnic group. As stated in Chapter 7, like most other reports using this dataset, this report confirmed the historically reported low rates of use for Pacific peoples.

Section 9.1 presents an overview of the methods used in this chapter along with model diagnostics, documenting the convergence of model parameters for estimates reported in this chapter. Section 9.2 reports the services received by Cook Islanders who are first time users of mental health services; their age of first use, and

the services they use in their first year. This section also includes a subsection that shows the incidence of those who have been seen in mental health services once, from July 2001 up to June 2008. Section 9.2 reports the prevalence of all users and the services they have used. Section 9.3 provides a discussion of some of the results shown in section 9.2.

Summary of findings

The findings show that around 2.5% of Cook Islanders were seen by New Zealand Government-funded mental health services between July 2001 and June 2008. Most, 85%, were seen by community mental health services. Around two out of five Cook Islanders seen each year, were new to mental health services and a small proportion, one in ten, were seen only once as of 2008. By 75 years of age, 10.6% of Cook Islanders would be seen by mental health services.

The incidence of mental health service use by Cook Islanders was comparable to other Pacific peoples' use and lower than NMNP, which in turn was lower than mental health service use by Māori. This contrasts with results presented in Chapter 6 showing Cook Islanders with rates of service use comparable to Māori and higher than others. This difference is possibly most likely due to historically inconsistent reporting of ethnicity in MHINC in comparison with the self-reported ethnicity in NZMHS. It could also possibly arise from Cook Islanders using specialist mental health services that are not reported to MHINC such as community mental health services.

9.1. Method

Hierarchical Bayes logistic models, as described in Chapter 8, have been used to produce posterior prevalence estimates and to report comparative rate ratios. This model has been developed to produce estimates of rates for Cook Islanders that are adjusted to account for missing ethnic group codes.

As with previous chapters, comparisons are drawn using ratios of prevalence estimates (RR) and the probability that the reported RR is greater than 1 ($P_{RR}(base)$), where “base” is the category that is chosen to be the reference group for the

comparison. A P_{RR} in excess of 0.9 or less than 0.1 has been used to indicate a strong difference between the prevalence of one group over another.

A further estimate for lifetime onset of service use is obtained by using life table methods for cumulative incidence of occurrence with the posterior estimated numbers.

9.1.1. Diagnosis of Bayesian model performance

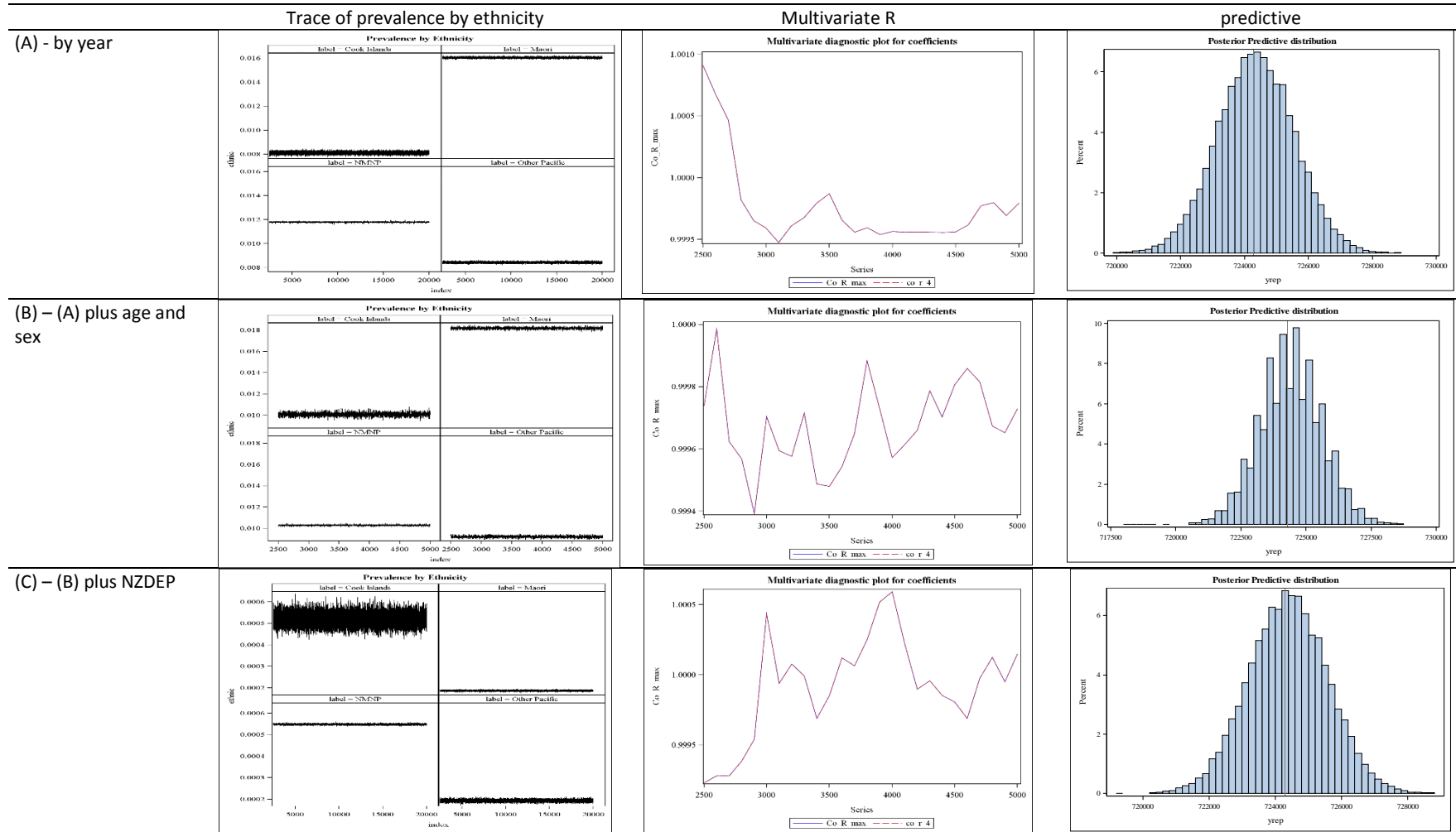
Table 9.1 show a summary of some diagnostic statistics that confirm the convergence and posterior predictive performance for the key summary statistics used in this chapter. Table 9.2 is a visual representation confirming the same results. The statistics of interest for each analysis show good convergence and predictive ability for the distributions estimates the prevalence of all service use.

Table 9.2 shows results for total service use. The first column provides the trace plots for the weighted posterior of annual service use by ethnicity. The order of the graphs is from top left by row; Cook Islands, other Pacific, Maori and NMNP. The middle column shows a sequence of the multivariate R (MVR) for each model posterior estimate reported in this chapter's results section.

Table 9.1 Diagnostic summary statistics for models of service use.

Disorder	MVR	Minimum Geweke	Yrep number (95% CR)	Yobs Total users	P(Yrep>Yobs)
Total service use					
A - by year	1.0005	0.97839	724308 (722332,726284)	724290	0.5190
B – A plus age and sex	1.0001	0.96463	724393 (722419,726366)	724290	0.5478
C – B plus NZDEP	1.0004	0.96463	724336 (722369,726304)	724290	0.5307
First service use					
A - by year	0.9999	0.96418	299851 (298575,301127)	299849	0.5001
B – A plus age and sex	0.9999	0.97053	299952 (298675,301229)	299849	0.5529
C – B plus NZDEP	0.9999	0.93600	299915 (298646,301185)	299849	0.5335
Single use					
A - by year	0.9999	0.97433	48078 (47566,48590)	48065	0.5192
B – A plus age and sex	0.9999	0.97826	48167 (47655,48680)	48065	0.6281
C – B plus NZDEP	0.9999	0.96968	48133 (47622,48644)	48065	0.5831

Figure 9.1 Visual diagnostic summary for models for total service use; trace plots by ethnicity, multivariate Gelman Rubin R and posterior predictive distribution.



The univariate Gelman-Rubin R calculated using three separate chains of 20,000 runs are summarized by the MVR. If the MVR falls below the 1.02 threshold for the Gelman-Rubin R, it indicates that all the individual R statistics also fall within the threshold. Similarly, the Geweke statistics for the posterior estimates of service use from each model show they have converged reasonably well, at least in terms of their start and end points for the analysis runs. Figure 9.1 confirms the convergence reported by the Geweke statistic and shows the familiar form of a converging series of estimates from their respective trace plots.

The posterior predictive distributions shown in the third column of figure 9.1 show that the model is able to predict with good accuracy, in terms of its mean, the total crude number of individuals who were seen by government funded mental health services.

9.2. Results

9.2.1. Prevalence among Cook Islanders

Use of government-funded specialist mental health services

In Chapter 5, it was shown that the estimated 12-month prevalence of Cook Islanders in the NZMHS with a mental disorder, who had visited a specialist mental health service for their mental health was: 20.7%. Applying this proportion to the estimated 12-month prevalence of disorder among Cook Islands adults of 31.0%, yields an overall estimated 12-month prevalence of mental health specialist service treatment of 6.4%. Furthermore, 2.5% of the 69% with no disorder also visited a specialist mental health service or 1.7% of the total population. The net result is an estimated 8.1% of the Cook Islands adult population who indicated that they had visited a specialist mental health service for treatment.

Table 9.2 reveals a lower utilization for Cook Islanders than indicated from the NZMHS. In 2008, 2.2% of Cook Islanders of all ages used government-funded specialist mental health services in New Zealand. Although the average was just under 1000 Cook Islanders per year between 2001 and 2008, numbers increased by over 80% from

Table 9.2 The number and rate per 1000 of Cook Islanders seen in specialist mental health services, 2001-2008 and annual average.

	Freq/Rate	Total users	First time use	Seen only once
By Year				
2001	n	717 (711,725)	486 (479,493)	64 (62,68)
	/1000	13.65 (13.5,13.8)	9.24 (9.1,9.4)	1.22 (1.2,1.3)
2002	n	803 (796,810)	371 (365,377)	68 (66,71)
	/1000	14.96 (14.8,15.1)	6.91 (6.8,7)	1.27 (1.2,1.3)
2003	n	841 (835,848)	345 (340,351)	59 (57,61)
	/1000	15.36 (15.3,15.5)	6.3 (6.2,6.4)	1.07 (1,1.1)
2004	n	870 (864,877)	316 (311,321)	50 (49,53)
	/1000	15.59 (15.5,15.7)	5.65 (5.6,5.7)	0.9 (0.9,0.9)
2005	n	967 (961,975)	337 (331,343)	60 (58,63)
	/1000	17 (16.9,17.1)	5.92 (5.8,6)	1.06 (1,1.1)
2006	n	1075 (1067,1083)	396 (390,403)	54 (52,58)
	/1000	18.53 (18.4,18.7)	6.83 (6.7,6.9)	0.94 (0.9,1)
2007	n	1178 (1171,1187)	425 (421,431)	81 (79,84)
	/1000	19.98 (19.9,20.1)	7.22 (7.1,7.3)	1.37 (1.3,1.4)
2008	n	1303 (1296,1311)	499 (494,505)	103 (101,106)
	/1000	21.73 (21.6,21.9)	8.32 (8.2,8.4)	1.72 (1.7,1.8)
By Age				
under 15	n	340 (336,344)	187 (184,191)	29 (27,31)
	/1000	11.43 (11.01,11.84)	6.35 (6.02,6.67)	0.98 (0.72,1.24)
15-24	n	242 (239,245)	93 (90,95)	16 (14,18)
	/1000	34.08 (32.1,36.06)	13.03 (11.24,14.81)	2.28 (1.18,3.37)
25-34	n	218 (215,221)	65 (63,67)	11 (9,13)
	/1000	39.18 (36.57,41.79)	11.85 (9.47,14.23)	2.04 (0.67,3.4)
35-44	n	99 (97,101)	27 (25,29)	6 (3,8)
	/1000	32.54 (28.02,37.06)	9.03 (4.62,13.43)	1.95 (0.00,4.51)
45-64	n	35 (33,37)	10 (7,13)	
	/1000	3.93 (1.69,6.17)	1.17 (-1.05,3.39)	
65 plus	n	36 (35,37)	15 (14,16)	
	/1000	18.24 (16.26,20.21)	7.85 (6.36,9.33)	

just over 700 to 1300. The twelve month utilization rate per thousand Cook Islanders in the same period which includes the population changes increased by 60%.

The main contributor to this increase is a change in the priority given to collecting ethnic group over the eight years under observation. Another likely contributor this increase is that the 2008 previous service users benefit from

retrospective prior recording of their ethnic group, while previous users in 2001 were not afforded that opportunity. For this reason the 2008 number and rates are reported in preference to the annual average. This is not only the most recent value, but also the year that has benefitted most from the updated ethnicity policy changes.

Table 9.2 also shows the age profile of specialist mental health service users. Just over a third of Cook Islanders, around 340 individuals per year, who were seen by specialist mental health services were under 15 years of age. Eight out of ten seen each year were under 24 years of age. Although the overall rate indicated a low prevalence of specialist mental health service use compared to NZMHS, the general pattern for age specific rates are similar with rates for 15-44 years in excess of 3.3%. One difference is an increase among 65 years and over, compared with the 55 to 64 year old cohort.

First time use of specialist mental health services

In 2008, 40% of Cook Islands users (around 400) were seen for the first time. That is, they had not previously been seen by a mental health service. Apart from 2001, the proportion of first time users from 2001 to 2008 was relatively constant at around 35% to 45% of the total number of users. The proportion reported for 2001 is

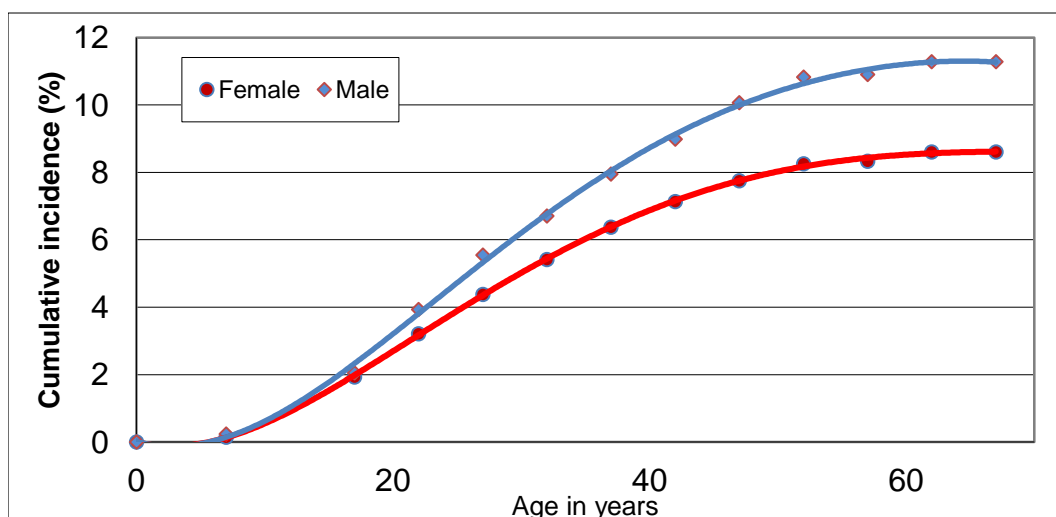


Figure 9.2 Cumulative onset of mental health service use with age.

most likely exaggerated by incomplete reporting of people seen in the system prior to 2001 when MHINC was set up.

Nearly nine out of ten Cook Islands users of specialist mental health services seen for the first time were under 24 years, and nearly half were less than 15 years of age. Perhaps not surprisingly, 55% of all users of specialist mental health services under the age of 15 years were seen for the first time. Conversely, 45% of users under 15 years were repeat users of specialist mental health services compared with 70% of 15 to 45 year olds.

Using life table methods with the incidence of first time users to specialist mental health services, the cumulated probability of engaging a service over a lifetime was calculated and plotted in figure 9.2. By 65 years, 11% of men and 8.5% of women are estimated to be seen by specialist mental health services.

Individuals seen only once.

Table 9.3 shows 7% of all users were seen only once. This is a censored number as it is possible that some may have been seen again in the years subsequent to 2008, or were seen by specialist mental health services not reporting to MHINC. The number and rate remained constant between 2001 and 2008. In 2008 just over 100 (around 1.7 per 1000) Cook Islanders were seen each year by mental health services who did not visit again. Nine out of ten of these people were under 24 years of age. Most of

Table 9.3 Numbers and unadjusted proportion seen by service group, annual average 2001-2008.

Service	freq	Total users	First time use	Seen only once
All users	n	969 (963, 975)	397 (392, 402)	67 (63, 72)
Community MH team	n	786 (781, 792)	288 (284, 293)	37 (32, 43)
	%	81.24%	72.5%	55.2%
Acute inpatient unit	n	119 (116, 121)	28 (21, 36)	
	%	12.5%	7.1%	
Substance treatment	n	185 (182, 188)	106 (103, 110)	26 (15, 36)
	%	19.0%	26.7%	38.8%
Forensic	n	84 (79, 89)	22 (9, 34)	
	%	8.7%	5.5%	

these people (55%) had been seen by community mental health teams and a further third were users of substance treatment services.

Services seen

Furthermore, table 9.3 shows that four out of five Cook Islanders who were seen by mental health services in New Zealand, nearly 800 people per year, were seen by community mental health teams. One in eight Cook Islands users were seen by acute inpatient services, and just under one in five by substance treatment services. In 2008, 200 Cook Islanders were seen by more resource intensive acute inpatient or forensic services.

As a proportion of all those seen in between 2001 and 2008, those seen for the first time, and those seen only once, were less likely to be seen by an acute inpatient, as a result of a serious acute episode, or a forensic service, as a result of a person with a mental illness breaking a law. Proportionately, those seen for the first time and in particular those seen only once were more likely to be seen in substance treatment service.

9.2.2. Ethnic comparisons

As reported above, using results from chapter 5 and section 6.2.1., which reported the prevalence of any 12-month disorder and service use, respectively, from the New Zealand Mental Health Survey, 8.1% of all Cook Islanders had used a specialist mental health service. A similar application to rates of mental health service use and prevalence by other Pacific, Māori and NMNP yield estimates of 3.5%, 8.3% and 5.7%, of the respective adult populations who were seen by such services. These are indicative proportions of people within each group who had seen a mental health service for their mental health problem each year.

In contrast, the rates of government-funded specialist mental health service use were all less than half those estimated above from NZMHS, but also the pattern across ethnic groups was considerably different. The pattern of ethnic group comparisons that emerged from the analyses of mental disorder prevalence and service use among NZMHS respondents was Cook Islands \approx Māori > Other Pacific \approx

Table 9.4 Estimated mental health specialist service use by ethnicity; rate per 1,000, RR and adjusted RR (95% CR).

	Cook Islands	Other Pacific	Māori	NMNP
All service users				
Rate per 1,000	17.2 (16.8,17.6)	16.6 (16.4,16.8)	34.6 (34.4,34.9)	22.8 (22.7,23)
RR -Unadjusted	1.000	0.964 (0.94,0.99)	2.015 (1.97,2.06)	1.327 (1.3,1.36)
RR – Adjusted for age and sex	1.000	0.909 (0.88,0.94)	1.748 (1.72,1.77)	1.063 (1.05,1.07)
First time users				
Rate per 1,000	7.1 (6.9,7.4)	7.4 (7.2,7.5)	13.9 (13.7,14)	9.6 (9.5,9.7)
RR -Unadjusted	1.000	1.041 (1.00,1.08)	1.950 (1.88,2.02)	1.349 (1.30,1.40)
RR – Adjusted for age and sex	1.000	1.691 (1.64,1.73)	1.126 (1.11,1.14)	0.983 (0.88,1.09)
Seen only once				
Rate per 1,000	1.2 (1.1,1.3)	1.3 (1.2,1.3)	2.2 (2.1,2.3)	1.5 (1.5,1.6)
RR -Unadjusted	1.000	1.057 (0.96,1.16)	1.836 (1.68,2)	1.278 (1.17,1.39)
RR – Adjusted for age and sex	1.000	0.969 (0.84,1.09)	1.634 (1.48,1.69)	1.047 (0.98,1.06)

NMNP. In the MHINC data the pattern of ethnic group comparison, after adjusting for age and sex, was Māori > NMNP > Cook Islands ≈ Other Pacific (Table 9.4).

As shown previously, 40% of Cook Islanders were seen for the first time each year and 10% were seen only once. These proportions were consistent across all ethnic groups.

While adjustment for age and sex reduced many of the ethnic differences for rates of total service use, the differences still remained. However, differences still remained distinct; even though NMNP had only 6% higher use, the $P_{RR} \approx 1.000$. Age and sex adjustment removed differences in rates of first time use and those seen only once between Cook Islanders and NMNP but, compared with Māori, differences remained.

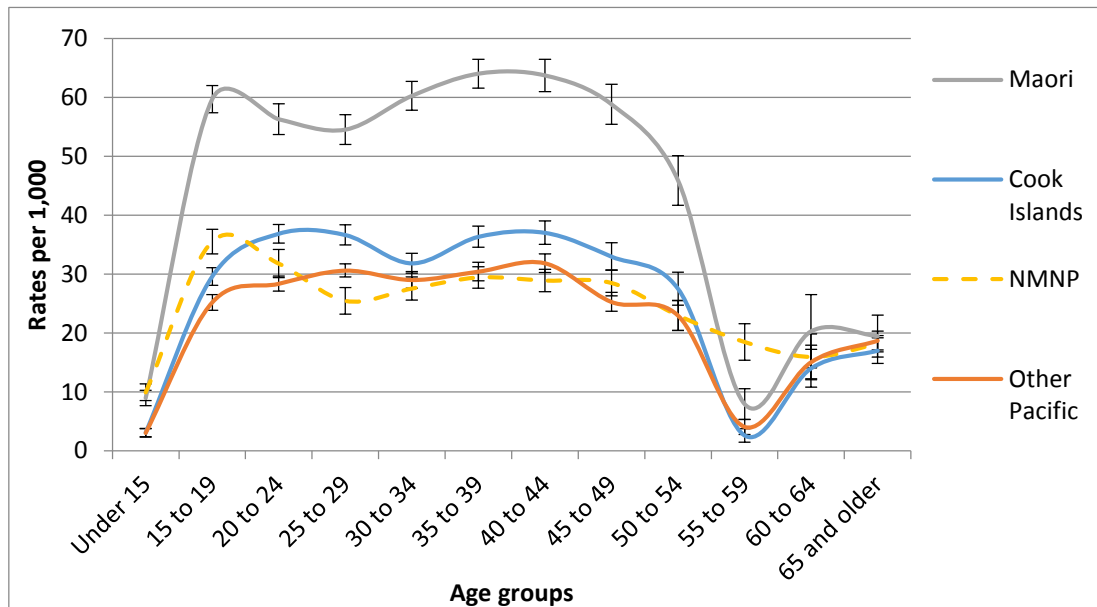


Figure 9.3 Any specialist mental health service use: age by ethnic group.

Figure 9.3 shows rates of specialist mental health service use by ethnicity across age groups. It shows that the four ethnic groups shared a common general pattern of rates of use with age. Two age groups had slight peak utilization at 15 to 24 years of age followed later by another peak among 35 to 44 year olds.

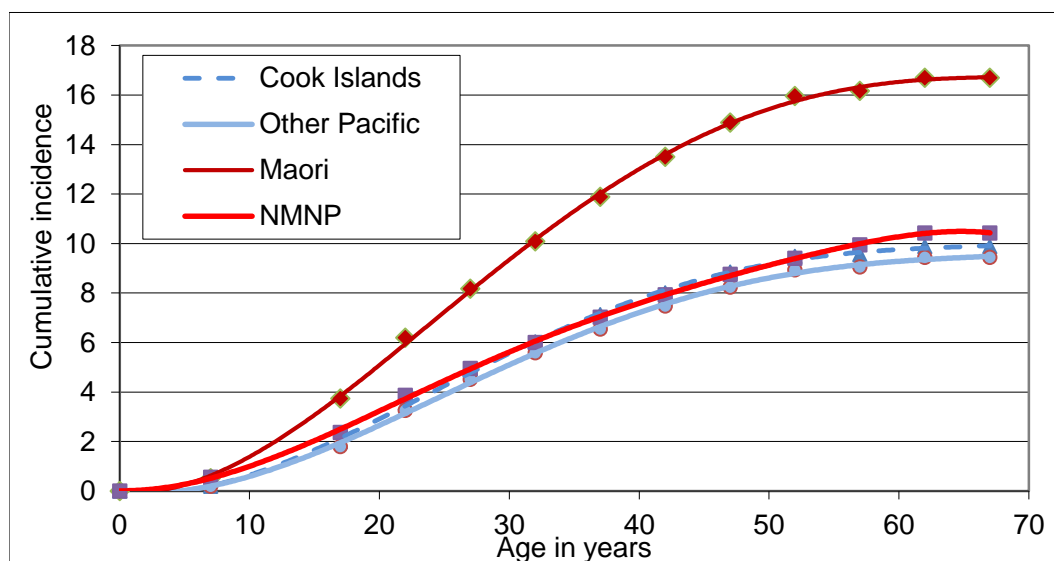


Figure 9.4 Onset of specialist mental health service use by ethnic group.

Age at first use

Using life table methods employed to produce figure 9.2 on the incidence of first time users in the age specific population, the cumulated probability of engaging a service over a lifetime was calculated and plotted in figure 9.4. It shows that service use among Cook Islanders over the course of their lifetime ran parallel and at a similar level to that of other Pacific as well as NMNP. Māori rates increased more rapidly from an early age until after 50 years of age. By the age of 65, around 10% of Cook Islanders and other Pacific had been seen by a government-funded specialist mental health service.

Services seen

Of those who had seen a specialist mental health service in 2008, table 9.5 shows that, after adjusting for age and sex, the proportions of Cook Islands users seen by each service were similar to those of other Pacific and to a lesser extent NMNP. Generally over 80% of people in the mental health system were seen by community mental health teams. Pacific and Māori peoples were at least 30% more likely to be seen by acute inpatient services and proportionately 50% more to two times as many Pacific and Māori were seen by forensic services.

Geographic deprivation and ethnicity

The age-adjusted rates of specialist mental health service use in areas of low deprivation were 24, 28 and 30 per 1,000 Cook Islanders, Other Pacific and Māori respectively. This compared to a rate of 14 per 1,000 for NMNP people living in the

Table 9.5 Proportions of mental health service users seen by service; 2008 adjusted for age and sex

	Cook Islands	Other Pacific	Māori	NMNP
Community mental health teams	84.2%	84.5%	76.6%	83.2%
Acute inpatient	12.1%	10.8%	11.4%	8.4%
Substance treatment	15.2%	14.9%	22.3%	15.8%
Forensic	6.8%	5.7%	7.8%	3.2%

similar areas. Figure 9.5 shows rate ratios across NZDEP06 quintiles relative to the first, least deprived group of geographic areas. It reveals a phenomenon originally published for Pacific in 2005 (Ministry of Health, 2005) showing that rates of service use among Pacific peoples varied little across geographic areas grouped by level of deprivation using the NZDEP06. Figure 9.5 shows that Pacific rates decreased with increased deprivation and were lowest in areas of greatest deprivation. This is in stark contrast to NMNP, whose rates of utilization rates show a strong association with deprivation, as does Māori to a lesser magnitude.

It shows that service use among NMNP in the areas of highest deprivation were 2.3 times those for people in the areas of lowest deprivation. The same rates for Cook Islanders in areas of highest deprivation were three quarters of those rates for people from areas of lower deprivation. The trend for other Pacific peoples was more dramatic where service use in areas of greatest deprivation was just over half those in areas of least deprivation.

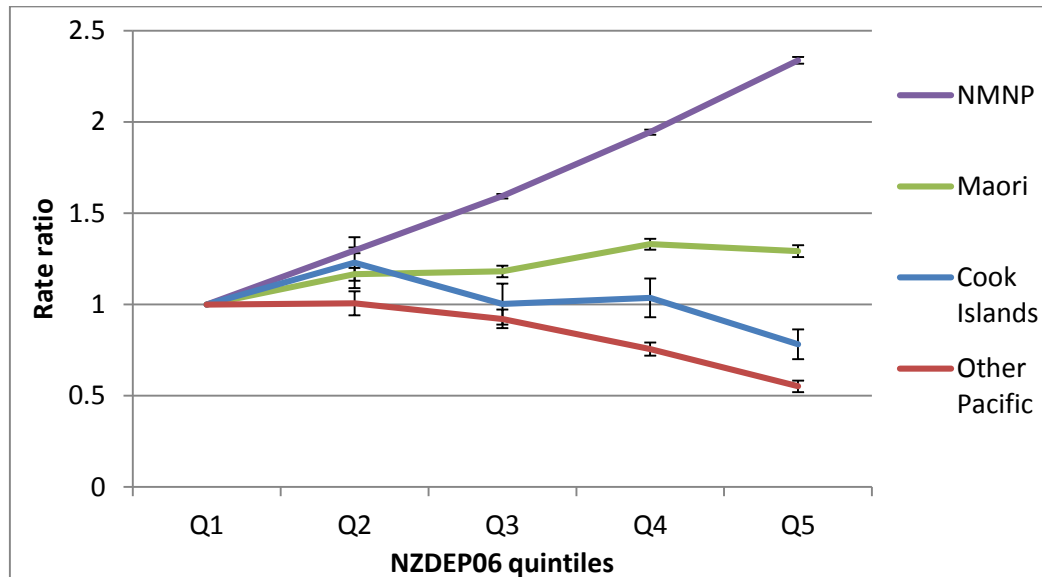


Figure 9.5 Rate ratios of mental health service use by NZDEP06 quintiles.

9.3. Discussion

9.3.1. Background

Te Rau Hinengaro (Oakley Browne et al., 2006c) indicated that in the previous 12 months, 3% of Pacific people had seen mental health specialist services for their mental health compared with 4.9% of the total population. The prevalence reported by MHINC is around half of that estimated by NZMHS. The reason for this lower prevalence is most likely because the NZMHS used a more inclusive definition of mental health specialist services than are able to be captured by the MHINC. It included private consultations with psychiatrists, psychologists, counsellors and mental health helpline contacts, not just the psychiatric admissions and other services provided by mental health specialty services which are captured in MHINC.

It has been shown (Foliaki et al., 2006a, 2006b) that Pacific peoples with a serious mental disorder were half as likely as NMNP to have seen any health service for their mental health problem, and Pacific peoples with any 12-month disorder were least likely ethnic group to have seen any health services for their mental health problems, even after adjusting for socio-demographic factors.

Preliminary published MHINC results had indicated that the average annual prevalence of mental health service use by Cook Islanders and other Pacific peoples were lower than both Māori and NMNP (Kokaua & Wells, 2009). Even after adjustment for different age and sex, structure of each population the differences remained significant.

By service category, over 80% of Cook Islands mental health service clients were seen by community services, a similar proportion to the three other comparative ethnic groups. However, 30% of Cook Islands clients were seen by inpatient services compared with 9% of NMNP, and 28% of Cook Islands clients were seen by forensic services compared to 3% of NMNP.

9.3.2. The hierarchical Bayes model

In 2009, a paper was published containing summary analyses of this data using logistic regressions (Kokaua & Wells, 2009). In addition, missing data, mainly ethnicity

and diagnosis, was addressed using multiple imputation. In this chapter we replicate some of the analyses of that paper using the models developed and described in Chapter 8. As reported in Chapter 8, the multiple imputation models produced similar results to the Bayesian models.

The hierarchical Bayes model used in this chapter is interesting in two ways. First, it has provided an alternative and convenient way of modelling data with observations that can be assumed missing at random. Secondly, although not absolutely necessary, the model was developed for aggregate data tables. Thus the model is applied in a situation where original unit record data is not available but an n-way table is available. Many an analyst, including myself, has been in a situation where a table of data is provided that includes a “not-specified” or similar category. This chapter provides an example of a logistic or Poisson model where the data used is in that format.

9.3.3. Summary of results

The importance of this dataset is that it reports a reasonably reliable and complete set of observations from all users of government-funded District Health Boards provider arm services between 2001 and 2008. From a historical perspective, it also gives an indication of what informed the government’s evidence base of prevalence of mental disorder among Pacific peoples as a whole. It was from this evidence that services were planned for Pacific peoples in New Zealand. Government funded mental health services, like all health services, are driven not only by the simple need but by their perceived need in terms of a government’s priority and the available resources to provide what is seen as current best practice. Ultimately, the use of mental health services is driven by communities understanding those needs and priorities as well as their willingness to take up the treatment.

The results in this study also show that while both Cook Islanders and Other Pacific peoples have rates of specialist mental health service use a third lower than NMNP their patterns of use, with a few exceptions, are similar to those who do interact with those services. In spite of lower annual use, by the time they reach 65

years of age, Cook Islanders and Other Pacific peoples share with NMNP a similar probability of around 10% of having been seen by a specialist mental health service.

One exception in the comparisons are that Pacific service users, Cook Islanders and Other Pacific peoples are proportionately 30% more likely to be seen in an acute inpatient service and 50% more likely to be seen in a forensic service than NMNP. The other major exception is that Pacific use is comparatively lower in areas of high deprivation both compared with NMNP in those areas and compared with areas of low deprivation.

One possible reason for the former is that a serious mental illness, and also disorder resulting in a criminal offence, are most likely to result in treatment. Results in chapter five show Cook Islanders have a higher prevalence of serious disorder. Conversely, community mental health treatment is less compulsory and the option to avoid treatment is available. Another reason, and possibly correlated, is the low treatment provision to Cook Islanders by community mental health teams could be a consequence of their opting to avoid such treatment for a less serious illness, leading in an increase in the number of people who develop a more serious illness. The consequence of which is more likely to result in an acute episode.

The other finding is one of comparatively low service use among communities in areas of high deprivation. These are areas where Pacific families are more prevalent and have established stronger traditional communities. Areas away from these communities have higher levels of specialist mental health service use.

Therein lies a quandary. Is the difference a product of greater treatment seeking in low deprivation, more contemporary, communities combined with traditional community's avoidance in areas of high deprivation? Or, are the latter communities protective in terms of requiring treatment from government-funded specialist mental health services while those in other areas are isolated? There is no current evidence to show that the prevalence of mental disorder is linked to neighbourhood deprivation indices.

Areas of lower deprivation consist of larger numbers of New Zealand-born Cook Islanders, a group more likely to seek treatment. Seventy one percent of Cook Islanders selected in the two quintiles of lowest deprivation were born in New Zealand. Older migrants have settled in established Pacific communities and make up 38% of the Cook Islanders in areas in the highest deprivation quintile compared with 18% of areas in the two lowest deprivation quintile.

However, there is a small but growing body of evidence in support of the argument for the positive influence of strong culture and social support on mental health.

9.3.4. Conclusions

There are many reasons that lead to Cook Islanders and other Pacific peoples to avoid treatment: understanding of mental illness, cultural background, knowledge and availability of services or perceived cost, to name a few. The evidence suggests that for whatever reasons, Cook Islanders are less likely to use government-funded mental health services in areas of highest population density. However, of some concern is that when they use mental health services, they appear more likely to receive treatment when their illness is extremely severe or under compulsion.

10 General Discussion

<i>10.0 Abstract</i>	206
<i>10.2 Methodology</i>	207
<i>10.3. Limitations of the study</i>	208
<i>10.4. Strengths of the study</i>	210
<i>10.5. Summary of findings</i>	212
<i>10.6. Implications from findings</i>	221
<i>10.7. Conclusions</i>	227

10.0 Abstract

The term “Pacific” as an ethnic group is an administrative construct, like most geographically-defined groups that are used to approximate cultural, racial or ethnic groups of people. In New Zealand, it is used to define those of the many ethnic groups from island nations throughout the Pacific. One of those groups, and the focus of this study, is comprised of people and descendants of people from the Cook Islands. This study is a piece of descriptive epidemiology that serves to highlight subgroups within a larger population cluster that are affected by increased risk of mental disorders and varying patterns of service use.

This thesis is comprised of two key elements. The first is an investigation of a methodology to improve the analysis of a small population such as the Cook Islands people. Hierarchical Bayesian models have been developed to address analytical issues that are specific to this project. The second component is the epidemiological analysis of mental disorder and service use among Cook Islanders in New Zealand. Within the latter, there are two further sections that represent the analysis of two separate data sets, each requiring different methodologies. One is survey-based with a complex design, where individuals are chosen with different probabilities of selection, even for different question sections in the questionnaire. The other is an administrative dataset developed by the New Zealand Ministry of Health to monitor government-funded specialist mental health services.

Generally, evidence shows that most of the ethnic differences in prevalence of mental disorders between Cook Islanders and others are explained by demographic factors. The only outstanding increased risk is for alcohol-related disorders that are not explained by their young population or seemingly by high proportions of people born in New Zealand. There is some evidence of excessive alcohol use by some sections of Cook Islands society that is moderated overall by a large proportion of abstinence. Like many communities in New Zealand the issue of excessive alcohol use is commanding a higher profile among youth, but these results appear to show a subtle level of alcohol use disorders among Pacific that is not limited to youth alone.

This chapter provides a discussion of key results from, and methodology developed for, this piece of work. There are potential implications for future health policy that affect Pacific communities in New Zealand.

10.2 Methodology

The approach has been to develop bespoke statistical models for the analyses of the NZMHS and MHINC datasets. The models for the NZMHS, described in Chapters 2 and 3 are Bayesian analogues of logistic or Poisson regressions for prevalence outcomes and Cox regressions with competing risks for onset of lifetime events. These address the complex design of the survey and question selection. The models for the MHINC, described in Chapters 7 and 8, are a novel application of the Bayesian logistic and Poisson regression to aggregate data that has a category for items not specified.

The Bayesian Cox regression model has been used to analyse onset of mental disorder by presenting cumulative incidence curves to the time of disorder onset. Furthermore, in the case of time to treatment and recovery from birth, this study has focused on the cumulative incidence of onset with competing risks. Very few Bayesian survival analyses have been applied to complex survey data and even fewer to the analysis by ethnic groups. Each model, as for the prevalence models, is set up to:

1. adapt to complex survey design; and is
2. reported for the four ethnic groups of interest.

The hierarchical Bayes model applied to MHINC data is interesting in two ways. Firstly, it has provided an alternative and convenient way to model data with observations that can be assumed missing at random. Secondly, although not absolutely necessary, the model was developed for aggregate data tables. Thus, the model is applied in a situation where original unit record data is not available but an n-way table is available. Many an analyst, including myself, has been in a situation where a table of data is provided that includes a “not specified” or similar category. This chapter provides an example of a logistic or Poisson model where the data used is in that format.

10.3. Limitations of the study

10.3.1. Model-based estimates

The NZMHS methodology and many of its limitations were dealt with by the study research group (Wells et al., 2006a). As far as this piece of work is concerned, any further limitations are mostly a result of the fact that modelling has been used to deal with a smaller sub-population. It is clear that this application has been used to try to improve the precision of the estimates for the analysis of Cook Islanders. However, the same method may smooth out many of the characteristics that it seeks to reveal. That is to say, even a model-based approach can have insufficient data to predict rare events in sparse cells in categorical models.

10.3.1. Data, data everywhere

MHINC is a vast dataset with confidentialised detail of over 90,000 individuals per year who used mental health services at some time between 31st July 2000 and 30th June 2008. Unfortunately, many of the tables contain data that are not consistently collected, meaning that much of the data must be used with caution and some of it is not useable at all. For example, because the dataset excludes, among other smaller community treatment services, long term residential stay services there is no indication of users of those services. Another example of inconsistent data collection is because in early years immediate diagnosis did not need to be reported, thus many people from this time have not had a diagnosis assigned.

At the time of the analysis for this study, it represented the best available data to reflect specialist mental health service use. For future studies, the subsequent PRiMHD database contains past MHINC and more recent and reliable data from a wider range of mental health services.

10.3.2. Recall bias

Estimating lifetime prevalence of mental disorder using a survey tool such as the NZMHS has also been shown to be problematic. As reported by Moffitt et al. (2010), problems with respondent recall can lead to substantial under-representation of lifetime prevalence estimates. It should be noted that the longitudinal studies lifetime prevalence estimates should compare to cumulative lifetime incidence of NZMHS. The lifetime prevalence estimates in the latter are calculated with right censored data, while a longitudinal study has the advantage of observing everyone at the age of the prevalence. However, it is unlikely that the differences observed would be overcome by the latter.

It is possible to develop a hierarchical Bayes model for lifetime prevalence that includes a hyper-parameter to represent this under-representation. This could conceivably be achieved by adding a conditioning parameter into the model and using the Moffitt estimates as a prior distribution for that parameter. This has not been done in this study.

10.3.3. Programming in SAS 9.2

One of the main constraints for the more complex models used in this study was the processing time required to run each model. While one is accustomed to waiting hours for complex models, and days for seriously complex models with large amounts of data, the processing time for even comparatively simple Cox regressions with 12,993 individuals in this study often required days for processing. This time requirement may not be an issue in a project where time is not an issue, but personal experience has shown many real world situations are dependent upon timelines, and as such, should be considered when employing some complicated models.

After deciding to use SAS 9.2 as the platform for processing the data, the best available software option for Bayesian analyses with a Gibbs sampler was to use

WinBugs version 4. Several people had developed macros for SAS to interface with WinBugs but even with many approaches to reduce the overall processing time it still remained excessive. For the more time-consuming models, it became more efficient to run WinBugs in Batch mode separately and call the data into SAS for post processing.

While BUGS is setup to run in R with comparative ease, the interface with SAS seemed less comfortable. A solution made available late in the study was to use a high speed computer. This required either using R or running the models in OpenBUGS. The latter required pre and post processing in SAS. The other alternative that became available later in the study was to use the MCMC procedure in SAS 9.3. Most of the models used in this study are now available in SAS 9.3.

10.4. Strengths of the study

10.4.1. Ability to analyse small populations

Few survey datasets have enough data to allow analyses at a sub-ethnic level such as for Cook Islanders. This can be because most studies are set up to analyse broader population groups, thus avoiding small population aberrations, or because study numbers do not support such analyses. In this instance, two substantial datasets are available, both of which have been set up and have sufficient numbers to enable a study of this group. The hierarchical models have also been used in an attempt to improve the precision of estimates from the survey data.

The importance of the NZMHS dataset is that it has informed, and continues inform, the processes that are reliant upon national prevalence of mental disorders and service use for mental health problems. From a Pacific perspective, it has also provided a wealth of information and changed previously held perceptions of mental illness and mental health service use in that community.

Design-based approaches use unbiased estimators for statistical inference for data that are gathered using complex sampling design such as the NZMHS. To produce such unbiased estimators a complex system of weights is required to reduce the biases of the estimators which would be obtained from unweighted estimators

(Pfeffermann, 1998; Little, 2004). Secondly, these estimators rely upon asymptotic theory to establish distribution or pseudo-distribution assumptions for the estimators. The result is a dependence upon larger samples to obtain increased precision.

Small area estimation methods have been developed to make inference about a small domain or sub-population, for whom a small sub-sample by conventional design-based theory would typically result in low levels of precision and would prohibit any useful inference (Ghosh & Rao, 1994; Rao, 2008; Pfeffermann, 2013). Hierarchical Bayesian models have been often used for small area estimation as it easily incorporates complex sampling design as long as the variables associated with the design are included in the analysis (Nandram & Sayit 2011). These attributes have been exploited for the models developed to analyse the NZMHS data. A further attribute that is inherent in Bayesian models is the potential for shrinkage from incorporating prior knowledge about the model. Stronger, more informed, priors will have a greater influence upon the increased precision than a less informed prior. While the latter does appear to be reflected in results, comparisons with estimates from models with non-informative priors over the semi-informative prior models that were used showed only a slight reduction in the precision of estimates. By far, the greater improvement in precision for prevalence estimates would appear to be from the borrowed precision by the sub-population from the wider sample as a whole.

The importance of the MHINC dataset is that it reports a reasonably reliable and complete set of observations from all users of government-funded District Health Boards provider arm services between 2001 and 2008. From a historical perspective, it also gives an indication of what informed the government's evidence base of prevalence of mental disorder among Pacific peoples as a whole. It was from this evidence that treatment services, or the lack of, were planned for Pacific peoples in New Zealand. The choice of tabulated data instead of unit record data is somewhat contrived in this context but presents an interesting analytical problem that required a novel application for Bayesian models. The use of tabulated data is also valuable for those analysts with no option but to analyse cross-tabulated data with missing or non-response fields.

As pointed out in chapter 9, Government-funded mental health services, as with other health services, are established not in response to population need but also to funding priorities and available resources. From within the latter constraint, services aim to provide what is seen as current best treatment practice. Ultimately, however, the use of mental health services by a community like Cook Islanders is driven by that communities understanding their own needs and priorities, in conjunction with their willingness to take up the treatment.

10.4.2 Methodology

A strength of Bayesian analyses is that one can improve the estimates from the analyses by incorporating prior specialist knowledge about the resulting statistic or contributing statistics at a lower level of the hierarchy. Earlier MHINC results were used to inform the NZMHS analyses. This is because MHINC represented a major source of data that informed perceptions of levels of mental illness in New Zealand prior to the NZMHS. This, along with international results, was used to inform the priors used in the NZMHS although in most cases the overwhelming contribution of the large sample was enough to over-ride all but unrealistically determined priors.

The Hierarchical models appeared to work satisfactorily with results seeming to reach convergence. For the models of diagnoses with no covariates, the predictive tests seemed to show good ability to estimate the observed occurrence. The covariate models seemed less capable to predict the observed occurrence but were still acceptable. Although not greatly different, models for Part II disorders also did not predict as well as those for Part I disorders. However, the results compare favourably with previously published results. The only other issue is the processing time for several chains of estimates, at around 2-3 hours for 20,000 runs for each chain.

10.5. Summary of findings

The study has brought to light the levels of mental disorder in New Zealand's Cook Islands communities that are in contrast to pre-NZMHS studies of Pacific nations and those living in New Zealand suggesting a low prevalence of mental disorder for Pacific peoples overall (Allen & Laycock, 1997; Ministry of Health, 2005). Each year, nearly one in three Cook Islands adults in New Zealand had a diagnosable 12 month

mental disorder, confirming findings published in earlier studies (Foliaki et al., 2006a, 2006b).

Te Rau Hinengaro (Foliaki et al., 2006a) reported that ethnic comparisons for any mental disorder for Cook Islands, Tongan and Samoan peoples showed initial indications that Cook Islanders had a higher 12 month prevalence of disorders than other Pacific groups. Several publications of NZMHS results have also reported the prevalence of mental disorder and service use for Māori in New Zealand (Baxter et al., 2006a, 2006b; Oakley Browne et al., 2006a) compared to the broader Pacific group and another composite group of people from non-Māori and non-Pacific (NMNP) ethnic groups.

As previously reported (Kokaua & Wells, 2009), results from this thesis showed that Cook Islanders also had elevated 12-month rates of mental disorders. A typical pattern was for Cook Islands and New Zealand Māori rates to be similar but higher than rates among other Pacific, and in turn above those for NMNP. The largest difference was usually between Cook Islanders and NMNP. Evidence shows that these differences for most disorders were almost entirely explained by differences in age and sex distributions within each population group. Comparisons with other ethnic groups revealed a pattern for lifetime disorder similar to that for 12 month prevalence of mental disorders where Māori > Cook Islanders > Other Pacific \approx NMNP. Adjustment for age and sex accounts for the differences in anxiety, eating and mood disorders between Cook Islanders and other Pacific or NMNP.

Section 6.5 showed that prior to 25 years of age, there appears to be a considerable group, as many as half with any disorder, of people that had neither been treated nor recovered. In fact, only half of people with any mental disorder were treated or recovered within 15-20 years of onset of their disorder. However, over the course of their lifetime there was a comparatively small group of Cook Islanders who remained without either receiving treatment, or recovered without treatment, for their mental disorder.

It has been previously shown that Cook Islands people were more likely than other Pacific peoples to seek treatment for their mental health problem but both

groups are less likely than Others and NZ Māori to visit any service, and specifically mental health specialist services in any given twelve months (Kokaua & Wells, 2006). There has also been a concern for many years that Pacific peoples seem to be over-represented in services that deal with extreme levels of mental illness (Ministry of Health, 2005). There has been an impression that combined Pacific people's use of mental health services in any given year, while generally lower than people from other ethnicities, required a level of treatment that was longer in duration and more costly (Gaines et al., 2003). These results seem to confirm that pattern for combined Pacific peoples' overall 12 month use of services for their mental disorder is lower than people from other ethnic groups. However, while this holds true for Cook Islanders for any service use, there appears to be less of a difference between Cook Islanders and NMNP use of mental health specialist services.

10.5.1 The effects of migration upon Cook Islanders to New Zealand

The evidence in this study shows that, in New Zealand, a Cook Islanders' risks of 12 month and lifetime prevalence, as well as cumulated lifetime incidence, of all disorders included in the study were higher than those for NMNP and other Pacific peoples. The results showed that much of the differences, particularly compared to NMNP, were mostly a result of confounding by age and sex differences at a population level. Beyond age and sex, with only a few exceptions, most, if not all, the remaining differences were mediated by either age at migration or, the somewhat related, place of birth variables. Additional socio-economic variable explained little more of the remaining differences in 12-month disorders.

The analysis of place of birth and 12-month disorder would suggest evidence that Cook Islanders and other Pacific peoples exhibit a "healthy immigrant" effect. The analysis of age at migration for Cook Islanders showed that those who immigrated also had lower risk of mental disorders. This is in spite of migrating to conditions of employment and socio-economic status that, for overall New Zealand, would place them at increased risk of poorer mental health. While a large part of this difference is explained by adjusting for age and sex, the effect still remains for all but Anxiety disorders.

Furthermore, immigrants who migrated before their teens also shared elevated risk with those who were born in New Zealand. This is consistent with an “Immigrant Paradox”, where the protective effect of the healthy immigrant is not extended to subsequent generations of migrant descendants who are born in the host country. This has been observed in many studies of Latin American immigrants to the USA (Alderete et al., 2000). Studies have also shown that subsequent generations of Latin migrant descendants shared similar levels of mood and substance use disorders to the overall host population (Karno et al., 1989; Orozco et al., 2013; Bostean, 2013; Eitle, Wahl & Aranda, 2009). Other studies that confirmed the Immigrant Paradox showed little or no difference between early age migrants and host country locals or children of immigrants (Breslau et al., 2007; Breslau et al., 2008; Alegria et al., 2008). While not conclusive for all Latin groups or other ethnic groups, many other studies also confirmed the Immigrant Paradox (Wu et al., 2010; Leong, Park & Kalibatseva, 2013; Williams et al., 2007).

Unlike many non-mental health related studies, comparatively few recent European studies appeared to support a wider Immigrant Paradox theory. Findings from a Belgian study of Moroccan immigrants confirmed the Immigrant Paradox but concluded that employment was a contributing factor to risk of psychosis in migrant groups (Fossion et al., 2002).

Several common theories emerged that attempt to explain the Immigrant Paradox. Known as a “selective” or “healthy” migrant hypothesis, migrants are asserted to be healthier to endure the process of migration, or the effects of acculturation on both descendants and immigrants. In a previous New Zealand study, it was suggested that a “healthy migrant” effect was present for Cook Islanders reported evidence of what was actually a “healthy immigrant” effect (Kokaua & Wells, 2009). In fact, there is insufficient evidence in this study to neither confirm nor refute a selective migrant hypotheses. In terms of the “*healthy migrant*” hypothesis, there is no evidence that shows Cook Island migrants are psychologically healthier than those who remain in the Cook Islands.

However, there is evidence to suggest that these results are more consistent with lower rates of mental disorder in their Island homes (Allen & Laycock, 1997). Bhugra (2005), suggests that rather than migrants who are more psychologically healthy immigrating, the greatest protective factor appears to be related to their country of origin as well as personal resilience. Region of origin has also been suggested as a confounder by other studies to mediate differences in migrant mental health (Jurado et al., 2014). It would appear that the low risk of mental disorders is associated with preadolescent upbringing in their native country, but, only if their native country had low prevalence of mental disorder (Breslau et al., 2008). Conversely, higher prevalence rates among migrants have been suggested may be due to higher prevalence in native country of origin (Amad et al., 2013).

Another suggested reason for the paradox is known as a “Salmon bias”. This suggests that less healthy immigrants, or those who become unwell, return to their home of origin. This also seems unlikely for Cook Islanders. While there is little evidence to support this hypothesis or otherwise, personal experience would suggest that while this may occur for low severity disorders, the range and quality of healthcare services available in New Zealand, particularly for mental illness, is considered superior. Thus, for severe disorders individuals are likely to remain in New Zealand.

Host acculturation, the process of a migrant group or individual blending with the culture of their host country at the expense of their native culture, is typically considered detrimental to the mental health of immigrants and their families (Flores & Brotanek, 2005). Native acculturation, or culture retention is considered beneficial. However, cultures who borrowed from their host culture while retaining their own native culture resulted in better mental health outcomes for immigrants as well as second generation migrants (Eitle et al., 2005). This would suggest that understanding the influence of acculturation on the health of all children will perhaps lead to the single most effective solution to poorer mental health in our time.

Studies on the impact of acculturation on migrant communities have suggested that adopting the host culture was not unhealthy but discarding

native/heritage culture was (Schwartz et al., 2011) and easing the process of integration into a host society will reduce the incidence of mental health problems (Haasen, Demilralay & Reimer, 2008).

Like many international studies, these findings have also highlighted the differences between the migrant Island born Cook Islander and the resident, New Zealand born, Cook Islander. Results from this study seem to support those international studies which showed lower rates of mental disorder among worker migrants (Flores & Brotanek, 2005). Cook Islanders who migrated as teen agers or older were less likely to have any mental disorder compared with other Cook Islanders, yet less likely to seek treatment for their disorder. This would appear to suggest that young immigrants and New Zealand born Cook Islanders are negatively affected by acculturation in New Zealand.

Boydell (2001), reported that ethnic density is protective for non-white immigrants in London. Immigrants to US it was found ethnic identity, family cohesion and native language proficiency were protective and social networking was protective for common mental disorders (Leong, Park & Kalibatseva, 2013). In a study of immigrants to New Zealand from Asia, Pacific, Britain, it was found that, along with discrimination and unemployment, friends and time with own ethnic group had a positive influence upon mental health (Pernice & Brook, 1996). A study of migrants from Samoa found that Samoans have a clear desire to stay connected to their villages and culture (McGarvey, Seiden, 2010).

In the 1970's, many newly immigrated Pacific communities sprang up in large density, low socio-economic, working-class areas in Auckland. In these communities, Pacific culture has thrived to the extent that many Auckland communities are now characterized by a pan-Pacific culture reflective of their demographic composition. This ethnic density, and supportive community, may have contributed to the healthier immigrant. However, Hajat et al. (2010) has suggested that acculturation may be related to improved health as much as decline, if the environment is high risk then acculturation is likely to be negative and the other way round if environment is low risk. The socio-economic risk factors that Pacific peoples inherited in communities

they had settled into may have had a greater negative effect on the more acculturated younger migrants and descendants.

It is worthy to note that Cook Islanders are more acculturated, less likely to retain their language and culture, than some other immigrant Pacific Islanders. For example, Samoans or Tongans, who make up most of the other Pacific group in the NZMHS, have become acculturated into New Zealand society while retaining much of their own cultural identity and language. This may be key to the difference in mental health between Cook Islanders and other Pacific. Secondly, Cook Islanders have a strong cultural similarity with Māori in New Zealand and are likely that “Host” acculturation in New Zealand would be influenced by Māori. As such, it may not be surprising that the characteristics of the acculturated Cook Islander may reflect the prevalence patterns of Māori rather than NMNP.

It would appear that in adapting to a contemporary New Zealand society, Cook Islands communities have had an impact upon the children of migrant workers in terms of vulnerability to mental illness. These have been magnified by their comparatively young structure. Presumably over time and as their population increases, with increased numbers in older age groups, subsequent generations of Cook Islanders may achieve the same levels of risk that was shared by NMNP. Yet the evidence presented suggests differences in some disorder groups are not entirely explained by demographic or socio-economic characteristics alone. The fact also that migrant Cook Islanders had much lower levels of disorder leaves one with the question as to what the “native origin” level of disorder risk for Cook Islanders could be. Is it possible to attain that while remaining subjected to the pressures of contemporary New Zealand society? Both Pacific and Asians reported discrimination by mental health services; mis- or over- diagnosis and mistreatment (Pernice and Brook, 1996).

Finally, it should also be noted that neither age, sex, age at migration, nor other covariates completely mediated the increased risk in alcohol and substance disorders. Thus, Cook Islanders have increased risk of alcohol use disorder above other Pacific and NMNP that does not reflect either an immigrant paradox, or even a “healthy immigrant” effect.

Many international studies have sought to show any existence, or lack of evidence, for a healthy immigrant or immigrant paradox. Hajat et al. (2010) concluded that no immigrant mortality paradox was present for Pacific people in New Zealand. This study suggests there is an immigrant paradox for any mental disorder but not for substance related disorders. They also found regional nativity influences for mortality. The evidence presented in this study suggest that there are intra-Pacific nativity influences for any mental disorder.

10.5.2 Use of mental health Services by Cook Islanders in New Zealand

Studies have shown the less acculturated immigrants were also less likely to use mental health services. Women, and those who were less acculturated, were more likely to use complimentary alternative medical services (Fang, Schinke, 2007; Schaffer et al., 2009).

The results from this study also shows that while both Cook Islanders' and Other Pacific people's rates of 12 month use of specialist mental health services were a third of that for NMNP, their patterns of use, with a few exceptions, were similar to others who interact with the same services. In spite of lower annual use, by the time they reached 50 years of age, Cook Islanders and Other Pacific peoples shared with NMNP a similar probability of about 10% having been seen by a specialist mental health service.

Very few of the ethnic differences in 12 month treatment for mental health problems were explained by external factors, with the exception of age at migration. Other studies have found that mental health service use is affected by legal and/or financial access to care, language, lack of knowledge and communication (Lindert et al., 2008; Vega, Kolody, & Aguilar-Gaxiola, 2001). Environmental influences such as transportation, employment, patient-provider issues and immigrant documentation were identified as barriers to immigrants accessing mental health care (Wells et al., 2013; Alegria et al. 2007). However, the findings from this study would suggest that the low use by Pacific peoples in New Zealand may be the result of factors other than demography and socio-economic status.

Further evidence would also suggest that, for whatever the reasons, Cook Islanders appear less likely than other New Zealanders to access specialist treatment services in the early stages of mental illness and more likely to receive treatment for acute episodes, if seriously unwell, or under compulsion.

While this is not an economic analysis, the impact of seemingly small differences in prevalence can be portrayed by considering the estimated funding that would be allocated to a population of this size. In 2008, the total national mental health budget was one billion dollars to address the needs of 100,000 people, or \$10,000 per person. Using this ballpark figure and ignoring the complexity of types of services delivered, table 10.1 shows an estimate of the total spend in 2008 if Cook Islanders had: a) the same levels of use as NMNP people, or b) the increased risk of serious disorder. Potentially, in the latter, more extreme case, the number of users would be increased by 63% to comprise more than 2% of the total population. The funding difference, though hypothetical, provides an indication of the burden that at best is carried by other health services but at worst is borne by the community itself each year. If fully realized the annual imbalance is likely to have had a cumulative

Table 10.1 Potential burden of increased risk of mental disorder on numbers of government-funded specialist mental health service users in 2008.

		Cook Islanders	Percent of all ethnic groups combined
Cook Islands 2008 adult population	number	59963	1.53%
People with any mental disorder	relative risk to NMNP	1.43	2.19%
People with a serious mental disorder	relative risk to NMNP	1.63	2.50%
Government funded mental health services			
a) 2008 use and estimated funding	number	1303	1.29%
	spend	\$ 13.03M	
b) Expected 2008 use with total population levels of service use	number	1548	1.51%
	spend	\$ 15.48M	
c) Expected 2008 use with Cook Islanders risk of serious disorder	number	2122	2.10%
	spend	\$ 21.22M	

effect upon care of Cook Islands people with mental health needs. A further complication is caused by the observation that all Pacific service users were 30% more likely to be seen in an acute inpatient service and 50% more likely to be seen in a forensic service than NMNP.

The prevalence of mental disorder was higher for Cook Islanders than anticipated prior to the NZMHS. However, this population still had comparatively low levels of treatment in government-funded mental health services. This was in spite of Cook Islanders having a high prevalence of mental disorder, particularly substance use related disorders. It was also despite some evidence that they had similar levels of treatment-seeking for mental health issues. Cook Islands men were less likely to receive treatment or recover from a mental disorder. However, among those with alcohol disorder, the group with the highest prevalence, New Zealand-born Cook Islands men, was also most likely to receive treatment or recover. The evidence presented points to a discrepancy in relative high levels of need and what might be considered a healthy level of specialist mental health services treatment by those who need it.

The other potential anomaly is that Pacific peoples' overall use of services was comparatively low in areas of high socio-economic deprivation, both compared with NMNP in those areas and compared with Pacific in areas of low deprivation. As pointed out in chapter nine, areas of lower deprivation consist of larger numbers of New Zealand-born Cook Islanders, a group more likely to seek treatment (Kokaua et al., 2009). Conversely, older migrants have settled in established Pacific communities in areas with the higher deprivation. The latter is a group who are less likely to seek treatment. In conjunction to the latter observation, there is some evidence in support of the argument for the positive influence of strong culture and social support on mental health (Borrows et al., 2010).

Another finding is that nearly half (47%) of people remained untreated or without any recovery as many as 25 years after the onset of their disorder. Oddly, the groups with a comparatively low risk of disorder appeared to have the highest risk of non-treatment or recovery.

10.6. Implications from findings

The areas of implications for potential future development are fourfold. They are; policy, future research, treatment and promotion.

10.6.1 Policy

In spite of many of the findings in this study, Cook Islands and other Pacific communities are moving positively to overcome the apparent inequity in levels of mental illness accompanied by an underutilization of support or treatment services. Over the past two decades, several Pacific specialist mental health and community based mental health services have been developed. In addition, a Pacific organization has grown to oversee the bridge between mental health Policy, key research and implementation in the Pacific community. Le Va² since its inception has developed into a key resource for mental health, disability and addictions workforce development initiatives as well as filling a gap for providing the Pacific mental health sector with valuable direction.

Migration, cultural identity and mental distress are linked and clinicians must take into account cultural background to enable a stronger therapeutic alliance (Bhugra, 2005). Long term, migrant specific treatments are recommended with multimodal and culture sensitive treatment options (Agorastos, Haasen & Huber, 2012).

In the past it has been found that immigrant patients had reportedly experienced discrimination by mental health services with mis- or over- diagnosis and mistreatment (Pernice & Brook, 1996). Since that publication, the whole of mental health service delivery in New Zealand has changed dramatically to a less institutionalized model and, hopefully, accountability structures have improved. However, at the time of this study, the interaction between mentally unwell Pacific peoples with specialist acute or forensic mental health services remains disproportionately high. Recent studies have reported that while there have been improvements in many areas of treatment for severe mental disorder in the general

² Le Va is part of Pacific Inc. Ltd, an organisation which is part of the Wise Group (www.Leva.co.nz)

population, these do not appear to extend to immigrants with severe mental illness (Arvidsson & Hultsjo, 2009; Orozco et al., 2013). Internationally, challenges remain in some countries to bring cultural competence and ethnic diversity as an everyday clinical practice in mental health care (Machleidt & Sieberer, 2013). However, seeking to find an optimal solution to service delivery need not overlook “common ground” (Kamperman, Komproe & de Jong, 2007). While most of the issues that arise from those studies might not apply to existing Pacific services, many are still relevant for non-Pacific services.

Among a growing plethora of models developed around cultural metaphors, two longstanding models of Maori and Pacific conceptualisations of health and wellbeing, Fono Fale models, and Te Whare Tapa Wha (Crawley, Pulotu-Endemann, & Stanley-Findlay, 1995; Durie, 1994), have served as a foundation for many mental health care services in New Zealand. Those models were based upon attributes of health and wellbeing in the context of a cultural setting. Several studies have further investigated concepts around ethnicity, traditional and contemporary culture, mental health and mental health service delivery for Pacific peoples (Bush et al., 2009). Understanding spiritual and cultural values of the collective group, their use of language and hospitality, and taking time to build a rapport, and a balance of mind, body and soul identified Pacific models. Individually values that, while not uniquely Pacific, were not descriptive of conventional medical models of treatment (Suaalii-Sauni et al., 2009).

The full realization of an overarching policy developed for the mental health of Pacific peoples in New Zealand reflecting the cultural diversity between individual Pacific communities and acknowledging the immigrant and New Zealand-born differences. Understanding the wider worldview of non-Eurocentric models of health and wellness, beyond the compartmentalized physical and separate mental wellbeing, has not been easy to implement in a bureaucracy as territorial as a nations health system. However, there have been several recent government initiatives, in primary mental health care and Whanau Ora, which offer opportunities to incorporate Pacific specific initiatives.

Prior to ten years ago, most of the Pacific initiatives appear to have developed as a reactive or opportunistic response to funding or policy opportunities; lacking a clear direction for the mental health and its treatment for Cook Islanders and other Pacific peoples in New Zealand. Furthermore, addressing the balance between native and host acculturation effects appears to be lacking. While it is easy to acknowledge the benefits of a balance between lower risk of mental disorders associated with native acculturation and higher risk yet increased service access by those who are more acculturated to New Zealand society. That is particularly difficult without understanding what is “healthy” about the native immigrant Pacific culture and how transferrable is other non-Pacific born communities.

10.6.2 Research questions

There are differences between Other Pacific peoples, and native Cook Island-born peoples, and New Zealand born Cook Islanders, that remain after accounting for demographic and selected socio-economic structures. Thus an interesting question is, what facilitates a mentally “healthy immigrant” from the Pacific? The flip side of that question is what aspects of “acculturation” in New Zealand, lead to improved or aggravated risk levels of disorder, and to unhealthy mental health treatment access or practices. Flores & Brotanek (2005), point out that understanding the influence of acculturation on the health of all children will perhaps lead to the single most effective solution to poorer mental health in our time. This would require a two way transnational study with potential to benefit the wider Pacific as well as Pacific migrants.

In addition, the impact of alcohol on the New Zealand-born, predominantly male, population is alarming. The results shown appear to suggest that there is also an underlying level of substance use leading to disorders among immigrant men. This puts a tarnish on the healthy immigrant for mental health, but additionally adds an interesting dimension to the immigrant paradox that requires further investigation.

Cook Islanders, for whatever reason, have extremely high levels of mental disorder that has previously gone unrecognised. An issue for mental health treatment has been the inappropriate entry by Pacific Islanders with symptoms of mental

distress, into specialist mental healthcare which is in addition to their mis-diagnosis when admitted to specialist mental health services. International studies have found that poor clinician understanding of cultural issues and language were considered likely to lead to miscommunication of disorder (Minas, Stuart & Klimidis, 1994). The development of a culturally sensitive diagnostic instrument has been found to reduce or remove relative ethnic differences in over diagnosis of schizophrenia (Zandi et al., 2010).

10.6.3 Treatment

Transcultural psychiatry involves careful and ongoing reflection of the culture and social background of patients. Differences in disease concepts can lead to communication problems and inappropriate care, leading to cultural competent diagnosis and treatment (Schouler-Ocak, Hasaan & Heinz, 2008). Mis-diagnosis of mentally ill immigrants was caused by culturally inappropriate diagnostic tools and language differences. High diagnosis of schizophrenia associated with immigrants with language difficulties (Schouler-Ocak et al., 2008). It should be pointed out that over the last five years there has been a marked improvement in the diagnosis of people seen at all levels of the mental health system in New Zealand. It is unknown how much those initiatives have impacted upon the diagnoses received by Pacific mental health service users.

The results from this study show that, in 2008, just over 1300 Cook Islanders out of 4200 Pacifica peoples overall, used mental health services. These results also suggest that most will be second generation Cook Islanders, born in New Zealand, and less likely to come from areas with high Pacific population densities. Around 400 Cook Islanders were seen for the first time; three quarters of whom were seen by community mental health teams, a quarter were seen in substance use treatment services, around 25 were seen by acute services and just over 25 were seen in forensic services. Although comparatively few, they represent an unacceptably high proportion of any community seen for the first time by such services. As reported, overall the proportion of Cook Islanders seen in acute inpatient services is 50% higher than and by forensic services two times that of NMNP. If that pattern had not changed since 2008, it would be a strong indication that while much activity had occurred in

the mental health sector, little had improved for the plight of Cook Islanders and probably Pacific peoples overall.

In 2009/10, just over 6700 Pacific peoples had been seen by mental health services and, by 2011/12, the number of Pacific peoples had increased to 8249 (Ministry of Health, 2013; 2014). It is possible that a major part of the twofold increase over the four year period between 2007/2008 and 2011/2012 is a result of improvements in the reporting procedures for ethnicity adopted by DHBs in New Zealand. The fact that overall there was a 50% increase in mental health service users in the same time period would suggest that the remaining increase was from additional Pacific service users. Any increase of this nature is likely to be a correction to what has been shown to be an underserved group in terms of mental health services. This would likely be the result of many recent Pacifika initiatives and developments in mental health services in New Zealand most of which can be reviewed online on the Le Va website.

The Pacifika mental health service population in 2011/2012 would suggest that around 2500 Cook Islanders were seen by mental health services. This level of treatment may well represent an appropriate increase to meet the level of psychiatric morbidity within the Cook Islands community. While the proportion of Pacific service users seen in acute inpatient services in 2011/2012 is similar to that of others, there should still be concern that the proportion seen in forensic services are still comparatively high.

It is important that health care professionals do not confuse or conflate Cook Islanders, particularly those born in New Zealand, with New Zealand Māori. The cultural differences, though subtle to clinicians from non-Pacific cultures, are real and more complex than has been considered in the past. Although, over the course of their lifetime, a comparatively small group of Cook Islanders remained either without treatment, or recovered from their mental disorder, section 6.5 showed that prior to 40 years of age, there appear to be a considerable number of people who had neither been treated nor recovered. In fact, only half of people with any mental disorder were treated or recovered within 15-20 years of onset of their disorder.

Many Pacific Islanders as a whole are still not receiving mental health treatment in the best possible setting.

10.6.4 Messages to Cook Islands communities

Further questions remain about many of the determinants of the ethnic differences found in this study. In particular, which protective aspects of their traditions, culture and world views are transferrable to New Zealand-born Cook Islanders? Conversely, what are the best approaches to traditional communities in New Zealand that will facilitate increased access to treatment for mental disorder?

Key messages to young New Zealand-born Cook Islanders could be: finding psychologically healthy pathways in the face of non-traditional values and availability of a variety of temptations and substance; incorporate a strong but youthful Cook Islands cultural and language presence in key health messages directed at that cohort; key risk factors that are evident for the rest of society in their age cohort are likely to be felt by this group. Their reaction to those risk factors must be viewed within a non-Eurocentric values system in order to effectively address the illness in the context of the whole person within their family and community.

For older immigrant Cook Islanders, the key message is that some will become mentally unwell but there are ways of identifying if they are becoming so, and also there are well established means of caring their way to becoming mentally well again. These messages need to be not only in Cook Islands language but with reference to the cultural values and principles of care that will maintain the *vaerua* (spiritual integrity) of the individual.

Mental health and healthy substance use, its maintenance, care and treatment, ought to be seen as part of the Cook Islands mainstream, reflecting the diversity of being from the Cook Islands and living in New Zealand.

10.7. Conclusions

Part of this thesis is descriptive, and documents the estimated prevalence of mental disorders, and resulting patterns of treatment seeking, and service use by Cook Islanders living in New Zealand. This chapter documents for the first time an extensive

picture of 12 month and lifetime mental disorders and some of its determinants. The content material itself is also unusual, as at the start of this project there were few research publications that reported on wider Pacific mental illness and mental health service use, and far less for Cook Islands people living in New Zealand.

The findings show that over a 12 month period, a third of Cook Islands adults had any disorder, one in ten, a serious disorder and a similar amount with a substance disorder. The 12 month prevalence of disorders among Cook Islanders was high compared to other Pacific and NMNP peoples. Many of the differences were explained by age and sex structure of this comparatively young Cook Islands population. Ethnic differences in mood, eating, substance and serious disorders remained after adjusting for age and sex. Even after adjustment for other covariates, ethnic differences in mood, eating, substance and serious disorders still remained. Other covariates that stood out after adjustment for both demographic and other socio-economic covariates were the higher prevalence associated with living in a single adult home, and the lower prevalence associated with being married and employed.

There are many reasons that lead to Cook Islanders and other Pacific peoples to avoid treatment: understanding of mental illness, cultural background, knowledge and availability of services or perceived cost, to name a few. The evidence suggests that for whatever reasons, Cook Islanders are less likely to use government-funded mental health services in areas of high deprivation which are also areas of highest Cook Islands population density. However, it is of some concern that Cook Islanders are more likely to receive mental health treatment when it is severe or under compulsion.

References

- Abbott, M. W., Wong, S., Williams, M., Au, M., & Young, W. (1999). Chinese migrants' mental health and adjustment to life in New Zealand. *Australian and New Zealand Journal of Psychiatry*, 33(1), 13-21.
- Abhary, S., & Koopowitz, L. F. (2004). Psychiatric aspects of detention: illustrative case studies. *Australian & New Zealand Journal of Psychiatry*, 38, 495-500.
- Aczon-Armstrong, M., & Reyes-Savail, F. (2013). Depression and Chronic Illness: Asian/Pacific Islander Adults in Hawaii. *Issues in Mental Health Nursing*, 34, 11. doi: 10.3109/01612840.2012.738356
- Aglipay, M., Colman, I., & Chen, Y. (2013). Does the healthy immigrant effect extend to anxiety disorders? Evidence from a nationally representative study. *J Immigr Minor Health*, 15(5), 851-857. doi: 10.1007/s10903-012-9677-4
- Agorastos, A., Haasen, C., & Huber, C. G. (2012). Anxiety disorders through a transcultural perspective: implications for migrants. *Psychopathology*, 45(2), 67-77. doi: 10.1159/000328578
- Ajwani, S., Blakely, T., Robson, B., Atkinson, J., & Kiro, C. (2003). Unlocking the numerator-denominator bias III: adjustment ratios for 1981-1999 mortality data: the New Zealand Census-Mortality Study. *New Zealand Medical Journal*, 116(1175), 456.
- Ajwani, S., Blakely, T., Robson, B., Tobias, M., & Bonne, M. (2003). Decades of Disparity: Ethnic mortality trends in New Zealand 1980-1999 (pp. 191). Wellington: Ministry of Health and University of Otago.
- Alderete, E., Vega, W. A., Kolody, B., & Aguilar-Gaxiola, S. (2000a). Lifetime prevalence of and risk factors for psychiatric disorders among Mexican migrant farmworkers in California. *American Journal of Public Health*, 90, 608-614.
- Alegria, M., Canino, G., Shrout, P. E., Woo, M., Duan, N., Vila, D., . . . Meng, X. L. (2008). Prevalence of mental illness in immigrant and non-immigrant U.S. Latino groups. *Am J Psychiatry*, 165(3), 359-369. doi: 10.1176/appi.ajp.2007.07040704
- Alegria, M., Mulvaney-Day, N., Woo, M., Torres, M., Gao, S., & Oddo, V. (2007). Correlates of past-year mental health service use among Latinos: results from the National Latino and Asian American Study. *Am J Public Health*, 97(1), 76-83. doi: 10.2105/ajph.2006.087197
- Allen, J., & Laycock, J. (1997). Major mental illness in the Pacific: a review. *Pacific Health Dialog*, 4(2), 105-118.
- Amad, A., Guardia, D., Salleron, J., Thomas, P., Roelandt, J. L., & Vaiva, G. (2013). Increased prevalence of psychotic disorders among third-generation migrants: results from the French Mental Health in General Population survey. *Schizophr Res*, 147(1), 193-195. doi: 10.1016/j.schres.2013.03.011
- Andrews, G. (1991). The Tolkien Report: A description of a model mental health service. Sydney: Clinical Research Unit for Anxiety Disorders, St Vincent's Hospital.
- Andridge, R., & Little, R. J. (2010). A Review of Hot Deck Imputation for Survey Non-response. *Int Stat Rev.*, 78(1), 25. doi: 10.1111/j.1751-5823.2010.00103.x.
- APA. (1994). *Diagnostic and Statistical Manual of Mental Disorders: DSM-IV* (4th ed.). Washington, DC: American Psychiatric Association.
- Arvidsson, H., & Hultsjo, S. (2009). Needs and care of migrants considered as severely mentally ill--cross-sectional and longitudinal studies of a Swedish sample. *Eur Psychiatry*, 24(8), 533-539. doi: 10.1016/j.eurpsy.2009.01.007

- Aseltine, R., & Kessler, R. C. (1993). Marital Disruption and Depression in a Community Sample. *Journal of Health and Social Behavior*, 34(3), 237-251.
- Baddeley, J. (1985). Traditional healing practices of Rarotonga, Cook Islands. In C. Parsons (Ed.), *Healing practices in the South*. Hawaii: The Institute for Polynesian Studies.
- Baker, D., North, K., & team, T. A. s. (1999). Does employment improve the health of lone mothers? . *Social Sciences and Medicine*, 49, 121-131.
- Bannerjee, S., Kauffman, R. J., & Wang, B. (2007). Modeling Internet firm survival using Bayesian dynamic models with time-varying coefficients. *Electronic Commerce Research and Applications*, 6, 332-342.
- Bauman, A. E., Sallis, J. F., Dzewaltowski, D. A., & Owen, N. (2002). Toward a Better Understanding of the Influences on Physical Activity. The Role of Determinants, Correlates, Causal Variables, Mediators, Moderators, and Confounders. *American Journal of Preventive Medicine*, 23(2S), 5-14.
- Baxter, J., Kingi, T. K., Tapsell, R., & Durie, M. (2006). Prevalence of mental disorders among Maori in Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS). *Australian and New Zealand Journal of Psychiatry*, 40(10), 914-923.
- Baxter, J., Kokaua, J., Wells, J. E., & Oakley Browne, M. A. (2006). Ethnic comparisons in Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS). *Australian and New Zealand Journal of Psychiatry*, 40(10), 905-913.
- Belin, T. R., Diffendal, G. J., Mack, S., Rubin, D. B., Schafer, J. L., & Zaslavsky, A. (1993). Hierarchical Logistic Regression Models for Imputation of unresolved Enumeration Status in Undercount Estimation. *Journal of the American Statistical Association*, 88(423), 1149-1159.
- Berry, J., Kim, U., Minde, T., & Mok, D. (1987). Comparative studies of acculturative stress. *International Migration review*, 21, 491-511.
- Bhugra, D. (2003). Migration and Depression. *Acta Psychiatrica Scandinavica*, 418(Supp 1), 67-72.
- Bhugra, D. (2004). Migration and mental health. *Acta Psychiatrica Scandinavica*, 109, 243-258.
- Bhugra, D. (2005). Cultural identities and cultural congruency: A new model for evaluating mental distress in immigrants. *Acta Psychiatrica Scandinavica*, 111, 84-93.
- Blakely, T., Richardson, K., Young, J., Callister, P., & Didham, R. (2009). Does Mortality vary between Pacific groups in New Zealand? Estimating Samoan, Cook Island Maori, Tongan, and Niuean mortality rates using hierarchical Bayesian modelling. *The New Zealand Medical Journal*, 122(1307), 18-29.
- Borrows, J. W., M, Schluter, P., Paterson, J., & Helu, S. L. (2010). Pacific Islands Families Study: The Association of Infant Health Risk Indicators and Acculturation of Pacific Island Mothers Living in New Zealand. *Journal of Cross Cultural Psychology*, 42(3), 26. doi: DOI: 10.1177/0022022110362750
- Bostean, G. (2013). Does selective migration explain the Hispanic paradox? A comparative analysis of Mexicans in the U.S. and Mexico. *J Immigr Minor Health*, 15(3), 624-635. doi: 10.1007/s10903-012-9646-y
- Boydell, J., Van Os, J., Mckenzie, K., & al., e. (2001). Incidence of schizophrenia in ethnic minorities in London: ecological study into interactions with environment. *British Medical Journal*, 323, 1336-1338.
- Breslau, J., Aguilar-Gaxiola, S., Borges, G., Kendler, K. S., Su, M., & Kessler, R. C. (2007). Risk for psychiatric disorder among immigrants and their US-born descendants: evidence from the National Comorbidity Survey Replication. *J Nerv Ment Dis*, 195(3), 189-195. doi: 10.1097/01.nmd.0000243779.35541.c6

- Breslau, J., Borges, G., Hagar, Y., Tancredi, D., & Gilman, S. (2009). Immigration to the USA and risk for mood and anxiety disorders: variation by origin and age at immigration. *Psychol Med*, 39(7), 1117-1127. doi: 10.1017/s0033291708004698
- Breslau, J., Borges, G., Tancredi, D. J., Saito, N., Anderson, H., Kravitz, R., . . . Mora, M. E. (2011). Health selection among migrants from Mexico to the U.S.: childhood predictors of adult physical and mental health. *Public Health Rep*, 126(3), 361-370.
- Breslau, J., Kendler, K. S., Su, M., Gaxiola-Aguilar, S., & Kessler, R. C. (2005). Lifetime risk and persistence of psychiatric disorders across ethnic groups in the United States. *Psychological Medicine*, 35(3), 317-327.
- Bridgeman, G. (1996). *Mental Illness and People from the Island Nations of the Pacific*. Wellington: Mental Health Foundation of New Zealand.
- Brooks, S. P., & Gelman, A. (1998). General Methods for Monitoring Convergence of Iterative Simulations. *Journal of Computational and Graphical Statistics*, 7(4), 434-455.
- Browne, W. J., Draper, D., Goldstein, H., & Rabash, J. (2002). Bayesian and likelihood methods for fitting multilevel models with complex level-1 variation. *Computational Statistics & Data Analysis*, 39, 203-226.
- Butterworth, P. (2004). Lone mothers' experience of physical and sexual violence: association with psychiatric disorders. . *The British Journal of Psychiatry*, 184, 21-27.
- Butterworth, P., Fairweather, A., Anstey, K., & Windsor, T. (2006). Hopelessness, demoralization and suicide behaviour: the backdrop to welfare reform in Australia. . *Australian and New Zealand Journal of Psychiatry*, 40, 648-656.
- Butar, F. B., & Lahiri, P. (2003). On measures of uncertainty of empirical Bayes small-area estimators. *Journal of Statistical Planning and Inference*, 112(1-2), 63-76. doi: [http://dx.doi.org/10.1016/S0378-3758\(02\)00323-3](http://dx.doi.org/10.1016/S0378-3758(02)00323-3)
- Bush, A., Chapman, F., Drummond, M., & Fagaloa, T. (2009). Development of a child, adolescent and family mental health service for Pacific young people in Aotearoa/ New Zealand. *Pacific Health Dialog*, 15(1).
- Cairney, J., Boyle, M. H., Offord, D., & Racine, Y. A. (2003). Stress, social support and depression in single and married mothers. . *Social Psychiatry & Psychiatric Epidemiology*, 38, 442-449.
- Cantor-Graae, E., & Selten, J. P. (2005). Schizophrenia and Migration: a meta-analysis and review. *American Journal of Psychiatry*, 162, 12-24.
- Carrigan, G., Barnett, A. G., Dobson, A. J., & Mishra, G. (2007). Compensating for Missing Data from Longitudinal Studies Using WinBUGS. *Journal of Statistical Software*, 19(7).
- Chen, C., Wakefield, J., & Lumely, T. (2014). The use of sampling weights in Bayesian hierarchical models for small area estimation. *Spatial and Spatio-temporal Epidemiology*, 11(0), 33-43. doi: <http://dx.doi.org/10.1016/j.sste.2014.07.002>
- Clayton, D. (1991). A Monte Carlo Method for Bayesian Inference in Frailty Models. *Biometrics*, 47(2), 467-485.
- Cockrum, J., & White, P. (1985). Influences on the Life Satisfaction of Never Married Men and Women. *Family Relations*, 34(4), 551-556.
- Collings, S., Mckenzie, S., Dowell, A. C., Currey, N., Gandar, P., & Rees, D. (2010). Toolkit for Primary Mental Health Care Development: Research Report. (pp. 30-35): University of Otago and Synergia Ltd.
- Congdon, P. (2002). *Introduction to bayesian statistical modelling*. Chichester, West Sussex, England: John Wiley and Sons Ltd.
- Congdon, P. (2005). *Bayesian Models for Categorical Data*. Chichester, West Sussex, England: John Wiley and Sons Ltd.

- Cook, B., Alegria, M., Lin, J. Y., & Guo, J. (2009). Pathways and correlates connecting Latinos' mental health with exposure to the United States. *Am J Public Health*, 99(12), 2247-2254. doi: 10.2105/ajph.2008.137091
- Cook Islands Statistics Office. (2008). *Population estimates & vital statistics*. Retrieved from <http://www.stats.gov.ck/CurReleases/popnestVital/popnestvital.htm>.
- Cotton, S. (1999). Marital Status and Mental Health Revisited: Examining the importance of risk factors and resources. *Family Relations*, 48(3), 225-233.
- Cox, D. R. (1972). Regression Models and Life Tables. *Journal of the Royal Statistical Society, Series B*, 34(2), 187-220.
- Crampton, P., & Davis, P. (1998). Measuring deprivation and socioeconomic status: why and how? *New Zealand Public Health Report*, 5(11/12), 81-84.
- Crawley, L., Pulotu-Endemann, F. K., Health, N. Z. M. o., & Stanley-Findlay, R. T. U. (1995). *Strategic Directions for the Mental Health Services for Pacific Islands People*: Ministry of Health.
- Crozier, T., Butterworth, P., & Rogers, B. (2007). Mental health problems among single and partnered mothers. The role of financial hardship and social support. . *Social Psychiatry & Psychiatric Epidemiology*, 42, 6-13.
- Curtis, E., Wright, C., & Wall, M. (2005). The epidemiology of breast cancer in Maori women in Aotearoa New Zealand: implications for ethnicity data analysis. *New Zealand Medical Journal*, 119(1209).
- Datta, G. S., Rao, J. N. K., & Torabi, M. (2010). Pseudo-empirical Bayes estimation of small area means under a nested error linear regression model with functional measurement errors. *Journal of Statistical Planning and Inference*, 140(11), 2952-2962. doi: <http://dx.doi.org/10.1016/j.jspi.2010.03.046>
- Demyttenaere, K., Bruffaerts, R., Posada-Villa, J., Gasquet, I., Kovess, V., Lepine, J. P., . . . Consortium, W. H. O. W. M. H. S. (2004). Prevalence, severity, and unmet need for treatment of mental disorders in the World Health Organization World Mental Health Surveys. *JAMA*, 291(21), 2581-2590.
- Dohrenwend, B. P. (2000). The role of adversity and stress in psychopathology: some evidence and its implications for theory and research. *Journal of Health and Social Behavior*, 41(1), 1-19.
- Durie, M. (1994). Māori psychiatric admissions: patterns and policy implications. In J. Spicer, A. Trlin & J. Walton (Eds.), *Social Dimensions of Health and Disease: New Zealand perspectives*. Palmerston North: Dunmore Press.
- Eitle, T. M., Wahl, A. M., & Aranda, E. (2009). Immigrant generation, selective acculturation, and alcohol use among Latina/o adolescents. *Soc Sci Res*, 38(3), 732-742.
- Endicott, J., Spitzer, R., Fliess, J., & Cohen, J. (1976). The Global Assessment Scale. A Procedure for Measuring Overall Severity of Psychiatric Disturbance. *Archive of General Psychiatry*, 33(6), 766-771.
- Escobar, J. I., Hoyos Nervi, C., & Gara, M. (2000). Immigration and mental health: Mexican Americans in the United States. *Harvard Review of Psychiatry*, 8, 64-72.
- Expert Advisory Group on Solutions to Child Poverty. (2012). *Solutions to Child Poverty in New Zealand: Evidence for Action*. Wellington, New Zealand.
- Fan, Y., Brooks, S. P., & Gelman, A. (2006). Output Assessment for Monte Carlo Simulations via the Score Statistic. *Journal of Computational and Graphical Statistics*, 15(1), 178-206.
- Farver, T. B. (2002). Comparison of ratio-synthetic, sample-size dependent and EBLUP estimators as estimators of food-animal productivity parameters. *Prev Vet Med*, 52(3-4), 313-332. doi: [http://dx.doi.org/10.1016/S0167-5877\(01\)00253-7](http://dx.doi.org/10.1016/S0167-5877(01)00253-7)

- Fang, L., & Schinke, S. P. (2007). Complementary alternative medicine use among Chinese Americans: findings from a community mental health service population. *Psychiatr Serv*, 58(3), 402-404. doi: 10.1176/appi.ps.58.3.402
- Fazel, M., Wheeler, J., & Danesh, J. (2005). Prevalence of serious mental disorder in 7000 refugees resettled in western countries; a systematic review. *Lancet*, 365, 1309-1314.
- Ferguson, T. S. (1973). A Bayesian analysis of Some Nonparametric Problems. *The Annals of Statistics*, 1(2), 209-230.
- Flores, G., & Brotanek, J. (2005). The healthy immigrant effect. *Archive of Podiatry and Adolescent Medicine*, 159, 295-297.
- Foliaki, S. A. (1997). Migration and Mental Health: The Tongan Experience. *International Journal of Mental Health*, 26, 36-54.
- Foliaki, S. (1999). Mental health among Tongan migrants. *Pacific Health Dialog*, 6(2), 288-294.
- Foliaki, S., Kokaua, J., Schaaf, D., & Tukuitonga, C. (2006). Twelve-month and lifetime prevalences of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Epidemiology Survey (NZMHS). In M. A. Oakley Browne, J. E. Wells & K. M. Scott (Eds.), *Te Rau Hinengaro: the New Zealand Mental Health Survey*. Wellington: Ministry of Health.
- Foliaki, S. A., Kokaua, J., Tukuitonga, C., & Schaaf, D. (2006). Twelve-month and lifetime prevalence of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS). *Australian and New Zealand Journal of Psychiatry*, 40(10), 924-934.
- Fossion, P., Ledoux, Y., Valente, F., Servais, L., Staner, L., Pelc, I., & Minner, P. (2002). Psychiatric disorders and social characteristics among second-generation Moroccan migrants in Belgium: an age-and gender-controlled study conducted in a psychiatric emergency department. *Eur Psychiatry*, 17(8), 443-450.
- Friedlin, B., & Korn, E. L. (2005). Testing treatment effects in the presence of competing risks. *Statistics in Medicine*, 24, 1703-1712.
- Gaber, T. J., Bouyrakhen, S., Herpertz-Dahlmann, B., Hagenah, U., Holtmann, M., Freitag, C. M., . . . Zepf, F. D. (2013). Migration background and juvenile mental health: a descriptive retrospective analysis of diagnostic rates of psychiatric disorders in young people. *Glob Health Action*, 6, 20187. doi: 10.3402/gha.v6i0.20187
- Gaines, P., Bower, A., Buckingham, W., Eagar, K., Burgess, P., Green, J., & Mellsop, G. (2003). New Zealand Mental Health Classification and Outcomes Study: Final report. Auckland: Health Research Council.
- Gelfand, A., Ghosh, S. K., Christiansen, C., Soumerai, S., & McLaughlin, T. J. (2000). Proportional Hazards Models: A Latent Competing Risk Approach. *Journal of the Royal Statistical Society. Series C*, 49(3), 385-397.
- Gelfand, A., & Smith, A. F. M. (1990). Sampling-based approaches to calculating marginal densities. *Journal of the American Statistical Association*, 85, 398-409.
- Gelman, A. (2006). Struggles with survey weighting and regression modelling. *Statistical Science*.
- Gelman, A., Carlin, J., Stern, H., & Rubin, D. B. (2004). *Bayesian Data Analysis* (2nd edition ed.). Florida, US: Chapman & Hall/CRC.
- Gelman, A., & Hill, J. (2007). *Data Analysis using Regression and Multilevel/Hierarchical Models*. New York, USA: Cambridge University Press.
- Geman, S., & Geman, D. (1984). Stochastic relaxation, Gibbs distribution and Bayesian restoration of images. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 6, 721-741.

- Ghosh, M., & Rao, J. N. K. (1994). Small Area Estimation: An Appraisal. *Statistical Science*, 9(1), 55-76.
- Gichangi, A., & Vach, W. (2005). The analysis of competing risks data: A guided tour. Odens: Danish National Research Foundation.
- Gilks, W. R., Richardson, S., & Spiegelhalter, D. J. (Eds.). (1996). *Markov Chain Monte Carlo in Practice*. Boca Raton, FL: Chapman & Hall/CRC.
- Gonzalez, H. M., Haan, M. N., & Hinton, L. (2001). Acculturation and the prevalence of depression in older Mexican Americans: baseline results of the Sacramento Area Latino Study on Aging. *J Am Geriatr Soc*, 49(7), 948-953.
- Greenland, S. (1984). Bias in methods for deriving standardized morbidity ratio and attributable fraction estimates. *Statistics in Medicine*, 3, 131-141.
- Greenland, S. (2001). Estimation of population attributable fractions from fitted incidence ratios and exposure survey data, with an application to electromagnetic fields and childhood leukemia. *Biometrics*, 57(182).
- Greenland, S., & Robins, J. (1986). Identifiability, Exchangeability and Epidemiological Confounding. *International Journal of Epidemiology*, 15(3), 412-418.
- Gregoire, T. G. (1998). Design-based and model-based inference in survey sampling: appreciating the difference. *Canadian Journal of Forestry Research*, 28, 1429-1427.
- Haasen, C., Sinaa, M., & Reimer, J. (2008). Alcohol use disorders among Afghan migrants in Germany. *Subst Abuse*, 29(3), 65-70. doi: 10.1080/08897070802218828
- Hajat, A., Blakely, T., Dayal, S., & Jatana, S. (2010). Do New Zealand's immigrants have a mortality advantage? Evidence from the New Zealand Census-Mortality Study. *Ethn Health*, 15(5), 531-547. doi: 10.1080/13557858.2010.496479
- Harel, O., & Zhou, X. H. (2007). Multiple imputation: Review of theory, implementation and software. *Statistics in Medicine*, 26, 3057-3077.
- Harris, R., Purdie, G., Robson, B., Wright, C., Zhang, J., & Baker, M. (2007). Estimating Maori Hospitalisations and Cancer Registrations. In B. Robson & R. Harris (Eds.), *Hauora: Maori Standards of Health IV. A study of years 2000-2005*. Wellington: Te Ropu Rangahau Hauora a Eru Pomare, School of Medicine and Health Sciences, University of Otago.
- Harris, R., Robson, B., Reid, P., & Keefe, V. (1997). CHE cultural reviews: Ethnicity data collection - error rates and training effectiveness, Report to the Central Regional Health Authority. Wellington: Te Ropu Rangahau Hauora a Eru Pomare, Wellington School of Medicine, University of Otago.
- Hastings, W. K. (1970). Monte Carlo sampling methods using Markov Chains and their applications. *Biometrika*, 57, 97-109.
- Hayat, M., & Sparapani, R. (2005). CODA2SAS (Version 2): Free Software Foundation.
- Hecht, J. (1985). Physical and social boundaries in Pukapukan theories of disease. In C. Parsons (Ed.), *Healing practices in the South*. Hawaii: The Institute for Polynesian Studies.
- Horton, N. J., & Lipsitz, S. R. (2001). Multiple imputation in practice: comparison of software packages for regression models with missing data. *American Statistician*, 55, 244-254.
- House, J., Lepowski, J., Kinney, A., Mero, R., Kessler, R. C., & Herzog, A. (1995). The Social Stratification of Aging and Health. *Journal of Health and Social Behavior*, 35(3), 213-234.
- Hovey, J. D., & Magana, C. G. (2002a). Exploring the mental health of Mexican migrant farm workers in the Midwest: psychosocial predictors of psychological distress and suggestions for prevention and treatment. *J Psychol*, 136(5), 493-513. doi: 10.1080/00223980209605546

- Hovey, J. D., & Magana, C. G. (2002b). Psychosocial predictors of anxiety among immigrant Mexican migrant farmworkers: implications for prevention and treatment. *Cultur Divers Ethnic Minor Psychol*, 8(3), 274-289.
- Huakau, J., Asiasiga, L., Ford, M., Pledger, M., Casswell, S., Suaalii-Sauni, T., & Lima, I. (2005). New Zealand Pacific peoples' drinking style: too much or nothing at all? *New Zealand Medical Journal*, 118(1216), U1491.
- Hudson, C. G., & Abbott, M. W. (2013). Modelling the geographic distribution of serious mental illness in New Zealand. *Social Psychiatry & Psychiatric Epidemiology*, 48, 25-36.
- Hunt, L. M., Schneider, S., & Comer, B. (2004). Should "acculturation" be a variable in health research? A critical view of research on US Hispanics. *Social Science & Medicine*, 59, 14.
- Ibrahim, J. G., Chen, M.-H., & Sinha, D. (2001). Bayesian Semiparametric Models for Survival Data with a Cure Fraction. *Biometrics*, 57(2), 383-388.
- Jang, Y., Kim, G., Chiriboga, D., & Kallimanis, B. (2007). A Bidimensional Model of Acculturation for Korean American Older Adults. *J Aging Stud*, 21(3), 267-275. doi: 10.1016/j.jaging.2006.10.004
- Jensen, J. (1988). *Income equivalences and the estimation of family expenditures on children*. Wellington: Department of Social Welfare.
- Jurado, D., Mendieta-Marichal, Y., Martinez-Ortega, J. M., Agrela, M., Ariza, C., Gutierrez-Rojas, L., . . . Gurpegui, M. (2014). World region of origin and common mental disorders among migrant women in Spain. *J Immigr Minor Health*, 16(6), 1111-1120. doi: 10.1007/s10903-013-9927-0
- Kamperman, A. M., Komproe, I. H., & de Jong, J. T. V. M. (2007). Migrant mental health: A model for indicators of mental health and health care consumption. *Health Psychology*, 26, 96-104.
- Karno, M., Golding, J. M., Burnam, M. A., Hough, R. L., Escobar, J. I., Wells, K. M., & Boyer, R. (1989). Anxiety disorders among Mexican Americans and non-Hispanic Whites in Los Angeles. *Journal of Nervous and Mental Disease*, 177(4), 8.
- Kalbfleisch, J. D. (1978). Non-Parametric Bayesian Analysis of Survival Time Data. *Journal of the Royal Statistical Society, Series B*, 40(2), 214-221.
- Kessler, R. C., Chui, W. T., Demler, O., & Walters, E. E. (2005). Prevalence, severity and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, 62, 617-627.
- Kessler, R. C., McGonagle, K. A., Zhao, S. N., Nelson, C. B., Hughes, M., Eshleman, S., . . . Kendler, K. S. (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: results from the National Comorbidity Survey. *Archives of General Psychiatry*, 51(1), 8-19.
- Kessler, R. C., Walters, E. E., & Forthofer, M. S. (1982). The Social Consequence of Psychiatric Disorders, III: Probability of Marital Stability. *American Journal of Psychiatry*, 155(8), 1092-1096.
- Khavarpour, F., & Rissel, C. (1997). Mental health status of Iranian migrants in Sydney. *Australian & New Zealand Journal of Psychiatry*, 31(6), 828-834.
- Kim, B. J., Sangalang, C. C., & Kihl, T. (2012). Effects of acculturation and social network support on depression among elderly Korean immigrants. *Aging Ment Health*, 16(6), 787-794. doi: 10.1080/13607863.2012.660622
- Klimidis, S., McKenzie, D. P., Lewis, J., & Minas, I. H. (2000). Continuity of contact with psychiatric services: immigrant and Australian-born patients. *Soc Psychiatry Psychiatr Epidemiol*, 35(12), 554-563.
- Kobayashi, C., Prus, S. G., & Lin, Z. (2008). Ethnic differences in self-rated and functional health: does immigrant status matter? *Ethnicity & Health*, 13(2), 19.

- Kokaua, J., Schaaf, D., Wells, E., & Foliaki, S. (2009). Twelve month prevalence, severity and treatment contact of mental disorders in New Zealand born and migrant participants in Te Rau Hinengaro: The New Zealand Mental Health Survey. *Pacific Health Dialog*, 15(1), 9 - 17.
- Kokaua, J., & Wells, E. (2009). Twelve month prevalence's of mental disorders and treatment contact among Cook Islanders resident in New Zealand. *Pacific Health Dialog*, 15(1), 79 - 88.
- Kwak, K., & Rudmin, F. (2014). Adolescent health and adaptation in Canada: examination of gender and age aspects of the healthy immigrant effect. *Int J Equity Health*, 13(1), 103. doi: 10.1186/s12939-014-0103-5
- Krishnan, V., Schoeffel, P., & Warren, J. (1994). *The Challenge of change: Pacific Island communities in New Zealand, 1986-1993*. Wellington, NZ: NZ Institute for Social Research & Development.
- Ladin, K., & Reinhold, S. (2013). Mental health of aging immigrants and native-born men across 11 European countries. *J Gerontol B Psychol Sci Soc Sci*, 68(2), 298-309. doi: 10.1093/geronb/gbs163
- Larsen, M. D. (2003). Estimation of small-area proportions using covariates and survey data. *Journal of Statistical Planning and Inference*, 112(1-2), 89-98. doi: [http://dx.doi.org/10.1016/S0378-3758\(02\)00325-7](http://dx.doi.org/10.1016/S0378-3758(02)00325-7)
- Larsen, M. D. (2003). Estimation of small-area proportions using covariates and survey data. *Journal of Statistical Planning and Inference*, 112(1-2), 89-98. doi: [http://dx.doi.org/10.1016/S0378-3758\(02\)00325-7](http://dx.doi.org/10.1016/S0378-3758(02)00325-7)
- Lehtonen, R., Djerf, K., Harkanen, T., & Laiho, J. (2002). *Design-based and Model-based Methods in Analysing Complex Health Survey Data: A Case Study*. Paper presented at the Statistics Canada Symposium.
- Leong, F., Park, Y. S., & Kalibatseva, Z. (2013). Disentangling immigrant status in mental health: psychological protective and risk factors among Latino and Asian American immigrants. *Am J Orthopsychiatry*, 83(2 Pt 3), 361-371. doi: 10.1111/ajop.12020
- Liddell, B. J., Chey, T., Silove, D., Phan, T. T., Giao, N. M., & Steel, Z. (2013). Patterns of risk for anxiety-depression amongst Vietnamese-immigrants: a comparison with source and host populations. *BMC Psychiatry*, 13, 329. doi: 10.1186/1471-244x-13-329
- Lindencrona, F., Ekblad, S., & Hauff, E. (2008). Mental health of recently resettled refugees from the Middle East in Sweden: the impact of pre-resettlement trauma, resettlement stress and capacity to handle stress. *Social Psychiatry & Psychiatric Epidemiology*, 43, 121-131.
- Lindert, J., Schouler-Ocak, M., Heinz, A., & Priebe, S. (2008). Mental health, health care utilisation of migrants in Europe. *European Psychiatry*, 14.
- Lindley, D. V., & Smith, A. F. M. (1972). Bayes estimates for the lineal model. *Journal of the Royal Statistical Society, Series B*, 34, 1-41.
- Little, R. J. (2004). To Model or Not to Model? Competing Modes of Inference for Finite Population Sampling. *Journal of the American Statistical Association*, 99(466), 546-556.
- Little, R. J. A. (1993a). Pattern Mixture Models for Multivariate Incomplete Data. *Journal of the American Statistical Association*, 88(421), 125-134.
- Little, R. J. A. (1993b). Post-Stratification: A Modeler's Perspective. *Journal of the American Statistical Association*, 88(423), 1001-1012.
- Little, R. J. A., & Rubin, D. B. (1987). *Statistical Analysis With Missing Data*. New York: Wiley.
- Livingston, G., Leavey, G., Kitchen, G., Manela, M., Sembhi, S., & Katona, C. (2001). Mental health of migrant elders--the Islington study. *Br J Psychiatry*, 179, 361-366.

- Lu, Y. (2008). Test of the 'healthy migrant hypothesis': a longitudinal analysis of health selectivity of internal migration in Indonesia. *Soc Sci Med*, 67(8), 1331-1339. doi: 10.1016/j.socscimed.2008.06.017
- Lu, Y., & Qin, L. (2014). Healthy migrant and salmon bias hypotheses: a study of health and internal migration in China. *Soc Sci Med*, 102, 41-48. doi: 10.1016/j.socscimed.2013.11.040
- Machleidt, W., & Sieberer, M. (2013). From Kraepelin to a modern and integrative scientific discipline: the development of transcultural psychiatry in Germany. *Transcult Psychiatry*, 50(6), 817-840. doi: 10.1177/1363461513508597
- Macpherson, C. (1996). Pacific Islands identity and community. In P. Spoonley, D. Pearson & C. Macpherson (Eds.), *Nga Patai: Racism and ethnic relations in Aotearoa/New Zealand*. Palmerston North: Dunmore Press.
- Macpherson, C. (2004). From Pacific Islanders to Pacific People: The past, present, and future of the Pacific population in Aotearoa. In P. Spoonley, C. Macpherson & D. Pearson (Eds.), *Tangata, Tangata: The changing contours of ethnicity in Aotearoa New Zealand* (pp. 135-156). Palmerston North: Dunmore Press.
- Manuela, S., & Sibley, C. G. (2013a). Exploring the Hierarchical Structure of Pacific Identity and Wellbeing. *Social Indicators Research*.
- Manuela, S., & Sibley, C. G. (2013b). The Pacific Identity and Wellbeing Scale (PIWBS): A Culturally-Appropriate Self-Report Measure for Pacific Peoples in New Zealand. *Social Indicators Research*, 112, 21. doi: DOI 10.1007/s11205-012-0041-9
- McGarvey, S., & Seiden, B. (2010). Health, wellbeing, and social context of Samoan migrant populations. *NAPA Bulletin*, 34, 16. doi: 10.1111/j.1556-4797.2010.01060.x
- McGrath, J., El-Shaadi, O., Cardy, S., Chapple, B., Chant, D., & Mowry, B. (2001). Urban birth and migrant status as risk factors for psychosis: an Australian case control study. *Social Psychiatry & Psychiatric Epidemiology*, 36, 533-536.
- Mila-Schaaf, K. (2011). Polycultural Capital and the Pasifika Second Generation: Negotiating Identities in Diasporic Spaces *Integration of Immigrants Programme* (pp. 48). Albany: Massey University.
- Mila-Schaaf, K., & Hudson, M. (2009). The interface between cultural understandings: Negotiating new spaces for Pacific mental health. *Pacific Health Dialog*, 15(1), 7.
- Minas, I. H., Stuart, G. W., & Klimidis, S. (1994). Language, culture and psychiatric services: a survey of Victorian clinical staff. *Australian & New Zealand Journal of Psychiatry*, 28, 9.
- Ministry of Health. (2005). *Te Orau Ora: Pacific Mental Health Profile*. Wellington: Ministry of Health.
- Ministry of Health. (2012). *Tupu Ola Moui 2012*. Wellington, New Zealand: Ministry of Health.
- Ministry of Health. (2013). *Mental Health and Addiction: Service Use 2009/10*. Wellington.
- Ministry of Health. (2014). *Mental Health and Addiction: Service Use 2011/12*. from Ministry of Health <http://www.health.govt.nz/publication/mental-health-and-addiction-service-use-2011-12>
- Ministry of Education. (2011). *Pasifika Education Plan 2009-2012*. Wellington, New Zealand: Ministry of Education Retrieved from <http://pasifika.tki.org.nz/Pasifika-Education-Plan>.
- Moffitt, T. E., Caspi, A., Taylor, A., Kokaua, J., Milne, B. J., Polanczyk, G., & Poulton, R. (2010). How common are common mental disorders? Evidence that lifetime prevalence rates are doubled by prospective versus retrospective ascertainment. *Psychological Medicine*, 40, 899.

- Morrell, S., Taylor, R., Slaytor, E., & P., F. (1999). Urban and rural suicide differentials in migrants and the Australian-born, New South Wales, Australia 1985-1994. *Social Science and Medicine*, 49, 81-91.
- Nandram, B., & Sayit, H. (2011). A Bayesian analysis of small area probabilities under a constraint. *Survey Methodology*, 37(2), 137-152.
- Nandram, B., & Sedransk, J. (1993). Bayesian Predictive Inference for a Finite Population Proportion: Two-stage Cluster Sampling. *Journal of the Royal Statistical Society, Series B*, 55(2), 399-408.
- Nandram, B., & Sedransk, J. (1993b). Empirical Bayes Estimation for the Finite Population Mean on the Current Occasion. *Journal of the American Statistical Association*, 88(423), 994-1000.
- New Zealand Health Information Service. (2006). *Mental Health Information National Collection: Data Dictionary, version 3.8*. Wellington: New Zealand Health Information Service.
- NZQA. (2012). Annual Report on NCEA and New Zealand Scholarship Data and Statistics (2011). Wellington: NZQA.
- Oakley Browne, M. A., Durie, M., & Wells, E. (2000). The New Zealand Survey of Mental Health and Well-being, Te Rau Hinengaro: A pilot study. Auckland: Auckland UniServices Ltd.
- Oakley Browne, M. A., Wells, J. E., & Scott, K. M. (Eds.). (2006a). *Te Rau Hinengaro: the New Zealand Mental Health Survey*. Wellington: Ministry of Health.
- Oakley Browne, M. A., Wells, J. E., & Scott, K. M. (2006b). Lifetime prevalence and projected lifetime risk of DSM-IV disorders in Te Rau Hinengaro: the New Zealand Mental Health Survey. *Australian and New Zealand Journal of Psychiatry*, 40(10), 865-874.
- Oakley Browne, M. A., Wells, J. E., & Scott, K. M. (2006c). Twelve month and lifetime health Service use in Te Rau Hinengaro: the New Zealand Mental Health Survey. *Australian and New Zealand Journal of Psychiatry*, 40(10), 855-864.
- Oppedal, B., & Roysamb, E. (2004). Mental health, life stress and social support among young Norwegian adolescents with immigrant and host national background. *Scand J Psychol*, 45(2), 131-144.
- Orozco, R., Borges, G., Medina-Mora, M. E., Aguilar-Gaxiola, S., & Breslau, J. (2013). A cross-national study on prevalence of mental disorders, service use, and adequacy of treatment among Mexican and Mexican American populations. *Am J Public Health*, 103(9), 1610-1618. doi: 10.2105/ajph.2012.301169
- Patterson, B., Kyu, H. H., & Georgiades, K. (2013). Age at immigration to Canada and the occurrence of mood, anxiety, and substance use disorders. *Can J Psychiatry*, 58(4), 210-217.
- Park, T., & Lee, S. Y. (1999). Simple pattern mixture models for longitudinal data with missing observations: Analysis of urinary incontinence data. *Statistics in Medicine*, 18, 2933-2941.
- Parsonage, P., Siō, L., Mariner, K., & Leger, N. (2009). Development of a Mental Health and Addiction Pacific Cultural Practice Framework for the Auckland Region: Promoting expertise that is "visible, valued and understood.". *Pacific Health Dialog*, 15(1), 7.
- Patel, V., Araya, R., de Lima, M., Ludermit, A., & Todd, C. (1999). Women, poverty and common mental disorders in four restructuring societies. *Social Science & Medicine*, 49(11), 1461-1471.
- Perlin, L., & Johnson, J. (1977). Marital Status, Life Strains and Depression. *American Sociological Review*, 42(5), 704-715.
- Pernice, R., & Brook, J. (1996). Refugees and immigrants mental health: association of demographic and post immigration factors. *Journal of Social Psychology*, 136, 511-519.

- Pfeffermann, D. (2011). Modelling of complex survey data: Why model? Why is it a problem? How can we approach it? *Survey Methodology*, 37(2), 115-136.
- Pfeffermann, D. (2013). New Important Developments in Small Area Estimation. *Statistical Science*, 28(1), 40-68.
- Pfeffermann, D., Skinner, C. J., Holmes, D. J., Goldstein, H., & Rabash, J. (1998). Weighting for Unequal Selection Probabilities in Multilevel Models. *Journal of the Royal Statistical Society, Series B*, 60(1), 23-40.
- Phiney, J. S., Horenczyk, G., Liebkind, K., & Vedder, P. (2001). Ethnic Identity, Immigration, and Well-Being: An Interactional Perspective. *Journal of Social Issues*, 57(3), 18.
- Pintillie, M. (2002). Dealing with competing risks: testing covariates and calculating sample size. *Statistics in Medicine*, 21, 3317-3324.
- Pole, N., Best, S. R., Metzler, T., & Marmar, C. R. (2005). Why are Hispanics at Greater Risk for PTSD? *Cultural Diversity and Ethnic Minority Psychology*, 11(2), 18. doi: 10.1037/10999809.11.2.144
- Ponizovsky, A. M., Radomislensky, I., & Grinshpoon, A. (2009). Psychological distress and its demographic associations in an immigrant population: findings from the Israeli National Health Survey. *Aust N Z J Psychiatry*, 43(1), 68-75. doi: 10.1080/00048670802534317
- Potochnick, S. R., & Perreira, K. M. (2010). Depression and anxiety among first-generation immigrant Latino youth: key correlates and implications for future research. *J Nerv Ment Dis*, 198(7), 470-477. doi: 10.1097/NMD.0b013e3181e4ce24
- Posanau, C. S. (1997). Substance Abuse in the Pacific Islands, with Special Reference to Papua New Guinea. *International Journal of Mental Health*, 26(3), 14.
- Prior, I. A. M., Welby, T. J., Ostbye, T., Salmond, C. E., & Stokes, Y. M. (1987). Migration and gout: The Tokelau Island migrant study. *British Medical Journal*, 295(22), 5.
- Rabe-Hesketh, S., & Skrondal, A. (2006). Multilevel Modelling of complex survey data. *Journal of the Royal Statistical Society Series A*, 169(4), 23.
- Rao, J. N. K. (2008). Some Methods for small area estimation. *Rivista Internazionale di Scienze Sociali*, 116(4), 387-406.
- Research Triangle Institute. (1999). SUDAAN: Software for the statistical analysis of correlated data. Research Triangle Park, North Carolina, USA.
- Riosmena, F., Wong, R., & Palloni, A. (2013). Migration selection, protection, and acculturation in health: a binational perspective on older adults. *Demography*, 50(3), 1039-1064. doi: 10.1007/s13524-012-0178-9
- Rubin, D. B. (1981). The Bayesian Bootstrap. *The Annals of Statistics*, 9(1), 130-134.
- Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys*. New York: Wiley.
- Rubin, D. B. (1996). Multiple Imputation after 18+ years. *Journal of the American Statistical Association*, 91(434), 473-489.
- Rubin, D. B., & Little, R. J. (2002). *Statistical analysis with missing data* (second ed.). New Jersey: John Wiley and sons.
- Rundberg, J., Lidfeldt, J., Nerbrand, C., Samsioe, G., Romelsjo, A., & Ojehagen, A. (2006). Mental symptoms, psychotropic drug use and alcohol consumption in immigrated middle-aged women. The Women's Health in Lund Area (WHILA) Study. *Nord J Psychiatry*, 60(6), 480-485. doi: 10.1080/08039480601022082
- Ryan, D., Southwick, M., Teevale, T., & Kenealy, T. W. (2011). Primary Care for Pacific People: A Pacific and Health Systems View. Wellington, New Zealand: Pacific Perspectives.
- Salmond, C., & Crampton, P. (2002). NZDep2001 Index of Deprivation (D. o. P. Health, Trans.). Wellington, New Zealand: Wellington School of Medicine and Health Sciences.
- Salmond, C., Crampton, P., & Sutton, F. (1998). *NZ Dep 96 Index of Deprivation: Instruction book*. Wellington: Health Services Research Centre.

- Saraceno, B., & Barbui, C. (1997). Poverty and Mental Illness. *Canadian Journal of Psychiatry*, 42, 285-290.
- Sarfati, D., & Scott, K. (2001). The health of lone parents in New Zealand. *The New Zealand Medical Journal*, 114(1133), 257-260.
- SAS Institute Inc. (1999). SAS. SAS Campus Drive, North Carolina: SAS Institute Inc.
- Schaffer, A., Cairney, J., Cheung, A., Veldhuizen, S., Kurdyak, P., & Levitt, A. (2009). Differences in prevalence and treatment of bipolar disorder among immigrants: results from an epidemiologic survey. *Can J Psychiatry*, 54(11), 734-742.
- Schafer, J. (1999). Multiple Imputation: a primer. *Statistical Methods in Medical Research*, 8, 3-15.
- Schenker, N., Treiman, D. J., & Weidman, L. (1993). Analyses of public use decennial census data with multiply imputed industry and occupation codes. *Applied Statistics*, 42(3), 545-556.
- Schluter, P., Tautolo, E., Taylor, S., & Paterson, J. (2013). Alcohol consumption by parents of Pacific families residing in New Zealand: Findings from the Pacific Islands Families Study. *Alcohol*, 47, 8.
- Schouler-Ocak, M., Bretz, H. J., Penka, S., Koch, E., Hartkamp, N., Siefen, R. G., . . . Heinz, A. (2008). Patients of immigrant origin in inpatient psychiatric facilities. *European Psychiatry*, 23, S21-S27.
- Schwartz, S. J., Weisskirch, R. S., Zamboanga, B. L., Castillo, L. G., Ham, L. S., Huynh, Q. L., . . . Cano, M. A. (2011). Dimensions of acculturation: associations with health risk behaviors among college students from immigrant families. *J Couns Psychol*, 58(1), 27-41. doi: 10.1037/a0021356
- Scott, K. M., Wells, E., Angermeyer, M., Brugha, T., Bromet, E. J., Demyttenaere, K., . . . Kessler, R. C. (2009). Gender and the relationship between marital status and first onset of mood anxiety and substance use disorders. *Psychological Medicine*.
- Sen, A., Banerjee, M., Li, Y., & Noone, A.-M. (2008). A Bayesian approach to competing risks analysis with masked cause of death. *Statistics in Medicine*, 29, 1681-1695.
- Simon, R. (2002). Revisiting the relationships among gender, marital status, and mental health. *American Journal of Sociology*, 107(4), 1065-1096.
- Sinha, D. (1998). Posterior Likelihood Methods for Multivariate Survival Data. *Biometrics*, 54(4), 1463-1474.
- Sinha, D., Chen, M.-H., & Ibrahim, J. G. (2003). Bayesian Inference for Survival Data with a Surviving Fraction *Lecture Notes-Monograph Series, Vol. 43, Crossing Boundaries: Statistical Essays in Honor of Jack Hall* (pp. 117-138): Institute of Mathematical Statistics.
- Sinha, D., & Dey, D. K. (1997). Semiparametric Bayesian Analysis of Survival Data. *Journal of the American Statistical Association*, 92(439), 1195-1212.
- Spiegelhalter, D., Thomas, A., Best, N., & Lunn, D. (2003). *WinBugs User Manual version 1.4*.
- Spoonley, P. (2001). Pacific Communities: Transforming the Politics of Place and Identity. In C. Macpherson, P. Spoonley & M. Anae (Eds.), *Tangata O Te Moana Nui: evolving identities of Pacific Peoples in Aotearoa New Zealand*. Palmerston North, N.Z.: Dunmore Press
- Stehman, S. V. (2000). Practical Implications of Design-Based Sampling Inference for Thematic Map Accuracy Assessment. *Remote Sensing of Environment*, 72(1), 35-45. doi: [http://dx.doi.org/10.1016/S0034-4257\(99\)00090-5](http://dx.doi.org/10.1016/S0034-4257(99)00090-5)
- Stillman, S., McKenzie, D., & Gibson, J. (2006). Migration and Mental Health: Evidence From a Natural Experiment (Economics, Trans.). Hamilton, New Zealand: University of Waikato.

- Straiton, M., Reneflot, A., & Diaz, E. (2014). Immigrants' use of primary health care services for mental health problems. *BMC Health Serv Res*, 14, 341. doi: 10.1186/1472-6963-14-341
- Suaalii-Sauni, T., Wheeler, A., Saafi, E., Robinson, G., Agnew, F., Warren, H., . . . Hingano, T. (2009). Exploration of Pacific perspectives of Pacific models of mental health service delivery in New Zealand. *Pacific Health Dialog*, 15(1), 10.
- Tautolo, E., Schluter, P., & Sundborn, G. (2009). Mental health well-being amongst fathers within the Pacific Island Families Study. *Pacific Health Dialog*, 15(1), 10.
- Therneau, T. M. (1996). Extending the Cox Model. In S. o. Biostatistics (Ed.), *Technical Report*. Rochester, Minnesota: Mayo Clinic.
- Tiatia, J., & Coggan, C. (2001). Young Pacific suicide attempts: a review of emergency department medical records, Auckland, New Zealand. *Pacific Health Dialog*, 8(1), 124-128.
- Tobias, M., Gerritsen, S., Kokaua, J., & Templeton, R. (2009). Psychiatric illness among a nationally representative sample of sole and partnered parents in New Zealand. *Australian and New Zealand Journal of Psychiatry*, 43, 136-144.
- Tongia, M. (2003). Te Neke'anga i Porirua: Changing values in Aotearoa. In R. Crocombe & M. T. Crocombe (Eds.), *Cook Islands Culture*. Suva, Fiji and Rarotonga, Cook Islands: University of the South Pacific.
- Umberson, D., Chen, M. D., House, J., Hopkins, K., & Slaten, E. (1996). The Effect of Social Relationships on Psychological Well-Being: Are Men and Women Really so different? *American Sociological Review*, 61(5), 837-857.
- Valdez, C. R., Padilla, B., Moore, S. M., & Magana, S. (2013). Feasibility, acceptability, and preliminary outcomes of the Fortalezas Familiares intervention for latino families facing maternal depression. *Fam Process*, 52(3), 394-410. doi: 10.1111/famp.12033
- Vega, W. A., Kolody, B., Aguilar-Gaxiola, S., Alderete, E., Catalano, R., & Caraveo-Anduaga, J. (1998). Lifetime prevalence of DSM-III-R psychiatric disorders among urban and rural Mexican Americans in California. *Archives of General Psychiatry*, 55(9), 771-778.
- Vega, W. A., Kolody, B., & Aguilar-Gaxiola, S. (2001). Help seeking for mental health problems among Mexican Americans. *J Immigr Health*, 3(3), 133-140. doi: 10.1023/a:1011385004913
- Vega, W. A., Kolody, B., & Warheit, G. J. (1985). Psychoneuroses among Mexican Americans and other Whites: Prevalence and Caseness. *Archives of General Psychiatry*, 75, 5.
- Victora, C. G., Huttly, S. R., Fuchs, S. C., & Olinto, M. T. A. (1997). The Role of Conceptual Frameworks in Epidemiological Analysis: A Hierarchical Approach. *International Journal of Epidemiology*, 26(1), 224-227.
- Webb, P., Bain, C., & Pirozzo, S. (2006). *Essential Epidemiology: an introduction for students and health professionals*: Cambridge University Press.
- Wells, A., Lagomasino, I. T., Palinkas, L. A., Green, J. M., & Gonzalez, D. (2013). Barriers to depression treatment among low-income, Latino emergency department patients. *Community Ment Health J*, 49(4), 412-418. doi: 10.1007/s10597-012-9547-5
- Wang, C.-P., & Ghosh, M. (2000). Bayesian Analysis of Bivariate Competing Risks Models. *Sankhya: The Indian Journal of Statistics, Series B*, 62(3), 388-401.
- Wells, E., Baxter, J., & Schaaf, D. (2007). *Substance use disorders in Te Rau Hinengaro: The New Zealand Mental Health Survey*. Wellington: Alcohol Advisory Council of New Zealand.
- Wells, E., McGee, M. A., Baxter, J., Agnew, F., & Kokaua, J. (2009). Onset and lifetime use of drugs in New Zealand: Results from Te Rau Hinengaro: The New Zealand Mental Health Survey 2003-2004. *Drug and Alcohol Review*, 28, 166-174.

- Wells, J. E., McGee, M. A., & Oakley Browne, M. A. (2006a). Chapter 12 Methods. In M. A. Oakley Browne, J. E. Wells & K. M. Scott (Eds.), *Te Rau Hinengaro: the New Zealand Mental Health Survey*. Wellington: Ministry of Health.
- Wells, J. E., McGee, M. A., & Oakley Browne, M. A. (2006b). Methods. In M. A. Oakley Browne, J. E. Wells & K. M. Scott (Eds.), *Te Rau Hinengaro: the New Zealand Mental Health Survey*. Wellington: Ministry of Health.
- Wells, J. E., Oakley Browne, M. A., Scott, K. M., McGee, M. A., Baxter, J., & Kokaua, J. (2006). Te Rau Hinengaro: The New Zealand Mental Health Survey: overview of methods and findings. *Australian & New Zealand Journal of Psychiatry*, 40, 835-844.
- Wells, J. E., Oakley Browne, M. A., Scott, K. M., McGee, M. A., Baxter, J., Kokaua, J., & for the New Zealand Mental Health Survey Research Team. (2006). Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS): overview of methods and findings. *Australian and New Zealand Journal of Psychiatry*, 40(10), 835-844.
- Whisman, M., & Bruce, M. L. (1999). Marital Dissatisfaction and Incidence of Major Depressive Episode in a Community Sample. *Journal of Abnormal Psychology*, 108(4), 674-678.
- Williams, D. R., Haile, R., Gonzalez, H. M., Neighbors, H., Baser, R., & Jackson, J. S. (2007). The mental health of Black Caribbean immigrants: results from the National Survey of American Life. *Am J Public Health*, 97(1), 52-59. doi: 10.2105/ajph.2006.088211
- WHO. (2001). 2001: Mental Health : new understanding, new hope *The World Health report*. Geneva Switzerland: World Health Organisation.
- WHO International Consortium of Psychiatric Epidemiology. (2000). Cross-national comparisons of the prevalences and correlates of mental disorders: WHO International Consortium in Psychiatric Epidemiology. *Bulletin of the World Health Organization*, 78(4), 413-426.
- Worth, M. (2004). Cook Islands Mental Health Cultural Competency Workshop. Auckland: Waitemata District Health Board.
- Wu, B., Chi, I., Plassman, B. L., & Guo, M. (2010). Depressive symptoms and health problems among Chinese immigrant elders in the US and Chinese elders in China. *Aging Ment Health*, 14(6), 695-704. doi: 10.1080/13607860802427994
- Yin, G., & Ibrahim, J. G. (2005). A General Class of Bayesian Survival Models with Zero and Nonzero Cure Fractions. *Biometrics*, 61(2), 403-412.
- Young, J., Graham, P., & Blakely, T. (2005). Modeling the Relation between Socio-economic Status and Mortality in a Mixture of Majority and Minority Ethnic Groups. *American Journal of Epidemiology*, 164(3), 282-291.
- Zandi, T., Havenaar, J. M., Smits, M., Limburg-Okken, A. G., van Es, H., Cahn, W., . . . van den Brink, W. (2010). First contact incidence of psychotic disorders among native Dutch and Moroccan immigrants in the Netherlands: influence of diagnostic bias. *Schizophr Res*, 119(1-3), 27-33. doi: 10.1016/j.schres.2010.02.1059
- Zhiyong, A., McArdle, J. J., Wang, L., & Hamagami, F. (2008). A SAS Interface for Bayesian Analysis With WinBUGS. *Structural Equation Modeling: A Multidisciplinary Journal*, 15(4), 705-728.
- Zhou, X. H., Eckert, G., & Tierney, W. M. (2001). Multiple imputation in public health research. *Statistics in Medicine*, 20, 1541-1549.
- Zolkowska, K., Cantor-Graae, E., & McNeil, T. F. (2001). Increased rates of psychosis among immigrants to Sweden: is migration a risk factor for psychosis? *Psychological Medicine*, 31(4), 669-678.
- Zolkowska, K., Cantor-Graae, E., & McNeil, T. F. (2003). Psychiatric admissions for psychosis in Malmo during the NATO bombing of Kosovo. *J Nerv Ment Dis*, 191(12), 820-826. doi: 10.1097/01.nmd.0000100926.46390.4c

Appendix A Published Papers

- Kokaua, J., & Wells, E. (2009). Page 213
Twelve month prevalence's of mental disorders and treatment contact
among Cook Islanders resident in New Zealand. *Pacific Health Dialog*, 15(1),
79 - 88.
- Kokaua, J., Schaaf, D., Wells, E., & Foliaki, S. (2009). Page 223
Twelve month prevalence, severity and treatment contact of mental
disorders in New Zealand born and migrant participants in Te Rau Hinengaro:
The New Zealand Mental Health Survey. *Pacific Health Dialog*, 15(1), 9 - 17.

Twelve-Month Prevalences Of Mental Disorders And Treatment Contact Among Cook Islanders Resident In New Zealand

Jesse Kokaua

J Elisabeth Wells

Author Information

Jesse Kokaua, Research Analyst Mental Health team, Population Health Directorate, Ministry of Health, Dunedin, New Zealand.

J Elisabeth Wells, Associate Professor Department of Public Health and General Practice, University of Otago, Christchurch, New Zealand.

Correspondence

Jesse Kokaua, Ministry of Health, Level 4, 229 Moray Place, PO Box 5849, Dunedin 9016, New Zealand. Telephone: +64 3 474 8546, Fax: +64 3 474 8090, Email: jesse_kokaua@moh.govt.nz

Abstract

Objective: To show the 12 month prevalences of mental disorders, 12-month treatment contact and use of mental health services among Cook Islanders resident in New Zealand.

Data: A) The New Zealand Mental Health Survey (NZMHS) is a nationally representative face-to-face household survey, carried out in 2003-2004. It surveyed 12,992 New Zealand adults aged 16 or more including 2374 Pacific peoples (500 Cook Islands Maori) and 2457 New Zealand Maori. B) An extract from the Mental Health Information National Collection (MHINC). This is a national dataset that is reported to by mental health services around New Zealand.

Method: Multiple logistic regression models are used to produce estimates from both sets of data. In the case of A) the NZMHS the results are weighted to account for different probabilities of selection and analysis takes account of the complex survey design.

Results: A previous paper¹ and this one confirm that Cook Islanders experience high prevalence of mental disorder. However, the difference is more attributable to their population age and gender structure or being New Zealand-born than from ethnicity. The prevalence was higher among New Zealand-born Cook Islanders than those born in the Cook Islands. Those born in the Islands with a disorder were less likely to have used a health service for their mental health compared with others and much less likely to have visited a specialist mental health service.

From MHINC, twelve month data on use of mental health services shows: high use of acute inpatient and Forensic mental health services by Cook Island clients but similar levels of community mental health services. Cook Islands clients were more commonly diagnosed with bipolar, psychotic or schizophrenic disorders. They were also more likely to be diagnosed with a substance disorder.

Conclusion: In spite of high levels of disorder Cook Islanders have low use of specialist mental health services. The exception to this is an over-representation in inpatient and forensic services. This experience of mental health services at the extreme end implies delayed or avoided treatment that has resulted in more serious levels of disorder among those Cook Islanders who are eventually seen by mental health services.

Key words: cross-sectional studies, epidemiology, mental disorders, Pacific, Cook Islands.

Introduction

The Cook Islands are a group of 15 islands in the South Pacific well known as a relaxed holiday destination with a colourful, appealing and varied culture. The peoples from these islands have a varied mix of cultural practices and languages. The past century has seen much interaction between the people of the Cook Islands and New Zealand since the Islands were annexed in 1900. People of the Cook Islands have both Cook Islands and New Zealand citizenship.

Increased demand for workers in New Zealand manufacturing and service industries during the 1950's and 60's led to greater numbers of people from the Cook Islands as well as from other non Cook Islands (NCI) Pacific nations emigrating to urban centres.^{2,3} International migration has become a feature of Cook Islands society to the extent that it is estimated that 85% of Cook Islands descendants live outside of the Cook Islands themselves.⁴ In 2006,

while 11,800 residents lived in the Cook Islands there were 52,600 Cook Islanders who lived in New Zealand at the same time.⁵ As a result there are many vibrant Cook Islands communities throughout New Zealand. Although largely in Auckland, there are strongly identified Cook Islands communities around the rest of New Zealand. Wellington, Hamilton, Hastings, Tokoroa, Christchurch and even as far south as Dunedin and Invercargill each have small but distinct Cook Islands communities. People of the Cook Islands who have settled in New Zealand and their descendants have quietly become a part of that society. Cook Islanders can be found at all levels of New Zealand society.

An economic downturn began in the 1970's and characterised New Zealand's economy through the 1980's and early 90's that led to many Pacific peoples in the manufacturing industries to be laid off. This created adverse consequences in general living conditions for many Pacific migrants and their families. It has been speculated that resulting adverse socio-economic, living conditions, acculturation and adjustment pressures have had a negative impact on the mental health of all Pacific peoples living in New Zealand. Recent years have seen some improvement in the social and economic environment for Pacific communities as a whole.

Like those who descended from non Cook Islands (NCI) Pacific nations, issues exist for Cook Islanders born or raised in New Zealand from an early age that differ from Island born.⁶ Issues of identity for young Pacific peoples are significant, in a bicultural and multicultural environment. Transition from Island culture to an urban, largely Pāpā'a dominated culture of New Zealand is difficult. Some evidence would point to a greater burden of this transition has been felt among the New Zealand born descendants of those who migrated rather than the migrants themselves.⁷

In the past there have been only a few publications about Cook Islands history, culture, health and traditional healing practices.⁸⁻¹⁰ Even fewer documents have dealt with mental illness among Cook Islanders in New Zealand. An observation of traditional healing practices was that physical manifestations possibly attributed to mental illness would be interpreted and treated as "maki tupapaku" or spiritual illness. Wātemata District Health Board (DHB) produced a workbook for a workshop on Cook Islands cultural competency for mental health services in New Zealand.¹¹ In it the authors proposed a Cook Islands model for mental health care as well as an in depth glossary of Cook Islanders translations for many concepts related to mental illness.

Very little has been reported on the prevalence of

mental disorder among Cook Islanders or even the use of mental health services by Cook Islanders in New Zealand. Foliaki et al¹ reported that Cook Islanders had a 12 month prevalence rate of mental disorder 50% higher than that of New Zealand as a whole. This paper seeks to expand on the analysis of Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS)¹ and combine this with patterns of use of mental health services in New Zealand from the Mental Health Information National Collection (MHINC), New Zealand's national database of mental health services.

Method

New Zealand Mental Health Survey

The NZMHS was a nationally representative household survey of 12 992 adults aged 16 years and over, with a stratified multistage clustered sample design. Face-to-face interviews were carried out between October 2003 and December 2004 by specially trained interviewers, in English. The response rate achieved was 73.3%. To enable analysis of Māori and Pacific peoples estimates with increased precision both groups were oversampled.¹²

Demography: Correlates included age at interview and sex, age at migration and place of birth.

Ethnicity: This was determined by self-identification, according to the ethnicity question in the 2001 Census of Population and Dwellings, which enables

a breakdown to individual island group for people of Pacific ethnicity. This paper uses an ethnicity breakdown of: 500 "Cook Islanders", 1874 people from other non Cook Islands Pacific ethnic groups ("NCI Pacific"), 2319 non Pacific New Zealand Māori ("NZ Māori"), and 7299 people from other, non Pacific-non Māori, ethnicities ("Others").

Diagnosis: Mental disorders have been identified using the Composite International Diagnostic Interview (CIDI) version 3.0, which covered anxiety disorders, mood, eating and substance disorders. There was a psychosis screener but this did not yield diagnoses for rare disorders like schizophrenia. People with a 12 month disorder were those who had previously met the criteria for that disorder and had displayed symptoms in the past 12 months.

'Serious' mental disorder was assigned if in the past 12 months there was either: an episode of bipolar I disorder; substance dependence with serious role impairment; a suicide attempt and any mental disorder; at least two areas of severe role impairment due to a mental disorder in the Sheehan Disability Scale domains; or overall functional impairment with

Foliaki et al reported that Cook Islanders had a 12 month prevalence rate of mental disorder 50% higher than that of New Zealand as a whole.

a Global Assessment of Functioning¹⁵ score of 50 or less in conjunction with a mental disorder.²⁰

Table footnotes refer to a "Long" and "Short" form version of the questionnaire. In order to reduce the overall length of interview only a selection of respondents were asked about less common disorders (Long version) while everyone was asked about common disorders (Short form).¹²

Analysis: Data was weighted to account for the clustered sample design, different probabilities of selection and differential non-response. All prevalence estimates reported are the population-weighted estimates. Multivariable models were analysed by multiple logistic regression using SUDAAN and SAS (version 9.1.2). If the number in the denominator was 30 or less, confidence intervals were calculated according to a method by Korn and Graubard.^{21,14}

The first "unadjusted" model regresses the logit of the (prevalence or service) variable of interest on ethnicity and migration (NZ born, not NZ born). The second, "adjusted" model is the same as the "unadjusted" model but also includes age at interview (16-24, 25-44, 45-64, 65+ years) and sex alongside ethnicity and migration.

New Zealand Mental Health Information National Collection

The Mental Health Information National Collection (MHINC) is "a national database of information collected by the Ministry of Health to support policy, monitoring and research".¹⁵ In New Zealand there are 21 agencies, owned by District Health Boards (DHBs), that provide services to 99% of clients seen by mental health services reporting to the database. In practice not all non-government owned services (NGOs) report to the MHINC.¹⁵ In most years the number of NGOs reporting to the MHINC was in excess of 30. This represented less than 10% of NGOs contracted to provide Mental Health services in New Zealand. The database used in this analysis contains data on individuals (clients) who had used a mental health service between July 2000 and June 2006.

Demography: A selection of demographic correlates include date of birth (age), gender, in addition to a geographic identifier. The latter enables a link to an indicator of local area deprivation (NZDEP2001).

Ethnicity: This is collected using the question in the 2001 census. Each client can report as many ethnic groups as they like but only three at most are recorded in the MHINC. The level of coding enables a breakdown to individual Island group for people of Pacific ethnicity. Ethnicity, in the MHINC is reported in two separate tables in MHINC and coding may change over time. "Pacific" and "Cook Island Maori" are counted if they identified themselves as such in

any year or in either of the two places reported in the MHINC. This method of capturing ethnicity is similar to the method described in an analysis of breast cancer among Maori in 2005.¹⁶

Diagnosis: DSM IV and ICD10 diagnoses are both reported although to remain consistent with the NZMHS output only DSM IV diagnosis is reported. Rare conditions such as schizophrenia and other psychotic disorders are captured in the MHINC.

Services: A variety of attributes associated with mental health service care have been captured and are listed fully in the data dictionary.¹⁵ This report focuses mainly on high level service use of community, inpatient or forensic services as a whole.

Analysis: This was carried out using logistic regressions in SAS version 9.2. In addition, missing data, mainly ethnicity and diagnosis, was addressed using multiple imputation.¹⁷⁻¹⁹ This was done using the additional SAS Procedures; MI and MIANALYSE.

Results from NZMHS

Prevalence of disorder

The twelve month prevalence rates for mental disorder and treatment sought for a mental health problem in the past year have been estimated using the NZMHS. These extend analyses of the prevalence of disorder among New Zealand residents originally or descended from the Cook Islands (Cook Islanders). These were introduced in two earlier publications in published 2006.^{20,1}

There is a typical pattern that emerges from looking at prevalence of mental disorder across the different ethnic groups: Cook Islanders are about the same as NZ Maori and higher than NCI (non Cook Islands) Pacific peoples who in turn are higher than the composite Other of non Maori and non Pacific ethnic groups. Many of these differences are reduced after adjusting the rates for population, age and sex.

As shown in Table 1, the 12 month prevalence of any mental disorder is 30.9% among Cook Islanders, 29.5% of NZ Maori, 24.2% of NCI Pacific and 10.3% of people of Others. All are significantly higher than Others. After adjustment for different age and sex structure of each population the 12 month prevalence of any mental disorder is 26.9% among Cook Islanders, 26.4% among NZ Maori, 21.6% among NCI Pacific peoples and 19.7% among people of Other ethnicities. Compared to Others, Cook Islanders still have higher prevalence after adjustment ($p=.03$) but the difference for NCI Pacific peoples are explained by age and sex ($p=.3$).

The 12 month prevalence of substance disorders in Cook Islands and NZ Maori is at least twice that for NCI Pacific peoples and over three times that of

Table 1 12 month prevalence of mental disorder¹ by ethnicity in NZMHS

Comparison	Adjusted	Cook Islands	NCI Pacific	NZ Maori**	Other
Any mental disorder ^a	unadjusted	30.9 (23.3, 38.5)	24.2 (20.3, 28.1)	29.5 (26.5, 32.4)	19.3 (18.0, 20.6)
	Adjusted for Age and Sex	26.9 (20.0, 33.7)	21.6 (18.0, 25.2)	26.4 (23.7, 29.0)	19.7 (18.4, 21.1)
Any mental disorder (excl substance) ^a	unadjusted	27.1 (19.9, 34.3)	22.1 (18.5, 25.7)	25.3 (22.8, 27.9)	17.9 (16.7, 19.1)
	Adjusted for Age and Sex	23.7 (17.2, 30.2)	20.0 (16.6, 23.4)	22.8 (20.4, 25.1)	18.3 (17.1, 19.5)
Any Substance disorder	unadjusted	9.5 (5.3, 13.7)	4.6 (3.2, 6.0)	9.0 (7.5, 10.5)	2.7 (2.3, 3.2)
	Adjusted for Age and Sex	7.0 (4.0, 10.1)	3.4 (2.4, 4.5)	7.2 (6.0, 8.4)	2.9 (2.4, 3.4)
Serious disorder ^{a†}	unadjusted	7.7 (4.3, 11.1)	5.7 (4.2, 7.2)	8.9 (7.5, 10.2)	4.1 (3.6, 4.6)
	Adjusted for Age and Sex	6.5 (3.5, 9.4)	5.0 (3.6, 6.3)	7.8 (6.6, 9.0)	4.2 (3.7, 4.7)

¹ DSM-IV CIDI 3.0 disorders with hierarchy. ²⁶ *Excluding Maori who were also Pacific*; ²⁷ *Assessed in the subsample who did the long form interview*. ²⁸ *For severity*. ²⁹ *For severity*.

Table 2 Odds ratios of ethnicity and NZ born from logistic regression on 12 month prevalence of mental disorder† among Pacific in NZMHS.

Disorder	Model	Description	Cook Islands vs NCIPacific (OR=1)	NZ Bom vs not (OR=1)
Any Disorder ^a	i) Ethnicity alone	OR (95%CI) p-value	1.41 (0.93,2.14) 0.1	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.27 (0.84,1.92) 0.3	1.81 (1.28,2.56) 0.0009
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	1.25 (0.82,1.9) 0.3	1.82 (1.1,2.39) 0.01
	i) Ethnicity alone	OR (95%CI) p-value	1.32 (0.87,1.99) 0.2	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.20 (0.80,1.80) 0.4	1.70 (1.20,2.42) 0.003
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	1.15 (0.76,1.74) 0.5	1.57 (1.05,2.34) 0.03
Substance	i) Ethnicity alone	OR (95%CI) p-value	2.33 (1.27,4.27) 0.006	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.95 (1.04,3.64) 0.04	2.35 (1.37,4.01) 0.002
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	2.15 (1.15,4.01) 0.02	1.52 (0.84,2.73) 0.2
	i) Ethnicity alone	OR (95%CI) p-value	1.44 (0.81,2.56) 0.2	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.36 (0.77,2.41) 0.3	1.37 (0.85,2.20) 0.2
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	1.38 (0.76,2.51) 0.3	1.13 (0.67,1.88) 0.6
Severe ^{a,c}	i) Ethnicity alone	OR (95%CI) p-value	1.41 (0.93,2.14) 0.1	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.27 (0.84,1.92) 0.3	1.81 (1.28,2.56) 0.0009
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	1.25 (0.82,1.9) 0.3	1.82 (1.1,2.39) 0.01
	i) Ethnicity alone	OR (95%CI) p-value	1.32 (0.87,1.99) 0.2	
	ii) Adjusted NZ Bom	OR (95%CI) p-value	1.20 (0.80,1.80) 0.4	1.70 (1.20,2.42) 0.003
	iii) Adjusted as for ii) plus age and sex	OR (95%CI) p-value	1.15 (0.76,1.74) 0.5	1.57 (1.05,2.34) 0.03

¹DSM-IV CIDI 3.0 disorders with hierarchy. ²⁶ *and/or* 12.4.1 ²⁸ Assessed in the subsample who did the long form interview. ²⁶ *and/or* 12.4.2 ¹ For severity. ²⁶ *and/or* 12.12.12 ²⁸ *and/or* 12.7

Others. After adjustment for different age and sex structure of each population the pattern remains similar. However, prior to adjustment NCI Pacific were significantly higher than Others but the difference became no longer significant after adjusting for age and sex ($p=.4$).

Thus many of the differences between Pacific, particularly NCI Pacific, and Others for most disorders are explained by differences in age and sex. Within Pacific, looking at Cook Islands and Non-Cook Islands ethnic groups, the first model includes only ethnicity (Cook Islands vs not) and then a second model adjusts for whether an individual is born in New Zealand (NZ born) or not and a further model also adjusts for age and sex. The results of the regressions are shown in Table 2.

In the case of diagnosed mental disorders, the odds ratio for ethnicity with no other factors is usually higher, indicating Cook Islanders are more likely to have a disorder than NCI Pacific peoples, but the odds ratios are not significant. However, with the introduction of place of birth, New Zealand born vs not born in New Zealand (NZborn), as a factor, the odds ratios for place of birth is significant. Although the difference is reduced, NZborn still are significantly more likely to have a disorder after adjusting for age and sex. The exception to this is for severe disorders where neither the odds ratios for ethnicity nor place of birth are significant.

In the case of substance disorder, not accounting for any the effects of other factors, Cook Islanders are more likely to have a disorder as NCI Pacific peoples. Even after adjusting for place of birth and age and sex, the odds ratios for both NZ born and ethnicity are still significantly greater than 1. This means that the differences between Cook Islanders and NCI Pacific ethnic groups, in substance disorder, are not fully explained by either place of birth or age and sex.

Age is a significant factor underpinning higher prevalence of substance disorder as well as serious disorder among Cook Islanders compared with NCI Pacific. People aged 16 to 24 years are most likely of all age groups to have substance disorder. They are also significantly more likely to have a severe disorder than older people.

Females have higher rates of mood disorders than males, and males have higher rates of substance disorders.

Service use

NCI Pacific peoples and Cook Islanders had the lowest proportions of people with a 12 month disorder to use any health service for their mental health problem compared to both NZ Maori and Others. Even after adjustment for different age and sex structure of each population NCI Pacific people remain significantly less likely to have seen anyone for their mental health problem. Cook Islanders are less, but not significantly, likely than Others to visit a service.

As shown in Table 3, the proportion who had used any mental health specialist service for their mental health problem is 26.4% among NZ Maori, 23.7% of Others, 17.2% of Cook Islanders, and 15.6% of NCI Pacific peoples. Pacific people, both Cook Islanders and NCI Pacific peoples, were significantly less likely to have seen anyone for their mental health problem, with or without adjustment for age and sex.

In summary Cook Islands people are more likely than NCI Pacific peoples to see someone for their mental health problem but both groups are less likely than Others and NZ Maori to visit mental health specialist services.

Table 3 12 month prevalence of service use by those with any disorder by ethnicity in NZMHS

Comparison	Adjusted	Cook Islands	NCI Pacific	NZ Maori ¹	Other
Mental Health Specialist Visit	unadjusted	17.2	15.6	26.4	23.7
		(12.7, 21.8)	(12.6, 18.6)	(24.2, 28.5)	(22.6, 24.8)
	Adjusted for Age and Sex	16.1	14.7	24.6	24.0
		(11.7, 20.5)	(11.8, 17.5)	(22.6, 26.7)	(22.8, 25.1)
Any Health Service	unadjusted	30.0	24.3	37.5	38.9
		(23.5, 36.5)	(20.9, 27.7)	(35.1, 39.8)	(37.6, 40.2)
	Adjusted for Age and Sex	30.1	24.4	36.9	39.0
		(23.4, 36.8)	(20.9, 27.9)	(34.6, 39.3)	(37.7, 40.3)

¹NZ Maori excluding Maori who were also Pacific

Results from the MHINC

Mental health service use

The estimated prevalence of mental health service use (clients per year) is calculated from the MHINC for the years from 2001/02 to 2005/06. The MHINC enables a breakdown of ethnic group to individual Island ethnicity but unlike the NZMHS does not enable an analysis by place of birth or migration status.

Table 4 Average annual prevalence of mental health service use by ethnicity, per 10,000 people † (MHINC)

	Cook Islands	NCI Pacific	NZ Maori‡	Other
Unadjusted	162.2 (148,177)	150.7 (137,164)	336.4 (327,346)	215.6 (213,218)
Adjusted† (i) Age and gender	196.2 (178,214)	173.6 (158,189)	350.1 (340,360)	213.9 (211,217)

†standardised to the New Zealand total 2006 population. ‡NZ Maori excluding Maori who were also Pacific

All services combined

Table 4 shows the average annual prevalence of mental health service use by ethnicity. NCI Pacific peoples and Cook Islanders had the lowest annual rates of people to use a mental health service compared to both NZ Maori and Others. Even after adjustment for different age and sex structure of each population the differences remain significant.

By service category

Table 5 shows that over 80% of Cook Islands mental health service clients were seen by community services, a similar proportion to the three other

comparison ethnic groups. However, 30% of Cook Islands clients are seen by inpatient services compared with 9% of Others clients and 28% of Cook Islands clients are seen by Forensic services compared to 3% of Others.

NCI Pacific and Cook Islanders had lower use of community mental health service than NZ Maori and Other. After adjusting for age sex little difference remained between Cook Islanders, NCI Pacific and people of Other ethnicities. The rate for NZ Maori remained higher after adjusting for age and sex.

Table 5 Average annual mental health service use: service category by ethnicity† (MHINC)

	Cook Islands	NCI Pacific	NZ Maori‡	Other
Community				
Unadjusted	131.5 (116,147)	122.6 (108,137)	245.7 (237,255)	177.1 (174,180)
Adjusted: Age and gender	162.0 (143,181)	143.3 (128,159)	255.6 (246,265)	176.3 (173,180)
Inpatient				
Unadjusted	48.1 (45,52)	30.6 (28,33)	48.6 (45,52)	19.8 (19,21)
Adjusted: Age and gender	39.0 (36,43)	25.0 (23,27)	44.7 (43,47)	19.1 (18,20)
Forensic				
Unadjusted	45.5 (40,51)	26.4 (24,28)	39.7 (37,42)	7.4 (7,8)
Adjusted: Age and gender	27.5 (20,36)	16.0 (14,18)	29.0 (26,32)	6.0 (5,6)

†standardised to the New Zealand total 2006 population. ‡NZ Maori excluding Maori who were also Pacific

The unadjusted rate who had used an inpatient mental health service for Cook Islanders and NZ Maori (48.1 and 48.6 per 10,000) is twice that and NCI Pacific (30.6) 50% higher than the rate for Others (19.8). After adjusting for age sex the rate for Cook Islanders reduced to be similar that of NCI Pacific but remained 50% higher than that for Others.

A similar pattern was evident for those who used Forensic services except the rate for Cook Islanders was six times, for NZ Maori more than five times and NCI Pacific more than four times that of Others. Even after adjustment the differences were between three to 4.5 times that of Others.

Table 6 Average annual mental health service use: diagnosis by ethnicity ¹ (MHINC)

	Cook Island	non CI Pacific	NZ Maori ²	Other
Anxiety				
Unadjusted	19.4	9.8	20.6	23.4
	(15,24)	(8,11)	(16,25)	(20,27)
Adjusted: Age and gender	25.9	12.2	21.0	23.2
	(17,35)	(10,14)	(17,25)	(20,27)
Bipolar				
Unadjusted	38.1	18.8	33.8	17.1
	(34,43)	(17,21)	(28,40)	(15,19)
Adjusted: Age and gender	39.5	18.4	33.7	16.1
	(36,43)	(16,21)	(28,40)	(14,18)
Depression				
Unadjusted	37.4	24.8	39.4	43.9
	(31,44)	(21,29)	(31,47)	(38,49)
Adjusted: Age and gender	39.0	22.6	39.9	42.8
	(31,47)	(20,26)	(33,47)	(37,48)
Schizophrenic disorders				
Unadjusted	94.9	65.5	91.5	24.1
	(81,109)	(56,75)	(77,106)	(21,27)
Adjusted: Age and gender	74.6	50.9	69.3	19.6
	(66,83)	(43,59)	(58,80)	(17,22)
Other Psychotic disorders				
Unadjusted	37.6	25.3	27.0	10.2
	(31,44)	(21,30)	(21,34)	(8,12)
Adjusted: Age and gender	35.5	20.5	20.2	8.6
	(28,43)	(17,24)	(15,26)	(7,11)
Alcohol				
Unadjusted	42.4	19.1	48.5	19.4
	(38,46)	(18,20)	(42,55)	(17,22)
Adjusted: Age and gender	26.8	10.8	34.4	15.7
	(18,35)	(9,12)	(28,41)	(13,18)

¹standardised to the New Zealand total 2006 population. ²NZ Maori excluding Maori who were also Pacific

By diagnosis

Among Cook Islanders the diagnoses of people who were seen by mental health services were from, most prevalent;

Order	Cook Islands	NCI Pacific	NZ Maori	Others
1	Schizophrenia	Schizophrenia	Schizophrenia	Depression
2	Alcohol related	Psychotic	Alcohol related	Schizophrenia
3	Bipolar	Depression	Depression	Anxiety
4	Psychotic	Alcohol related	Bipolar	Alcohol related
5	Depression	Bipolar	Psychotic	Bipolar
6	Anxiety	Anxiety	Anxiety	Psychotic

Individuals can receive more than one diagnosis so they can be counted in more than one diagnostic total. It should also be noted that around one third of people seen had a temporary diagnosis, where a specific diagnosis had not been determined.

For Cook Islanders, NCI Pacific and NZ Maori the most common diagnosis was schizophrenia followed by alcohol related disorder for Cook Islanders and NZ Maori or Psychotic disorders for NCI Pacific. Depression and anxiety, the two least likely diagnoses among Cook Islanders clients are two of the three most common among Others.

Table 6 shows that Cook Islanders (94.9 per 100,000) were nearly four times more likely to receive a diagnosis of Schizophrenia compared with Others (24.1). After adjusting for age and sex the rate among Cook Islanders was still 3.5 times that of Others. NZ Maori and NCI Pacific were also over three times the rate for Other ethnicities. A similar pattern was evident among those with psychotic disorders. The rates of those who had an alcohol related disorder for Cook Islanders (42.4) was more than twice that for Others (19.4). After adjusting for age sex the difference between Cook Islanders, NCI Pacific and Others was no longer significant.

The rates of those who had a bipolar disorder for Cook Islanders (38.1) was also more than twice that for Others (17.1). After adjusting for age sex the difference between Cook Islanders was still more than twice the rate of Others.

Discussion

New Zealand Mental Health Survey

The NZMHS shows the prevalence of mental disorder among Cook Islands residents in New Zealand. This analysis of the NZMHS has extended that of Foliaki et al¹²⁰ which showed a high prevalence of mental

disorder among Cook Islanders peoples compared with NCI Pacific peoples or New Zealand as a whole.

Adjusting for age and sex enables us to see that many of the differences in prevalence of disorder are

largely due to the age and gender structure of the Cook Islands population living in New Zealand.

These results show the prevalence of disorder among "New Zealand-born" Cook Islands people is higher than those who migrated to New Zealand as is also shown in an analysis of ethnicity, migration and disorder.⁸ The results suggest that early exposure to the New

Zealand society may be associated with higher levels of mental disorder. The affect of place of birth on rates of disorder is greater than ethnicity. Thus, simply being a Cook Islander does not increase the likelihood of having a disorder. Nonetheless, even after adjustment for demographic factors, substance related disorder, predominantly alcohol, is still high.

National mental health service use (MHINC)

Te Rau Hinengaro¹²¹ indicated that, in the previous 12 months, 3% of Pacific people had seen mental health specialist services for their mental health compared with 4.9% of the total population. The prevalence reported by MHINC is around half of that estimated by NZMHS. The reason for this lower prevalence is most likely because the NZMHS used a more inclusive definition of mental health specialist services than are able to be captured by the MHINC. It included private consultations with psychiatrists, psychologist, and counsellors and mental health helpline contacts, not just the psychiatric admissions and other services provided by mental health specialty services which are captured in MHINC.

It has been shown¹²⁰ that Pacific peoples with a serious mental disorder were half as likely to have seen any health service for their mental health problem and Pacific peoples with a 12 month disorder

There has long been a concern that Pacific peoples seem to be over represented in services that deal with extreme levels of mental health care

were least likely to have seen health service for their mental health problem even after adjusting for socio-demographic factors.

The results in this paper also show that while both Cook Islanders and NCI Pacific groups have lower use of health services if they have a disorder Cook Islanders are slightly more likely to have seen someone for their mental health problem. The pattern is similar for use of a mental health specialist service.

There has long been a concern that Pacific peoples seem to be overrepresented in services that deal with extreme levels of mental health care.^{22,23} Generally, there has been an impression that Pacific peoples use of mental health services, while generally lower than people from other ethnicities, generally required a level of treatment that was longer in duration and more costly. These results seem to confirm that pattern for Cook Islands clients.

There is a need for a better understanding of the underlying protective and risk factors for mental health and mental illness among all Pacific populations. While it is true that, age, gender and place of birth account for many of the differences between Cook Islanders and other ethnic groups there still remains a need for further investigation into other factors that contribute to better mental health of Cook Islanders in New Zealand. However, just because we understand a bit better the mechanisms that underpin higher levels of disorder in the Cook Islands population does not negate the fact that there is still a comparatively high burden of mental disorder in existence. It appears to be the price for making the adjustment to New Zealand that appears to be extracted more from the children and grandchildren of those who migrated to New Zealand.

Cook Islanders do have a high prevalence of mental disorder and particularly substance use yet relatively low levels of treatment sought for such problems. Another finding from an analysis of the impact of migration⁸ seemed to point to particularly low use of health services by older migrants. This is also likely to be the case with Cook Islanders. So while treatment may be low among Cook Islanders generally the solution is not a one size fits all remedy.

Yet, it should be remembered that even with relatively high prevalence of mental disorder, 70% of Cook Islands people did not have a disorder when surveyed. Of those who have a disorder only a relatively small proportion would require treatment and under ordinary treatment conditions an even smaller number would be severely impaired for a great length of time.

However, there are some concerns raised by the results presented here about mental illness that should not be ignored by the Cook Islands population resident in New Zealand as well as those who plan for and work in services that treat people with problems related to mental disorder. These results point to:

- Relative high levels of need
- Particularly high rates of substance use, and
- Non-access to specialist mental health services for treatment by those who need it.

There are many reasons that lead to avoiding treatment; understanding of mental illness, cultural background, knowledge and availability of services or perceived cost, to name a few. The evidence suggests that for whatever reasons, Cook Islanders appear to only receive treatment when it is extremely severe or under compulsion.

Acknowledgements

Te Rau Hinengaro: The New Zealand Mental Health Survey was funded by the Ministry of Health, Alcohol Advisory Council and Health Research Council of New Zealand. The survey was carried out in conjunction with the World Health Organization World Mental Health (WMH) Survey Initiative. We thank the WMH staff for assistance with instrumentation, fieldwork and data analysis. These activities were supported by the US National Institute of Mental Health (R01MH070884), the John D and Catherine T MacArthur Foundation, the Pfizer Foundation, the US Public Health Service (R13-MH066849, R01-MH069864, and R01 DA016558), the Fogarty International Center (FIRCA R01-TW006481), the Pan American Health Organization, Eli Lilly and Company, Ortho-McNeil Pharmaceutical, Inc., GlaxoSmithKline, and Bristol-Myers Squibb. WMH publications are listed at: <http://www.hcp.med.harvard.edu/wmh/>

Other members of the Te Rau Hinengaro Research Team are M Oakley-Browne, J Baxter, T K Kingi, R Tapsell, M H Durie, K M Scott and C Gale.

We particularly acknowledge the input by the Pacific Advisory Group: Fulmaono Karl Pulotu-Endemann, Francis Agnew, Vito Malo, Reverend Felloalga Tauleale-ausumai, Hemiquaver Lesatele, Lina-Jodi Vaine Samu Tuiloma and Sefita Hao'uili.

We thank the Kaitiaki Group for their input and support for this survey and we thank all the participants.

References

- Folliaki SA, Kokaua J, Tukuitonga C, Schaaf D, for the New Zealand Mental Health Survey Research Team. Twelve-month and lifetime prevalence of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS). *Australian and New Zealand Journal of Psychiatry* 2006; 40:924-934.
- Spoonley P. Pacific Communities: Transforming the Politics of Place and Identity. In: Macpherson C, Spoonley P, and Anae M, eds. *Tangata O Te Moana Nui: evolving identities of Pacific Peoples in Aotearoa New Zealand*. Palmerston North, N.Z.: Dunmore Press 2001.
- Krishnan V, Schoeffel P, Warren J. The Challenge of change: Pacific Island communities in New Zealand, 1986-1993. Wellington, NZ: NZ Institute for Social Research & Development, 1994.
- Tongia M. Te Neke'anga i Porirua: Changing values in Aotearoa. In: Crocombe R and Crocombe MT, eds. *Cook Islands Culture*. Suva, Fiji and Rarotonga, Cook Islands: University of the South Pacific, 2003.
- Office CIS. Population estimates & vital statistics. In: Islands SC, ed. 2008.
- Tiatia J, Coggan C, Young Pacific suicide attempts: a review of emergency department medical records, Auckland, New Zealand. *Pacific Health Dialog* 2001; 8:124-128.
- Flores G, Brotanek J. The healthy immigrant effect. *Archives of Podiatry and Adolescent Medicine* 2005; 159:295-297.
- Kokaua J, Folliaki S, Schaaf D. Migration, ethnicity and twelve-month prevalence rates of mental disorders and treatment contact in Te Rau Hinengaro: The New Zealand Mental Health Survey. *Pacific Health Dialogue* to be published.
- Hecht J. Physical and social boundaries in Pukapukan theories of disease. In: Parsons C, ed. *Healing practices in the South*. Hawaii: The Institute for Polynesian Studies, 1985.
- Baddeley J. Traditional healing practices of Rarotonga, Cook Islands. In: Parsons C, ed. *Healing practices in the South*. Hawaii: The Institute for Polynesian Studies, 1985.
- Worth M. Cook Islands Mental Health Cultural Competency Workshop. Auckland: Waitemata District Health Board, 2004.
- Wells JE, Oakley Browne MA, Scott KM, McGee MA, Baxter J, Kokaua J, Te Rau Hinengaro: The New Zealand Mental Health Survey: overview of methods and findings. *Australian & New Zealand Journal of Psychiatry* 2006; 40:835-844.
- Korn EL, Graubard BI. Confidence intervals for proportions with small expected number of positive counts estimated from survey data. *Survey Methodology* 1998; 24:193-201.
- Korn EL, Graubard BI. *Analysis of health surveys*. New York: Wiley, 1999.
- New Zealand Health Information Service. *Mental Health Information National Collection: Data Dictionary*, version 3.8. Wellington: New Zealand Health Information Service, 2006.
- Curtis E, Wright C, Wall M. The epidemiology of breast cancer in Maori women in Aotearoa New Zealand: implications for ethnicity data analysis. *New Zealand Medical Journal* 2005; 119.
- Schafer J. Multiple Imputation: a primer. *Statistical Methods in Medical Research* 1999; 8:3-15.
- Harel O, Zhou XH. Multiple imputation: Review of theory, implementation and software. *Statistics in Medicine* 2007; 26:3057-3077.
- Horton NJ, Lipsitz SR. Multiple imputation in practice: comparison of software packages for regression models with missing data. *American Statistician* 2001; 55:244-254.
- Folliaki S, Kokaua J, Schaaf D, Tukuitonga C, for the New Zealand Mental Health Survey Research Team. Twelve-month and lifetime prevalences of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Epidemiology Survey (NZMHS). In: Oakley Browne MA, Wells JE, and Scott KM, eds. *Te Rau Hinengaro: the New Zealand Mental Health Survey*. Wellington: Ministry of Health, 2006.
- Oakley Browne MA, Wells JE, Scott KM, for the New Zealand Mental Health Survey Research Team. Twelve month and lifetime health Service use in Te Rau Hinengaro: the New Zealand Mental Health Survey. *Australian and New Zealand Journal of Psychiatry* 2006; 40:855-864.
- Ministry of Health. *Te Orau Ora: Pacific Mental Health Profile*. Wellington: Ministry of Health, 2005.
- Gaines P, Bower A, Buckingham W, Eagar K, Burgess P, Green J, Mellisop G. *New Zealand Mental Health Classification and Outcomes Study: Final report*. Auckland: Health Research Council, 2003.
- Wells JE, McGee MA, Oakley Browne MA. Methods. In: Oakley Browne MA, Wells JE, and Scott KM, eds. *Te Rau Hinengaro: The New Zealand Mental Health and Wellbeing Survey*. Wellington: Ministry of Health, forthcoming.
- Wells JE. Prevalence and severity across aggregated disorders. In: Oakley Browne MA, Wells JE, and Scott KM, eds. *Te Rau Hinengaro: The New Zealand Mental Health and Wellbeing Survey*. Wellington: Ministry of Health, forthcoming.

Twelve-month prevalence, severity, and treatment contact of mental disorders in New Zealand born and migrant Pacific participants in Te Rau Hinengaro: The New Zealand Mental Health Survey

Jesse Kokaua

David Schaaf

J Elisabeth Wells

Siale Alo Foliaki

Author Information

Jesse Kokaua, Research Analyst, Population Health Directorate, Ministry of Health, Dunedin, New Zealand

David Schaaf (PhD), Principal Research Analyst Ministry of Pacific Island Affairs, Wellington, New Zealand

J Elisabeth Wells, Associate Professor Department of Public Health and General Practice, University of Otago, Christchurch, New Zealand

Siale Alo Foliaki, Consultant Psychiatrist, Counties-Manukau District Health Board, Auckland, New Zealand

Correspondence

Jesse Kokaua, Ministry of Health, Level 4, 229 Moray Place, PO Box 5849, Dunedin 9016, New Zealand

Telephone: +64 3 474 8546, Fax: +64 3 474 8090, Email: jesse_kokaua@moh.govt.nz

Abstract

Objective: To investigate differences in 12-month prevalences of mental disorders and 12-month treatment contact among New Zealand born and migrants in separate ethnic groups in Te Rau Hinengaro: The New Zealand Mental Health Survey (NZMHS).

Data: The NZMHS is a nationally representative face-to-face household survey, carried out in 2003-2004 with a response rate of 73.3%. It surveyed 12,992 New Zealand adults aged 16 and over. Pacific people were over sampled. This paper focuses on the 2374 Pacific participants but includes for comparison 8160 non-Maori-non-Pacific participants (Others).

Method: Multiple logistic regression models were used to produce estimates weighted to account for different probabilities of selection and taking account of the complex survey design.

Results: The prevalence of mental disorder was lowest among those who migrated as adults compared with those who migrated as young children (child migrants) or New Zealand-born (NZ born) migrant descendants in both Pacific and other ethnic groups. While Pacific people have higher rates of disorder than Others, many of the observed differences between Pacific and Others were explained by population differences in age and sex.

Service use in the last 12 months by people with a disorder was low among Pacific peoples overall, but specifically among older migrants. Older Pacific migrants with a disorder had particularly low use of specialist mental health services.

Conclusion: An interesting picture has emerged regarding need for and use of mental health services. The burden of mental disorder is highest while service use was lower among Pacific peoples generally. Those born in or who migrated as children to New Zealand had higher levels of disorder but were also more likely to use services than older migrants.

Key words: cross-sectional studies, epidemiology, mental disorders, migration, Pacific, ethnicity.

Introduction

The social and cultural fabric of Pacific peoples in New Zealand society is diverse, complex and heterogeneous. There are differences between cultural groups and also within cultural groups in terms of norms, customs, language, cultural values and behaviours.

Since the early 1950's demand for workers in the

manufacturing and service industries culminated in increasing numbers of Pacific peoples emigrating to urban centres of New Zealand. This accelerated dramatically with the economic boom of the 1960's and early 1970's^{1, 2}. The establishment of South Pacific Work Schemes recruited labourers from Fiji, Samoa, Tonga, Tuvalu and Kiribati throughout the 1970's. However the economic downturn in

that started in the 1970's and characterised New Zealand's economy in the 1980's and 90's led many Pacific peoples in the manufacturing industries to be laid off or in underemployment.

This created adverse consequences in general living conditions for many Pacific migrants and their families. This alongside pressures of adjustment and acculturation has been speculated to have had a negative impact on the mental health of Pacific peoples living in New Zealand. In addition two distinctive sub-cultures have emerged; a younger New Zealand born and raised population and an older Island Born and raised². This has fostered issues such as shifts and tensions in traditional customs, norms, beliefs and values, which affects individuals' sense of belonging and identity, and social cohesion. Issues of identity for young Pacific peoples are significant, in a bicultural and multicultural environment, balancing the desires to retain a cultural heritage while living in a contemporary society.

There is general recognition that the transition from Island culture to urban and largely *palagi* (European) dominated cultural norms in New Zealand is difficult and issues of successful adjustment and adaptation to the New Zealand environment and culture need to be considered more thoroughly.

There has been much international evidence of an association between migration and psychiatric disorder or mental wellbeing. These include separate analyses of refugees as well as immigrant worker populations.⁴⁻⁷

In addition, there is the emerging notion of a "healthy migrant" in spite of apparent high risk as observed initially among Hispanic or Mexican migrants to the US⁸. This is counter to results from some other studies that pointed to worse mental health among migrants. In a meta-analysis of schizophrenia⁹ showed that first generation migrants had high rates but 2nd generation migrants were higher. Higher rates among migrants were influenced by risk factors prevalent in the communities from which individuals had migrated and the ease of their transition into their host country.

Bhugra¹⁰⁻¹² also observed that prevalence of mental disorder was associated with migration but these differences were dependent upon the predisposition of the individual to stress as well as the cultural and social factors from which they came from and arrived to. The European experience tends to highlight the heterogeneity of the groups broadly called migrants⁶.

There is a lack of information and research on Pacific peoples' immigration experiences and mental health

although there has been some social and historical analysis.^{13, 14} Most research has been undertaken on the immigration experiences of refugees, which does not include Pacific peoples.

Only a few Australian or New Zealand based migration studies have been undertaken on the prevalence of mental disorders among immigrants. The Australian experience is different from that of New Zealand Pacific peoples as many publications deal with early European,¹⁵ recent middle eastern immigrants^{16, 17} or recent issues among those detained under Australian migration regulations.¹⁸ Within New Zealand, one study focused upon Chinese immigrants¹⁹ and another on a general population comparison which included a small Pacific sample²⁰. These focused on general mental disorder or feelings of anxiety or depression with a non clinical rating and seemed to point to aspects of migration as the main influences on disorders, more so than ethnic differences as pointed out in the latter paper. A commentary on the mental health of Tongan migrants²¹ pointed to growing concerns about increasing mental illness and substance issues compared with those resident in the Kingdom of Tonga.

Among New Zealand-born Pacific people, 31.4% had a mental disorder which was twice as that of people who migrated at age 18 and over (15.1%).

Prior to the New Zealand Mental Health Survey (NZMHS) estimates about the prevalence of mental disorders among Pacific people in New Zealand had been drawn from the few prevalence studies performed in the Island nations²² or from Pacific people's use of mental health services in New Zealand.^{23, 24} In 2006, using NZMHS data, Foliaki

et al^{25, 26} reported the 12 month prevalence of mental disorder among Pacific people by age at migration and showed that among New Zealand-born Pacific people, 31.4% had a mental disorder which was twice as that of people who migrated at age 18 and over (15.1%). That observation supported international studies that pointed towards migrants having a lower lifetime prevalence of mental disorders.²⁷⁻²⁹

In this paper we compare the 12 month prevalence, severity and treatment contact of mental disorders among New Zealand's Pacific migrant population with their New Zealand born counterparts.

Method

Sample

The NZMHS was a nationally representative household survey of 12 992 adults aged 16 years and over, with a stratified multistage clustered sample design. Face-to-face interviews were carried out between October 2003 and December 2004 by specially trained interviewers, in English. The response rate achieved was 73.3%. More detail regarding survey methods is provided elsewhere.³⁰

Pacific people were oversampled. In total, there were 2374 Pacific people, of whom 138 reported both Pacific and Maori ethnicity. This paper includes all 2374 Pacific participants. Some comparisons are made with the 8160 'Others' (non-Maori non-Pacific). All participants answered questions relating to service use as well as mood, substance and some anxiety disorders while a subset of participants went on the answer questions about other anxiety disorders in the long form of the interview.^{31, 32 section 13.4.2}

Definitions

Socio-demographic correlates include age at interview, sex and ethnicity and are assessed using 2001 Census of Population and Dwellings questions when possible.

Questions about age at arrival and years since migrating to New Zealand were asked of those who were born outside New Zealand. In earlier analyses²⁵ age at migration was grouped into four categories: those who migrated to New Zealand at ages less than 12, between 12 and 18 years and 18 years and older and those who did not migrate to New Zealand (NZ born). In this paper, three groups have been used combining those who migrated at 12-18 years and those who migrated at 18 years and older, thus forming one group who migrated at age 12 or more (older migrants). This was to increase the numbers of respondents aged under 45 years of age who migrated at older ages. The other migrant group were those also born in the islands that migrated to New Zealand at age below 12 years (young migrants).

Mental disorders were defined in terms of 12 month prevalence, using the Composite International Diagnostic Interview (CIDI) version 3.0, a widely used computer assisted structured interview that produces valid and reliable psychiatric diagnoses. The CIDI generates DSM IV diagnoses by determining whether the respondent has ever in their lifetime met the criteria for the disorder, then determines the last time the person had an episode or key symptoms of the disorder (irrespective of treatment). If this was within 12 months of interview, this is classified as a 12 month disorder. Prevalence of rare conditions such as schizophrenia and other psychotic disorders could not be reliably estimated from this household survey. Organic brain syndromes such as dementia were also excluded from data collection.²⁰

Serious mental disorder was assigned if in the past 12 months there was either: an episode of

bipolar I disorder; substance dependence with serious role impairment; a suicide attempt and any mental disorder; at least two areas of severe role impairment due to a mental disorder in the Sheehan Disability Scale domains; or overall functional impairment found in the National Comorbidity Study Replication²³ to be associated with a Global Assessment of Functioning²⁴ score of 50 or less in conjunction with a mental disorder.²⁰

Analyses

Data were weighted to account for the clustered sample design, different probabilities of selection and differential non-response and post-stratified to the 2001 New Zealand Census of Population and Dwellings by age sex and ethnicity. All prevalence estimates reported are the population-weighted estimates. Multivariable models were analysed by multiple logistic regression using SUDAAN and SAS (version 9.1.2).

The first 'unadjusted' model regresses the logit of the (prevalence or service) variable of interest on ethnicity (Pacific and Other) and migration (NZ born, young and older migrants). The second, 'adjusted' model is the same as the 'unadjusted' model but also includes age at interview (16-24, 25-44, 45-64, 65+ years) and sex alongside ethnicity and migration.

Results

Age at Migration of those sampled

Table 1. Place of birth or age at migration for Pacific and Others by age group: percentage (95%CI).

Pacific	Age Group (Years)	NZ Born n=889	Young migrants n=307	Older migrants n=1178
	16 to 24	69.0 (62.5, 75.5)	16.8 (12.2, 21.4)	14.2 (9.0, 19.4)
	25 to 44	44.8 (40.4, 49.6)	15.7 (12.5, 18.9)	39.5 (34.7, 44.3)
	45 to 64	12.2 (8.8, 15.7)	7.3 (4.6, 10.0)	80.4 (76.3, 84.6)
	65+	2.4 (0.0, 5.1)	3.2 (0.6, 5.7)	94.4 (90.6, 98.2)
	Total	42.1 (38.6, 45.6)	13.5 (11.5, 15.6)	44.3 (40.7, 48)
Others ¹	Age Group (Years)	NZ Born n=6182	Young migrants n=402	Older migrants n=1576
	16 to 24	70.2 (66.1, 74.3)	11.1 (8.5, 13.6)	18.8 (15.2, 22.4)
	25 to 44	73.1 (70.9, 75.3)	5.4 (4.5, 6.3)	21.5 (19.4, 23.7)
	45 to 64	76.9 (74.9, 79)	4.5 (3.7, 5.4)	18.5 (16.7, 20.4)
	65+	74.5 (72.2, 76.8)	2.5 (1.7, 3.3)	23.0 (20.8, 25.2)
	Total	74.1 (72.6, 75.6)	5.4 (4.8, 6.0)	20.5 (19.1, 21.8)

¹ Non-Maori Non-Pacific

Table 1 is the weighted percentage in different age

groups for Pacific and Other participants, by place of birth and age at migration. For Pacific participants, 42.1% (n=889) were born in New Zealand (NZ born), 13.5% (n=307) migrated under 12 years of age (young migrants) and 44.3% (n=1178) migrated to New Zealand when they were 12+ years and older (older migrants). Other participants comprised of people from non-Maori and non-Pacific ethnic groups of whom three quarters (74.1%), were born in New Zealand (n=6182), 5.4% (n=402) migrated under 12 years of age (young migrants), and 20.5% (n=1576) migrated to New Zealand when they were 12+ years and older (older migrants).

Among Pacific participants, much higher proportions of people in the two younger age groups were NZ born. On the other hand a higher proportion (74.1%), of Other participants were born in New Zealand compared with 42.1% of Pacific participants, which reflects our recent migration history. Interestingly, only 5.4% of Other participants were young migrants compared with 13.5% in Pacific participants. Both however are small compared with the other two categories in both ethnic groups.

Twelve month prevalence and severity of mental disorders in migrant and New Zealand born Pacific people

Table 2 shows the twelve month prevalence and severity of diagnosed mental disorders for Pacific and Other participants by place of birth and age at migration. The prevalence of any mental disorder among Pacific participants, not adjusted for age or sex, was 31.9% for NZ born, 31.0% for young migrants and 16.6% for older migrants. Among Other participants the prevalences for any mental disorder were; 20.6% for NZ born, 18.9% for young migrants and 14.7% for older migrants.

Overall, for Pacific participants, the prevalence of mental disorder was higher for NZ born, followed by their young migrants and then their older migrants counterparts. These differences were dependent on age and sex as when they

were adjusted or controlled for, the differences were much reduced and often were no longer statistically significant. Other participants showed the same pattern as Pacific participants whereby the NZ born showed higher prevalence of mental disorders, followed by the young migrants then older migrants. As for Pacific participants, these differences were reduced following adjustment for age and sex but with larger sample sizes in the Other participants group they remained statistically significant.

A similar overall pattern was shown for severity of mental disorders. However the difference among NZ born and the migrant groups changed little with adjustment for age and sex.

Table 3 is the odds ratios for mental disorders by

Table 2. 12-month prevalence and severity of diagnosed mental disorders¹ among Pacific and 'Other' participants by place of birth and age at migration.

	Pacific			Other		
	NZ Born	Young migrants	Older migrants	NZ Born	Young migrants	Older migrants
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Mental Disorder						
<i>Any mental disorder¹</i>						
Unadjusted	31.9 (26.3, 37.6)	31.0 (21.4, 40.6)	16.6 (13.3, 19.9)	20.6 (19.1, 22.1)	18.9 (13.9, 23.8)	14.7 (12.2, 17.3)
Adjusted for Age and Sex	24.1 (19.1, 29.1)	24.7 (16.2, 33.3)	17.2 (13.7, 20.7)	20.8 (19.3, 22.3)	17.0 (12.5, 21.5)	15.4 (12.8, 18.0)
<i>Any mood disorder</i>						
Unadjusted	11.6 (7.8, 15.4)	13.3 (8.3, 18.4)	4.6 (3.3, 5.9)	7.7 (6.9, 8.5)	10.5 (7.2, 13.8)	6.0 (4.4, 7.5)
Adjusted for Age and Sex	8.3 (5.5, 11.0)	10.3 (6.3, 14.2)	4.8 (3.4, 6.2)	7.8 (7.0, 8.6)	9.3 (6.3, 12.2)	6.2 (4.6, 7.8)
<i>Any Anxiety disorder¹</i>						
Unadjusted	20.5 (16.2, 24.8)	17.9 (11.2, 24.6)	11.7 (8.8, 14.5)	15.1 (13.9, 16.3)	12.8 (9.0, 16.6)	10.8 (8.7, 12.9)
Adjusted for Age and Sex	16.6 (12.7, 20.6)	14.4 (8.7, 20.1)	11.8 (8.9, 14.7)	15.2 (13.9, 16.4)	12.0 (8.4, 15.6)	11.3 (9.1, 13.5)
<i>Any Substance disorder</i>						
Unadjusted	8.1 (5.9, 10.4)	4.2 (1.7, 6.7)	3.0 (1.4, 4.6)	3.0 (2.5, 3.6)	4.5 (2.0, 7.1)	1.2 (0.5, 1.9)
Adjusted for Age and Sex	4.1 (2.9, 5.3)	2.6 (1.1, 4.2)	3.5 (1.6, 5.4)	3.2 (2.6, 3.8)	3.3 (1.4, 5.1)	1.2 (0.5, 1.9)
Severity						
<i>Serious mental disorder¹</i>						
Unadjusted	7.0 (4.6, 9.4)	7.9 (3.9, 11.8)	4.2 (2.7, 5.6)	4.4 (3.8, 5.0)	4.4 (2.3, 6.5)	2.9 (1.9, 3.9)
Adjusted for Age and Sex	4.9 (3.1, 6.6)	6.0 (2.9, 9.2)	4.3 (2.8, 5.9)	4.5 (3.8, 5.1)	3.8 (2.0, 5.7)	3.0 (2.0, 4.1)
<i>2 or more disorders¹</i>						
Unadjusted	4.7 (3.1, 6.2)	5.4 (2.3, 8.5)	1.8 (1.0, 2.6)	4.1 (3.5, 4.6)	5.1 (2.7, 7.5)	2.5 (1.6, 3.4)
Adjusted for Age and Sex	3.4 (2.1, 4.6)	4.1 (1.6, 6.6)	1.9 (1.1, 2.7)	4.1 (3.5, 4.7)	4.6 (2.4, 6.8)	2.6 (1.7, 3.6)

¹ DSM-IV CIDI 3.0 disorders with hierarchy [32: section 13.4.1]; ² Assessed in the subsample who did the long form interview [32: section 13.4.2];

Table 3. Odds ratios and the severity of mental disorders¹ by ethnicity, place of birth and age at migration.

	Pacific vs Other ^{II} (Reference Group)	Pacific only	
		NZ Born vs Older migrants ^{III} (Reference Group)	Young migrants vs Older migrants ^{III} (Reference Group)
	OR (95% CI) p-value	OR (95% CI) p-value	OR (95% CI) p-value
Mental Disorder			
Any mental disorder[†]			
Unadjusted	1.2 (1.0, 1.5) 0.04	2.4 (1.6, 3.4) <0.0001	2.3 (1.4, 3.7) 0.001
Adjusted for Age and Sex	1.1 (0.9, 1.4) 0.4	2.2 (1.5, 3.3) 0.0001	2.1 (1.2, 3.4) 0.005
Any mood disorder			
Unadjusted	1.0 (0.8, 1.3) 0.9	2.7 (1.7, 4.4) <0.0001	3.2 (1.9, 5.4) <0.0001
Adjusted for Age and Sex	0.9 (0.7, 1.1) 0.3	2.6 (1.6, 4.3) 0.0001	3.1 (1.8, 5.2) <0.0001
Any anxiety disorder[†]			
Unadjusted	1.1 (0.9, 1.4) 0.4	2.0 (1.3, 2.9) 0.0006	1.7 (1.2, 2.8) 0.07
Adjusted for Age and Sex	1.0 (0.8, 1.2) 0.8	1.9 (1.2, 3.1) 0.006	1.5 (0.9, 2.7) 0.2
Any Substance disorder			
Unadjusted	1.4 (1.0, 2.0) 0.04	2.9 (1.5, 5.4) 0.001	1.4 (0.6, 3.3) 0.4
Adjusted for Age and Sex	1.2 (0.8, 1.7) 0.4	1.7 (0.9, 3.5) 0.1	1 (0.4, 2.3) 0.9
Severity			
Any serious mental disorder[†]			
Unadjusted	1.3 (0.9, 1.7) 0.1	1.7 (1.2, 2.9) 0.04	2.0 (1.3, 3.8) 0.04
Adjusted for Age and Sex	1.0 (0.7, 1.3) 0.8	1.4 (0.8, 2.5) 0.2	1.7 (0.8, 3.2) 0.1
2 or more disorders[†]			
Unadjusted	0.8 (0.6, 1.1) 0.2	2.6 (1.5, 4.6) 0.0007	3.0 (1.4, 6.5) 0.004
Adjusted for Age and Sex	0.7 (0.5, 0.9) 0.02	3.0 (1.4, 6.4) 0.004	3.1 (1.4, 6.9) 0.007

¹ DSM-IV CIDI 3.0 disorders with hierarchy [32: section 13.4.1]; ^{II} Assessed in the subsample who did the long form interview [32: section 13.4.2]; ^{III} These results are taken from a logistic regression using both Pacific and other participants and also account for place of birth and age at migration; [†] These results are taken from a logistic regression for Pacific participants only.

ethnicity, place of birth and age at migration. The first column in Table 3 reports the odds ratios from logistic regressions on responses from both Pacific and Other participants. It compares the two ethnic groups (Other is the reference ethnic group), having taken into account age at migration of respondents. This was the model used to estimate the prevalence rates shown in table 2. Table 3 showed that Pacific participants reported an odds ratio that was 20% higher for any mental disorder ($p=0.04$) compared with that for Other participants. The odds ratio for

any substance disorder among Pacific participants was 40% higher than Other participants ($p=0.04$). In terms of severity, there were no ethnic differences. However, after adjustment for age at interview and sex, these ethnic differences were no longer statistically significant. Interestingly, the odds ratio reported by Pacific participants was 30% less than Other participants for multiple disorders ($p=0.02$).

Columns 2 and 3 in Table 3 report the odds ratios from the logistic regressions on the Pacific participants only. They show a comparison for Pacific participants between older migrants with 1) NZ born and 2) young migrants.

The odds ratio of NZ born Pacific participants having any mental disorder in the 12 months prior to the survey were 2.4 times that of older migrants ($p<0.0001$). Moreover, they had 2.7 times the odds ratio of being diagnosed with any mood disorder ($p<0.0001$), twice that of having any anxiety disorder ($p=0.0006$), and nearly three times that of having any substance disorder ($p=0.001$).

In terms of severity, the odds ratio for NZ born Pacific participants was 70% higher for any serious mental disorder ($p=0.04$), and 2.6 times higher for two or more disorders ($p=0.0007$).

Overall for Pacific participants, the differences between NZ born and older migrants were largely independent of age and sex as the odds ratios were reduced very little after adjustment and remained significant, except for substance use disorder and severity. For substance use disorder the odds ratio decreased from 2.9 to 1.7 and became non-significant ($p=0.1$). For severity, there was only a small decrease of 1.7 ($p=0.04$) down to 1.4 ($p=0.2$). The odds ratio of NZ born having 2 or more disorders was three times higher than their older migrants counterparts ($p=0.004$).

The third column of Table 3 is the comparison between young migrants and older migrants for Pacific participants only. Pacific people that were young migrants had odds ratios that were over twice that for older migrants for any mental disorder ($p=0.001$) and over three times for any mood disorder ($p<0.0001$). In terms of severity, the odds ratios of young migrants having any serious mental disorder was two times more than that of older migrants ($p=0.04$), and three times higher for two or more disorders ($p=0.004$).

Overall for Pacific participants, the differences between young and older migrants were also independent of age and sex as the odds ratios were reduced very little after adjustment and remained significant. After adjustment for age and sex the odds ratios for any mental disorder was 2.1 ($p=0.005$) and 3.1 for any mood disorder ($p<0.0001$). In terms of severity, only young migrants with two or more disorders remained independent of age and sex ($OR=3.1$, $p=0.007$) compared to older migrants.

(51.4%) were highest, followed by young migrants' (53.0%) and older migrants (34.3%). Only NZ born and older migrants were statistically significantly different and this remained significant after adjusted for age and sex.

Over all, the ethnic pattern of service utilisation is different from that for the prevalence of mental disorders. Other participants have lower prevalence of mental disorder than Pacific participants but were more likely to use any health service or specialist

Table 4. Prevalence of health service use in the past 12 months among 'Pacific' and 'Other' participants, who had a 12 month mental disorder, by place of birth and age at migration.

	Pacific			Other		
	NZ Born	Young migrants	Older migrants	NZ Born	Young migrants	Older migrants
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Visits to any health service for a mental health problem[†]						
Unadjusted	54.6 (46.4, 63.7)	44.6 (31.5, 57.8)	39.4 (30.2, 48.7)	75.5 (72.6, 78.3)	70.2 (59.4, 81.0)	62.1 (54.6, 69.7)
Adjusted for Age and Sex	62.5 (54.2, 70.7)	48.8 (35.2, 62.5)	36.8 (27.9, 45.7)	74.9 (71.9, 77.8)	72.2 (61.9, 82.6)	62.7 (55.1, 70.3)
Mental health specialist service use[†]						
Unadjusted	38.7 (30.2, 47.1)	32.1 (19.4, 44.9)	12.9 (5.7, 19.2)	51.4 (48.3, 54.4)	53.0 (41.4, 64.5)	34.3 (27.2, 41.4)
Adjusted for Age and Sex	40.6 (31.9, 49.3)	32.3 (19.5, 45.0)	12.9 (6.6, 19.1)	51.1 (48.0, 54.2)	53.8 (42.2, 65.4)	34.8 (27.7, 42.0)

[†] Assessed for those who had a mental disorder

Service use

Table 4 is the prevalence of health service use in the past 12-months among Pacific and Other participants who had a mental disorder by place of birth and age at migration.

The percentage of Pacific participants diagnosed with a mental disorder in 12 months that visited any health service for their mental health problem was 54.6% for NZ born, 44.6% for young migrants and 39.4% for older migrants. Mental health specialist service use by Pacific participants was 38.7% for NZ born, 32.1% for young migrants and 12.9% for older migrants. This difference remained even after adjustment for age and sex. Interestingly the difference in visits to any health service for a mental health problem became statistically significant after adjusted for age and sex among NZ born and older migrants Pacific participants.

Use of health services for mental health disorder was much higher for Other participants with disorder than for Pacific participants with disorder but showed a similar pattern. It was highest for NZ born (75.5%), followed by young migrants (70.2%) and older migrants (62.1%) when looking at any health service use. For mental health specialist service use NZ born

mental health services if they had a mental disorder.

Table 5 shows the odds ratios for health service use in the past 12 months by ethnicity, place of birth and age at migration.

Column 1 in Table 5, shows that Pacific participants were 60% less likely to visit any health service for a mental health problem with odds ratio of 0.4, ($p<0.0001$), compared with Other participants. The same pattern was

found for mental health specialist service use. Pacific participants were 50% less likely to visit a mental health specialist with odds ratio of 0.5 ($p<0.0001$), compared with Other participants. These odds ratios remained statistically significant after adjustment for age and sex.

Columns 2 and 3 of Table 5 show the odds ratios for service use in the past 12 months for Pacific participants only who were diagnosed with any mental illness 12 months prior to participating in the survey. The odds ratio for NZ born participants diagnosed with a mental disorder in the past 12 months and visited any health service for a mental health problem was two and a half times more than that of their older migrants counterparts ($p<0.0001$). The same pattern was found for mental health specialist service use. NZ born participants had odds ratio of visiting a mental health specialist that were nearly six times that of older migrants ($p<0.0001$). These differences remained statistically significant and increased after adjustment for age and sex.

Finally, young migrants who were diagnosed with a mental disorder in the past 12 months prior to taking part in the survey, had odds ratio of 4.6 ($p=0.0007$), nearly five times that of their older migrants counterparts, to visit a mental health specialist. A

similar pattern was found in terms of visits to any health service for a mental health problem where the odds ratio for young migrants was 1.9 ($p=0.04$), nearly double the odds ratio for their older migrants counterparts for visits to any health service for a mental health problem.

Overall Pacific participants were less likely to use any health services or see a mental health specialist for a mental disorder compared to Other participants. This finding remained after adjustment for age and sex. Pacific older migrants were less likely than their NZ born or young migrants counterparts to use any health provider or mental health specialist for a mental health disorder.

Table 5. Odds ratios for health service use in the past 12 months by ethnicity, place of birth and age at migration

	Pacific vs Other [†] (Reference Group)	Pacific only	
		NZ Born vs Older migrants ^{††} (Reference Group)	Young migrants vs Older migrants ^{††} (Reference Group)
	OR (95% CI) p-value	OR (95% CI) p-value	OR (95% CI) p-value
Visits to any health service for a mental health problem[‡]			
Unadjusted	0.4 (0.3, 0.6) <0.0001	2.5 (1.6, 4) <0.0001	1.9 (1.3, 2.8) 0.04
Adjusted for Age and Sex	0.5 (0.3, 0.6) <0.0001	3.1 (1.9, 5.1) <0.0001	2.2 (1.4, 3.2) 0.02
Mental health specialist service Use[§]			
Unadjusted	0.5 (0.4, 0.7) <0.0001	5.7 (2.9, 11.2) <0.0001	4.6 (1.9, 11.2) 0.0007
Adjusted for Age and Sex	0.5 (0.4, 0.7) <0.0001	6.6 (3.1, 13.8) <0.0001	4.7 (1.8, 12.1) 0.001

[†] Assessed for those who had a 12 month mental disorder; ^{††} These results are taken from a logistic regression using both Pacific and other participants and also account for place of birth and age at migration; [‡] These results are taken from a logistic regression for Pacific participants only.

Discussion

This paper confirmed previous results for Pacific and Other ethnic groups that showed Pacific people had a higher 12 month prevalence of any disorder and serious disorder compared with Others.²⁵ A similar pattern was shown in terms of severity of mental disorders. However these ethnic differences in prevalence were mostly explained by age and sex except for the prevalence of multiple disorders. The paper also showed that Pacific people also were less likely to utilise health services if they had a mental disorder. These ethnic differences remained after adjustment for both age and sex. This is the classic 'Inverse Care Law', where the "availability of good medical care tends to vary inversely with the need for it in the population served".²⁶

This paper also showed that the prevalence of mental disorders was higher among NZ born followed by young migrants than older migrants for both Pacific

and Other participants. This pattern was found for diagnosis of mental disorders as well as severity. For Pacific participants the difference between NZ born and older migrants changed little with adjustment for age and sex, except for substance disorder. This may suggest that early exposure to the New Zealand environment is strongly associated with high levels of mental disorder among Pacific people. In addition, among Pacific participants, NZ born were more likely to use any health care service compared to their older migrants counterparts.

These findings ask questions around pressures of adjustment and acculturation. These might include social, geographic, cultural, and economic pressures.

These are important factors that require further investigation in terms of their actual impact on mental health of Pacific people. Furthermore, are these symptoms of a health system failure or are there societal and wider cultural issues at play?

The authors acknowledge that while these results highlight some important issues about Pacific migrants and their descendants, as a cross-sectional study a direct link to migration as a cause of mental disorders among Pacific people cannot be ascertained. The issues around migration of Pacific people would need further study to be better understood.

Acknowledgements

Te Rau Hinengaro: The New Zealand Mental Health Survey was funded by the Ministry of Health, Alcohol Advisory Council and Health

Research Council of New Zealand. The survey was carried out in conjunction with the World Health Organization World Mental Health (WMH) Survey Initiative. We thank the WMH staff for assistance with instrumentation, fieldwork and data analysis. These activities were supported by the US National Institute of Mental Health (R01MH070884), the John D and Catherine T MacArthur Foundation, the Pfizer Foundation, the US Public Health Service (R13-MH066849, R01-MH069864, and R01 DA016558), the Fogarty International Center (FIRCA R01-TW006481), the Pan American Health Organization, Eli Lilly and Company, Ortho-McNeil Pharmaceutical, Inc., GlaxoSmithKline, and Bristol-Myers Squibb. WMH publications are listed at <http://www.hcp.med.harvard.edu/wmh/>

Other members of the Te Rau Hinengaro Research Team are M Oakley-Browne, J Baxter, T K Kingi, R Tapsell, M H Durie, K M Scott and C Gale.

We particularly acknowledge the input by the Pacific Advisory Group: Fulmaono Karl Pulotu-Endemann, Francis Agnew, Vito Malo, Reverend Feiloaiga Tauleale-ausumai, Hemiquaver Lesatele, Lina-Jodi Vaine Samu Tuiloma and Sefita Hao'uili.

We thank the Kaitiaki Group for their input and support for this survey and we thank all the participants.

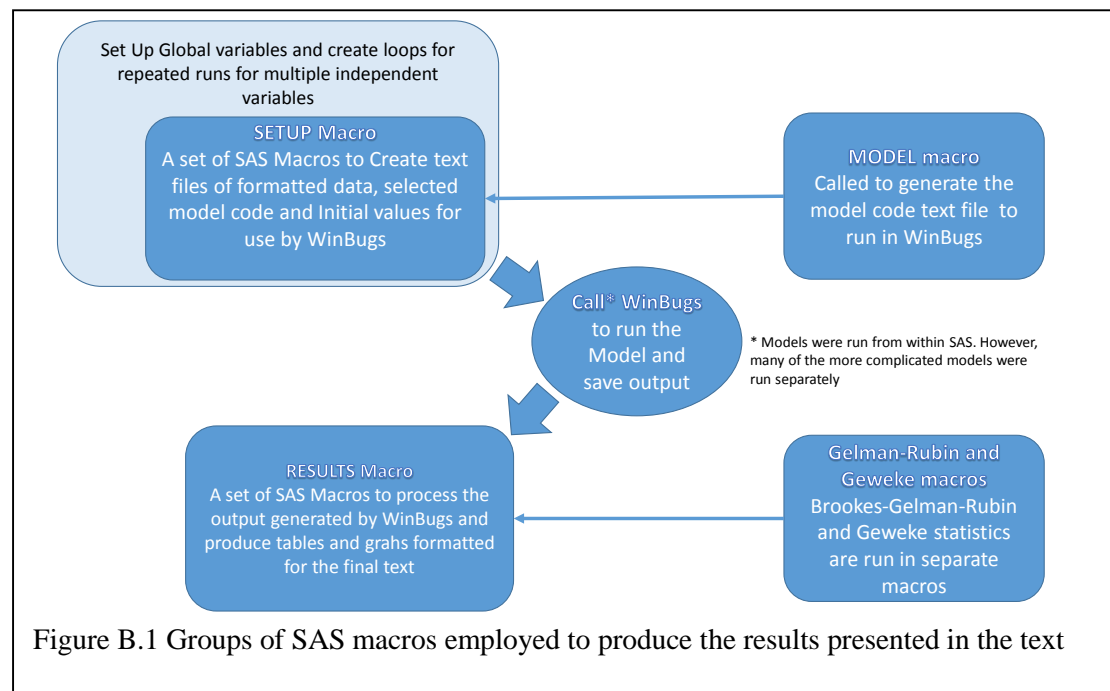
References

1. Spoonley P. Pacific Communities: Transforming the Politics of Place and Identity. In: Macpherson C, Spoonley P, and Anae M, eds. *Tangata O Te Moana Nui: evolving identities of Pacific Peoples in Aotearoa New Zealand*. Palmerston North, N.Z.: Dunmore Press 2001.
2. Krishnan V, Schoeffel P, Warren J. The Challenge of change: Pacific Island communities in New Zealand, 1986-1993. Wellington, NZ: NZ Institute for Social Research & Development, 1994.
3. Tiatia J, Coggan C, Young Pacific suicide attempts: a review of emergency department medical records, Auckland, New Zealand. *Pacific Health Dialog* 2001; 8:124-128.
4. Lindencrona F, Ekblad S, Hauff E. Mental health of recently resettled refugees from the Middle East in Sweden: the impact of pre-resettlement trauma, resettlement stress and capacity to handle stress. *Social Psychiatry & Psychiatric Epidemiology* 2008; 43:121-31.
5. Abhary S, Koopowitz LF. Psychiatric aspects of detention: illustrative case studies. *Australian & New Zealand Journal of Psychiatry* 2004; 38:495-500.
6. Lindert J, Brähler E, Wittig U, Mielck A, Priebe S. [Depression, anxiety and posttraumatic stress disorders in labor migrants, asylum seekers and refugees. A systematic overview]. *Psychotherapie, Psychosomatik, medizinische Psychologie* 2008; 58:109-22.
7. Fazel M, Wheeler J, Danesh J. Prevalence of serious mental disorder in 7000 refugees resettled in western countries: a systematic review. *Lancet* 2005; 365:1309-1314.
8. Flores G, Brotanek J. The healthy immigrant effect. *Archives of Pediatrics and Adolescent Medicine* 2005; 159:295-297.
9. Cantor-Graae E, Selten JP. Schizophrenia and Migration: a meta-analysis and review. *American Journal of Psychiatry* 2005; 162:12-24.
10. Bhugra D. Migration and Depression. *Acta Psychiatrica Scandinavica* 2003; 418:67-72.
11. Bhugra D. Migration and mental health. *Acta Psychiatrica Scandinavica* 2004; 109:243-258.
12. Bhugra D. Cultural identities and cultural congruency: A new model for evaluating mental distress in immigrants. *Acta Psychiatrica Scandinavica* 2005; 111:84-93.
13. Macpherson C. Pacific Islands identity and community. In: Spoonley P, Pearson D, and Macpherson C, eds. *Nga Patai: Racism and ethnic relations in Aotearoa/New Zealand*. Palmerston North: Dunmore Press, 1996.
14. Macpherson C. From Pacific Islanders to Pacific People: The past, present, and future of the Pacific population in Aotearoa. In: Spoonley P, Macpherson C, and Pearson D, eds. *Tangata, Tangata: The changing contours of ethnicity in Aotearoa New Zealand*. Palmerston North: Dunmore Press, 2004:135-156.
15. Morrell S, Taylor R, Slaytor E, P. F. Urban and rural suicide differentials in migrants and the Australian-born, New South Wales, Australia 1985-1994. *Social Science and Medicine* 1999; 49:81-91.
16. Khavarpour F, Rissel C. Mental health status of Iranian migrants in Sydney. *Australian & New Zealand Journal of Psychiatry* 1997; 31:828-834.
17. McGrath J, El-Shaadli O, Cardy S, Chapple B, Chant D, Mowry B. Urban birth and migrant status as risk factors for psychosis: an Australian case control study. *Social Psychiatry & Psychiatric Epidemiology* 2001; 36:533-536.
18. Koopowitz LF, Sotoodeh A. Psychiatric aspects of detention: illustrative case studies. *Australian & New Zealand Journal of Psychiatry* 2004; 38:495-500.
19. Abbott MW, Wong S, Williams M, Au M, Young W. Chinese migrants' mental health and adjustment to life in New Zealand. *Australian and New Zealand Journal of Psychiatry* 1999; 33:13-21.
20. Pernice R, Brook J. Refugees and immigrants mental health: association of demographic and post immigration factors. *Journal of Social Psychology* 1996; 136:511-519.
21. Foliaki S. Mental health among Tongan migrants. *Pacific Health Dialog* 1999; 6:288-294.
22. Allen J, Laycock J. Major mental illness in the Pacific: a review. *Pacific Health Dialog* 1997; 4:105-118.
23. Ministry of Health. *Te orau ora: Pacific mental health profile*. Wellington: Ministry of Health, 2005.
24. Bridgeman G. *Mental illness and people from the island nations of the Pacific*. Wellington: Mental Health Foundation of New Zealand, 1996.
25. Foliaki S, Kokaua J, Schaaf D, Tukuitonga C, for the New Zealand Mental Health Survey Research Team. Twelve-month and lifetime prevalences of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Epidemiology Survey (NZMHS). In: Oakley Browne MA, Wells JE, and Scott KM, eds. *Te Rau Hinengaro: the New*

- Zealand Mental Health Survey. Wellington: Ministry of Health, 2006.
26. Foliaki SA, Kokaua J, Tukuitonga C, Schaaf D, for the New Zealand Mental Health Survey Research Team, Twelve-month and lifetime prevalence of mental disorders and treatment contact among Pacific people in Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS). *Australian and New Zealand Journal of Psychiatry* 2006; 40:924-934.
 27. Vega WA, Kolody B, Aguilar-Gaxiola S, Alderete E, Catalano R, Caraveo-Anduaga J, Lifetime prevalence of DSM-III-R psychiatric disorders among urban and rural Mexican Americans in California. *Archives of General Psychiatry* 1998; 55:771-778.
 28. Escobar JI, Hoyo Nervi C, Gara M, Immigration and mental health: Mexican Americans in the United States. *Harvard Review of Psychiatry* 2000; 8:64-72.
 29. Breslau J, Kendler KS, Su M, Gaxiola-Aguilar S, Kessler RC, Lifetime risk and persistence of psychiatric disorders across ethnic groups in the United States. *Psychological Medicine* 2005; 35:317-27.
 30. Wells JE, Oakley Browne MA, Scott KM, McGee MA, Baxter J, Kokaua J, for the New Zealand Mental Health Survey Research Team, Te Rau Hinengaro: the New Zealand Mental Health Survey (NZMHS): overview of methods and findings. *Australian and New Zealand Journal of Psychiatry* 2006; 40:835-844.
 31. Wells JE, McGee MA, Oakley Browne MA. Methods, In: Oakley Browne MA, Wells JE, and Scott KM, eds. Te Rau Hinengaro: the New Zealand Mental Health Survey. Wellington: Ministry of Health, 2006.
 32. Wells JE, McGee MA, Oakley Browne MA. Methods, In: Oakley Browne MA, Wells JE, and Scott KM, eds. Te Rau Hinengaro: The New Zealand Mental Health and Wellbeing Survey. Wellington: Ministry of Health, forthcoming.
 33. Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE, Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry* 2005; 62:617-627.
 34. Endicott J, Spitzer RL, Fleiss JL, Cohen J, The Global Assessment Scale: a procedure for measuring overall severity of psychiatric disorders. *Archives of General Psychiatry*. 1976; 27:766-771.
 35. Baxter J, Kokaua J, Wells JE, McGee MA, Oakley Browne MA, Ethnic comparisons of the 12 month prevalence of mental disorders and treatment contact in Te Rau Hinengaro: The New Zealand Mental Health Survey. *Australian & New Zealand Journal of Psychiatry* 2006; 40:905-913.
 36. Hart J, The inverse care law. *Lancet* 1971; 7696:405-412.

Appendix B Programmes for Bayes Models

As stated in Chapter 3, the modules to run the macros that process the data and produce the results for the text are organised into three stages. Figure B.1 presents into which the three main stages the SAS macros are grouped. The “set-up” macro extracts the data from a SAS dataset and saves text files formatted for use in WinBugs and calls the appropriate model code, held in the “Model” macro set. For smaller models this macro will call WinBugs to run the model and produce results. Finally, the “Results” macro is used to format the output for the main body of the text. Note most of the diagnostic graphs are produced in SAS



In Practice, for larger models, the “set-up” macros were run without running WinBugs. The Winbugs model was then run separately and the “results” macros run to process the output.

It is important to note that the generic WinBugs model must be checked that it is able to run in WinBugs before calling the model from a SAS Macro.

Prevalence Model Code

```

/*****
/*
/*          PREVALENCE DATA MODELS CODE
/*
/*
/*****
/*****
/*      Example of code to call selected models
/*
/*****

%global modcode;
%let modcode=0_0;
%global nco; %let nco=0;
%global neth; %let neth=4;
%global nage; %let nage=6;
%global agesel; %let agesel=;

/*****
/*          Twelve Month Disorder
/*
/*****

%global nsamp;
%let nsamp=12992; /* %let nsamp=10748; %let nsamp=10535; */
%global despri;
%let despri=mueth=c(.234,-
.118,.426,0),sexpre=.426,muage=c(.778,.852,.602,.426,.101,0),;
%global subpri;
%let subpri=pre_sub0=c(1.204,.426,0),;
%global covpri;
%let covpri=;
%global cov;
%let cov=;
%global sigpri;
%let sigpri=sigmax=1,sigmax_eth=.5,sigmax_age=.5,sigmax_sex=.5;

%global path; %let path=H;;
%global runpath; %let runpath=H;;
%global dir; %let dir=nzmhs/;%global input;%let
input=NZMHSdat.PHD_trh_curf_v6;
%let Tabpath=H:\;

/*****          Model Any Twelve Month Disorder - no covariates *****/
%global brn_no;
%let brn_no=5000;
%global modruns;
%let modruns=10000;
%MainModel(modcode=0_0a,dep=Any12,nchain=3,nparm=24,nsim=10000,pt=2,slct=sel
ect,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_0a_,
            title=Table 4.1 output FEB-2013
            );
/*****          Model Twelve Month Anxiety Disorder - no covariates *****/
%global brn_no;
%let brn_no=10000;
%global modruns;
%let modruns=20000;
%MainModel(modcode=0_T2,dep=anx12,nchain=3,nparm=24,nsim=20000,pt=2,slct=sel
ect,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_T2_,
            title=Table 4.1 output FEB-2013
            );
/*****          Model Twelve Month Mood Disorder - no covariates *****/
%MainModel(modcode=0_T6,dep=mood12,nchain=3,nparm=13,nsim=20000,pt=1,slct=,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_T6_,
            title=Table 4.1 output FEB-2013
            );

/*****
/*          LIFETIME Disorders
/*
/*****

%global nsamp;

```

```

%let nsamp=12992; /* %let nsamp=10748; %let nsamp=10535; */
%global despri;
%let despri=mueth=c(.234,-
.118,.426,0),sexpre=.426,muage=c(.778,.852,.602,.426,.101,0),;
%global subpri;
%let subpri=pre_sub0=c(1.204,.426,0),;
%global covpri;
%let covpri=;
%global sigpri;
%let sigpri=sigmax=1,sigmax_eth=.5,sigmax_age=.5,sigmax_sex=.5;

%global path; %let path=H;
%global runpath; %let runpath=H;
%global dir; %let dir=nzmhs; %global input; %let
input=NZMHSdat.PHD_trh_curf_v6;
%let Tabpath=H;
%global brn_no;
%let brn_no=10000;
%global modruns;
%let modruns=20000;
/***** Model Any Lifetime Disorder - no covariates *****/
%MainModel(modcode=0_L1,dep=anyLT,nchain=3,nparm=24,nsim=20000,pt=2,slct=sel
ect,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_L1_,
            title=Table 4.1 output FEB-2013
            );
/***** Model Lifetime Anxiety Disorder - no covariates *****/
%MainModel(modcode=0_L2,dep=anxLT,nchain=3,nparm=24,nsim=20000,pt=2,slct=sel
ect,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_L2_,
            title=Table 4.1 output FEB-2013
            );
/***** Model Any Lifetime Mood Disorder - no covariates *****/
%MainModel(modcode=0_L6,dep=moodLT,nchain=3,nparm=13,nsim=20000,pt=1,slct=,
            nthin=1,var=pi1 pi2 pi3 pi4,dsout=Mod0_L6_,
            title=Table 4.1 output FEB-2013
            );

/*****
/*      Run Models with Covariates, NOTE a different Modelout macro */
*****/

/*      State the diagnosis of interest      */
%global dep;
%let dep=any12;

/*      State the prior locations for parameters      */

%global path; %let path=C:\Users\jesse\Documents;
%global runpath; %let runpath=C:\Users\jesse\Documents;
%global dir; %let dir=nzmhs; %global input;
%let input=NZMHSdat.PHD_trh_curf_v6;
%macro prireset;
%global despri;
%let despri=mueth=c(.234,-.118,.426,0), sexpre=.426,
            muage=c(.778,.852,.602,.426,.101,0),;
%global deseth;
%let deseth=mueth=c(.234,-.118,.426,0),;
%global subpri;
%let subpri=pre_sub0=c(1.204,.426,0),;
%global sigpri;
%let sigpri=sigmax=.5,sigmax_eth=.5,sigmax_age=.5,sigmax_sex=.5;
%global sigeth;
%let sigeth=sigmax=.5,sigmax_eth=.5;
%mend;

%prireset;

```



```

/*      Process Results for Any disorder by Age at Migration      */
%global modcode;
%let modcode=1_1;
%global nsamp;
%let nsamp=10527; /* analysis of non-Maori only; */
%global nage; %let nage=6;
%global neth; %let neth=3;
%global agesel; %let agesel=and ethnic4 ne 3;
%global nco; %let nco=1;
%global nlevel1; %let nlevel1=3;
%global covpri;
%let covpri=covpre1=c(0.4,0.0,-0.4),;
%global modruns; %let modruns=40000; /* number of model runs; */
%global dsout; %let dsout=Model&modcode._;
%global despri;
%let despri=mueth=c(.234,-
.118,.426),sexpre=.426,muage=c(.778,.852,.602,.426,.101,0),;
%global deseth;
%let deseth=mueth=c(.234,-.118,.426),;
%modelout(cov=migrn,
part=2,
selector=select,
logfile=Model&modcode._&dep._cmigrn,
modelfile=mo&modcode.T1,
datafile1=d1&modcode.T1,
datafile2=d2&modcode.T1,
initsfile=in&modcode.T1,
batchfile=TE&modcode.T1);
%pireset;

%global path; %let path=C:\Users\jesse\Documents;
%global runpath; %let runpath=C:\Users\jesse\Documents;
%global dir; %let dir=nzmhs/;%global input;%let
input=NZMHSdat.PHD_trh_curf_v6;

/*****
/*      Run Models with Multiple Covariates, NOTE same Modelout as for      */
covariate models
/*****/
/*      Preamble - setup global variables      */
%global modcode;
%let modcode=1_9;
%global nco; %let nco=8;
%global nlevel1; %let nlevel1=1;
%global covlist;
%let covlist = nzbrn solep alone marid noqual unemp loinc hidep;
%global covpri;
%let covpri= covpre1=1,covpre2=.5,covpre3=1,covpre4=-
.8,covpre5=.8,covpre6=.8,covpre7=1,covpre8=.5,;
%global modruns; %let modruns=40000; /* number of model runs; */
%global dsout; %let dsout=Model&modcode._;

%global dep; /*      State the diagnosis of interest      */
%let dep=any12;

/*      Process Results for Any disorder by multiple Covariates      */
%modelout(cov=ALL,
part=2,
selector=select,
logfile=Model&modcode._&dep._ALL,
modelfile=mo&modcode.T1,
datafile1=d1&modcode.T1,
datafile2=d2&modcode.T1,
initsfile=in&modcode.T1,
batchfile=TE&modcode.T1);
%global dep;
%let dep=mood12;

```

```

/*      Process Results for MOOD disorder by Multiple Covariates      */
%modelout(cov=ALL,
    part=,
    selector=,
    logfile=Model&modcode._&dep._ALL,
    modelfile=mo&modcode.T6,
    datafile1=d1&modcode.T6,
    datafile2=d2&modcode.T6,
    initsfile=in&modcode.T6,
    batchfile=TE&modcode.T6);

/*****
/*****      Data Set Up for Prevalence Models      *****/
/*****      by      *****/
/*****      Jesse Kokaua      *****/
/*****      created 09-12-2013      *****/
/*****
/*****      MODEL with NO covariates      *****/
/*****
%macro modelout(dep,
    part,
    selector,
    logfile,
    modelfile,
    datafile1,
    datafile2,
    initsfile,
    batchfile,
    modeltype);

/*****      Select the subset of data for processing      *****/
proc sort data=nzmhsdat.BAZ00;
by nzmeshbl;run;
data BAZ10;
    merge nzmhsdat.BAZ00 (in = x1)
          nzmhsdat.BAZ02;
    by nzmeshbl;
if x1 &agesel;
keep ivnum eth wgt2 sex age pst lau age4 yobs &selector. ;
    lau = psuI;
    pst = ssu-1;
    pt2 = partII + 1;
    eth = ethnic4;
    sex = gender-1;
    age = age6;
    anyl2=any_mental_12;
    anyLT=any_mental_LT;
    if (chronic = 1 and any_mental_12 = 1) then mphys_comb12 = 1; else
mphys_comb12 = 0;
    if (chronic = 1 and any_mental_LT = 1) then mphys_combLT = 1; else
mphys_combLT = 0;
    %if (&part. = 2) %then %do;
        if partII = 1 then yobs = "NA"; else/* choose dependent variable*/
yobs = put(&dep., numtxt.);
        %end; %else %do;
yobs = put(&dep., numtxt.); %end;
    if PH100_1 = 1 then select = 1;
    else if PH102>0 then select = PH102+1;
    else if PH108>0 then select = PH108+6;
wgt2=wgt_person4/wgt_person3;
run;

/*****      Create output files for WinBugs processing      *****/
%modelset(&dep.,&part.,&selector,&logfile.,&modelfile.,&datafile1.,&datafile2
.,&initsfile.,&batchfile.);

/*****      Create Model files for WinBugs processing      *****/

```

```

%&modeltype.uset;

/***** Call WinBugs and process the above statements *****/
DATA _NULL_; /*create a .bat file to run WinBUGS*/
  FILE "C:\users\kokje4lp\My Documents\WinBUGS14\&batchfile.u.bat";
  PUT "C:\users\kokje4lp\My Documents\WinBUGS14\WinBUGS14.exe" ' ' /PAR
  &batchfile.u.txt";
  PUT 'exit';
RUN;

DATA _NULL_;Run WinBUGS in SAS X windows
  X call "C:\users\kokje4lp\My Documents\WinBUGS14\&batchfile.u.bat";
RUN;
%end;
%mend modelout;

/***** MODEL with additional covariates *****/
%macro modelout(cov,part,
                selector,
                logfile,
                modelfile,
                datafile1,
                datafile2,
                initsfile,
                batchfile);
proc sort data=nzmhsdat.BAZ00;
by nzmeshbl;run;
data BA10;
  merge nzmhsdat.BAZ00 (in = x1)
        nzmhsdat.BAZ02;
  by nzmeshbl;
  length yobs migrn nzbrn parnt solep labfc unemp $2;
if x1 &agesel;
keep ivnum eth wgt2 sex age pst lau age4 yobs &selector.
  %if &cov.=ALL %then %do; &covlist.%end; %else
  %if &cov.=BEST %then %do; &covlist. %end; %else
  %do; covarl %end; ;
  anyl2 = any_mental_12;
  %if &neth.=3 %then %do; eth=put(ethnic4,noMaor.);%end;
  %else %do; eth=ethnic4;%end;
  lau = psuI;
  pst = ssu-1;
  pt2 = partII + 1;
  sex = gender;
  age = age6;
  %if (&part. = 2) %then %do;
    if partII = 1 then yobs = "NA";
    else/* choose dependent variable*/
      yobs = put(&dep.,numtxt.);
    %end; %else %do;
      yobs = put(&dep.,numtxt.); %end;

    if ethnic4 = 3 then migrn = "NA"; else
migrn=put(age_at_migrn,covlcode.);/* Age at Migration */
    if ethnic4 in (1 2) then do; if age_at_migrn=. then emigrn=1; else
emigrn=put(age_at_migrn,covlcode.)*1;end;else
    if ethnic4 = 4 then do; if age_at_migrn=. then emigrn=4; else
emigrn=put(age_at_migrn,covlcode.)*1+3;end;/* Age at Migration by Pacific */
    if ethnic4 = 3 then nzbrn = "NA"; else nzbrn=NZBORN;/* NZ born only */
    if age in (1 2) then do; if age_at_migrn=. then cmigrn=1; else
cmigrn=put(age_at_migrn,covlcode.)*1;end;else
    if age in (3 4) then do; if age_at_migrn=. then cmigrn=4; else
cmigrn=put(age_at_migrn,covlcode.)*1+3;end;else
    if age in (5 6) then do; if age_at_migrn=. then cmigrn=7; else
cmigrn=put(age_at_migrn,covlcode.)*1+6;end;/* Age at Migration by Pacific */
    if ethnic4 = 3 then nzbrn = "NA"; else nzbrn=NZBORN;/* NZ born only */

```

```

hhld = put(NZN16PLU,cov2code.)*1; /* Number of adults 1 2 or 3+ */
if NZN16PLU=1 then ALONE=1; else ALONE=0; /* Living alone only */
if SC3 = 1 then marit = 1; else /* Marital Status */
if SC3 in (2 3) then marit = 2; else
if SC3 = 4 then marit = 3; else
if SC3a = 1 then marit = 4;
else marit = 5;
if marit in (1 4) then Marid = 1; else marid = 0; /* Married only */
if age6 = 6 then parnt = "NA"; else parnt=put(sole_parent,cov3code.)*1; /*
Parental status */
if age6 = 6 then solep = "NA"; else if parnt=1 then solep=1; else
solep=0; /* Sole Parental only */
qual = put(educate3,cov4code.)*1; /* Education */
if educate3 = 1 then noqual=1; else noqual=0;
labfc=lfstatus; /* Labourforce status */
if age6 = 6 then unemp = "NA"; else if labfc=1 then unemp=1; else
unemp=0; /* Sole Parental only */
incom=ee4;
if ee4 = 1 then loinc=1; else loinc=0;
deprv=nzdep5;
if nzdep5 = 5 then hidep=1; else hidep=0;
if PH100_1 = 1 then select = 1; /* part II selection variable*/
else if PH102>0 then select = PH102+1;
else if PH108>0 then select = PH108+6;
%if &cov.^="ALL" %then %do; %if &cov.^="best" %then %do;
covarl=&cov.; %end; %end;
wgt2=wgt_person3/wgt_person2;
run;

%modelset(&dep,&part.,&selector,Model&modelfile._&dep._&cov.,&modelfile.,&data
tafile1.,&datafile2.,&initsfile.,&batchfile.);

%logistuset;

%logistaset;

%mend modelout;

/*****
/***** Model statements for Prevalence Models *****/
/***** by *****/
/***** Jesse Kokaua *****/
/***** created 09-12-2013 *****/
/*****/
%macro modelset(dep,
part,
selector,
logfile,
modelfile,
datafile1,
datafile2,
initsfile,
batchfile);
proc sort data = BA10;
by eth sex age; run;

/*****
/***** Print out data in column format for WinBugs *****/
/*****/
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';

filename &datafile1. "&path./WinBUGS14/nzmhs/&datafile1..txt";
proc printto file=&datafile1. new;
run;

```

```

proc print data=BA10 noobs label width=min style=data[cellwidth=5];
  label eth='eth[]' age='age[]' sex='sex[]' yobs='yobs[]' pst='ssu[]'
    lau='psu[]'
  /** add part ii indicator *****/
  %if (&part = 2) %then %do; select = 'slct[]' %end;
  /** add covariate indicators *****/
  %if (&nco>0) %then %do;
    %if &cov.=ALL %then %do;
      nzbrn='nzbrn[]' alone='aln[]' marid='mar[]' solep='sol[]'
noqual='noq[]'
      unemp='une[]' loinc='inc[]' hidep='hid[]' %end; %else
      %if &cov.=BEST %then %do;
      nzbrn='nzbrn[]' alone='alone[]' marid='marid[]' solep='solep[]'
noqual='noqual[]'
      unemp='unemp[]' loinc='loinc[]' hidep='hidep[]' %end; %else
    %do;
      covarl="covl[]"
    %end;
  %end;;
  var eth sex age lau yobs pst &selector.
  %if (&nco>0) %then %do;
    %if &cov.=ALL %then %do;
      nzbrn alone marid solep noqual unemp loinc hidep %end; %else
      %if &cov.=BEST %then %do;
      nzbrn alone marid solep noqual unemp loinc hidep %end; %else
    %do;
      covarl
    %end;
  %end;;

run;
proc printto; run;
data _null_;
  file &datafile1. mod;
  put@1 "END";
  put @1 " ";
run;

options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/&datafile2..txt";
proc printto; run;
DATA _NULL_;
  FILE "&path./WinBUGS14/nzmhs/&datafile2..txt";
  PUT "list(N = &nsamp.);";
  PUT "&despri.";
  %if (&part = 2) %then %do;
    PUT "&subpri."; %end;
  %if (&nco>0) %then %do; PUT "&covpri."; %end;
    PUT "&sigpri.";
  PUT ")";
RUN;

/***** Print out WinBugs syntax to run the model *****/
/***** Print out WinBugs syntax to run the model *****/
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint
symbolgen mlogic;
title1 ' ';

filename fileout2 "&path.\WinBUGS14\&batchfile..txt";
proc printto; run;
data _null_;
  file fileout2;
  put@1 "display('log')"; /*log file*/
  put@1 "check('&dir.&modelfile..txt')"; /* model code */
  put@1 "data('&dir.&datafile1..txt')"; /* data code */

```

```

    put@1 "data('&dir.&datafile2..txt')"; /* constants code */
    put@1 "compile(3)"; /* compile model step */
*   put@1 "inits(1, '&dir.&initsfile..txt')"; /* set initial values */
    put@1 "gen.inits()"; /* generate initial values */
*   put@1 "update(2000)";
    put@1 "set(age_be)";
*   put@1 "set(be0)";
    put@1 "set(beta_str)";
    put@1 "set(beta_3)";
    put@1 "set(eth_be)";
    %if (&nco>0) %then %do;
        %do j=1 %to &nco;
            put@1 "set(cov_b&j)";%end;%end;
    %if (&part = 2) %then %do;
        put@1 "set(pre_co)";%end;
        put@1 "set(sex_be)";
        put@1 "set(yrep.mean)";
        put@1 "update(&modruns.)";
        put@1 "coda(*, '&dir.&logfile._coda')";
        put@1 "coda(yrep.mean, '&dir.&model&modcode._yrep_&dep._coda')";
        put@1 "stats(*)"; /* print statistical summary */
        put@1 "save('&dir.&logfile..txt')"; /* output */
        put@1 "quit()"; /* output */
run;
%mend modelset;

/*****
**          Logistic model with none or one covariate          **
*****/
%macro logisticset;
FILENAME model "&path./WinBUGS14/nzmhs/&modelfile..txt";
data _null_;
    file model;
    put@1 "model";
    put@1 "{";
    put@1 "# LOOP THROUGH INDIVIDUALS SAMPLED";
    put@1 "for( i in 1:N) {";
    put@1 "    yobs[i] ~ dbern(pi[i]);";
    put@1 "    logit(pi[i]) <- eth_be[eth[i]] + sex_be*sex[i];";
    put@1 "    + age_be[age[i]] + beta_psu[psu[i],(ssu[i]+1)]";
/**** add part ii component *****/
    %if (&part = 2) %then %do;
        put@1 "    + pre_co[slct[i]] ";
    %end;
/**** add a single covariate component *****/
    %if (&nco. = 0) %then %do; %end; %else %do;
        put@1 "    + cov_b1[cov1[i]]";
    %end;
    put@1 "}";
    put@1 "# Posterior predictive checks ";
    put@1 "for( i in 1:N) {";
    put@1 "    yrep[i] ~ dbern(pi[i]);";
    put@1 "}";
    put@1 "yrep.mean[1]<-mean(yrep[]) ";
    put@1 "yrep.mean[2]<-mean(pi[]) ";
    put@1 "# END LOOP THROUGH Yi ";
    put@1 "#";
    put@1 "# STATE PRIOR DISTRIBUTIONS";
    put@1 "#";
    put@1 "# ETHNICITY";
    put@1 "for( ki in 1 : &neth.) {";
    put@1 "# PRIOR Beth ";
    put@1 "    eth_be[ki] ~ dnorm(mueth[ki],tau_eth)";
    put@1 "    }";
    %if (&nco. = 0) %then %do; %end; %else %do;
        put@1 "# COVARIATES";
        put@1 "for( cc in 1 : &nlevel1) {";
        put@1 "    cov_b1[cc] ~ dnorm(covpre1[cc],tau_le1) ";

```

```

    put@1 "          }";
    put@1 "sigma.tau_le1~ dunif(0,10)";
    put@1 "tau_le1<-1/(sigma.tau_le1*sigma.tau_le1)";
%end;
    put@1 " #      AGE      ";
    put@1 " for( aa in 1 : 6) {";
    put@1 "   age_be[aa] ~ dnorm(muage[aa],tau_age)";
    put@1 "   }";
    put@1 "# PRIORS SEX";
    put@1 "sex_be ~ dnorm(sexpre,tau_sex)";
    put@1 " #      LOCAL AREA SAMPLE UNIT";
    put@1 " for( s in 1 : 2) {";
    put@1 "   for( j in 1 : 1260) {";
    put@1 "     beta_psu[j,s] <- beta_3 + beta_str*(s-1) ";
    put@1 "   }";
    put@1 " }";
%if (&part = 2) %then %do;
    put@1 "# PART II SELECTION ";
    put@1 "   pre_co[1] ~ dnorm(pre_sub0[1],tau_sub1) ";
    put@1 " for( q in 2 : 6) {";
    put@1 "   pre_co[q] ~ dnorm(pre_sub0[2],tau_sub2) ";
    put@1 "   }";
    put@1 "   for( phh in 7 : 11) {";
    put@1 "     pre_co[phh] ~ dnorm(pre_sub0[3],tau_sub3) ";
    put@1 "   }";
%end;
    put@1 " #      HYPERPARAMETER for Cluster";
    put@1 "   beta_3 ~ dnorm(0,tau_3) ";
    put@1 " #      PACIFIC STRATA ";
    put@1 "   beta_str ~ dnorm(0.0,tau_str) ";
    put@1 "# VARIANCE PRIORS";
    put@1 "sigma.tau_0~ dunif(0,sigmax)";
    put@1 "tau_0<-1/(sigma.tau_0*sigma.tau_0)";
    put@1 "sigma.tau_eth~ dunif(0,sigmax_eth)";
    put@1 "tau_eth <-1/(sigma.tau_eth*sigma.tau_eth)";
    put@1 "sigma.tau_age~ dunif(0,sigmax_age)";
    put@1 "tau_age <-1/(sigma.tau_age*sigma.tau_age)";
    put@1 "sigma.tau_sex~ dunif(0,sigmax_sex)";
    put@1 "tau_sex <-1/(sigma.tau_sex*sigma.tau_sex)";
    put@1 "sigma.tau_str~ dunif(0,sigmax)";
    put@1 "tau_str <-1/(sigma.tau_str *sigma.tau_str )";
    put@1 "sigma.tau_pre~ dunif(0,sigmax)";
    put@1 "tau_pre <-1/(sigma.tau_pre*sigma.tau_pre)";
    put@1 "sigma.tau_sub1~ dunif(0,sigmax)";
    put@1 "tau_sub1 <-1/(sigma.tau_sub1 *sigma.tau_sub1 )";
    put@1 "sigma.tau_sub2~ dunif(0,sigmax)";
    put@1 "tau_sub2 <-1/(sigma.tau_sub2 *sigma.tau_sub2 )";
    put@1 "sigma.tau_sub3~ dunif(0,sigmax)";
    put@1 "tau_sub3 <-1/(sigma.tau_sub3 *sigma.tau_sub3 )";
    put@1 "sigma.tau_3~ dunif(0,sigmax)";
    put@1 "tau_3<-1/(sigma.tau_3*sigma.tau_3)";
    put@1 "}";

run;
%mend logisticset;

/*****
/***** Logistic model with multiple covariates covariate *****/
/*****/
%macro logistcoset;
FILENAME model "&path./WinBUGS14/nzmhs/&modelfile..txt";
data_null;
file model;
put@1 "model";
put@1 "{";
put@1 "# LOOP THROUGH INDIVIDUALS SAMPLED";
put@1 "for( i in 1:N) {";
put@1 "   yobs[i] ~ dbern(pi[i])";

```

```

put@1 " sol[i] ~ dbern(psi[i]);
put@1 " nzb[i] ~ dbern(npi[i]);
put@1 " une[i] ~ dbern(upi[i]);
put@1 " logit(pi[i]) <- eth_be[eth[i]] + sex_be*sex[i];
put@1 " + age_be[age[i]] + beta_psu[psu[i],(ssu[i]+1)];
%if (&part = 2) %then %do;
put@1 " + pre_co[slct[i]] ";
%end;
put@1 " + cov_b1*nzb[i] + cov_b2*sol[i] + cov_b3*aln[i];
put@1 " + cov_b4*mar[i] + cov_b5*noq[i] + cov_b6*une[i];
put@1 " + cov_b7*inc[i] + cov_b8*hid[i] ";
put@1 " logit(psi[i])<-s0+s1[eth[i]]+s2*sex[i];
put@1 " logit(npi[i])<-n0+n1[age[i]]+n2*sex[i];
put@1 " logit(upi[i])<-u0+u1[eth[i]]+u2*sex[i];
put@1 "}";
put@1 " # Posterior predictive checks ";
put@1 "for( i in 1:N) {";
put@1 " yrep[i] ~ dbern(pi[i]);
put@1 "}";
put@1 "yrep.mean[1]<-mean(yrep[]) ";
put@1 "yrep.mean[2]<-mean(pi[]) ";
put@1 "# END LOOP THROUGH Yi ";
put@1 " #";
put@1 " # STATE PRIOR DISTRIBUTIONS";
put@1 " #";
put@1 " # ETHNICITY";
put@1 "for( ki in 1 : &neth.) {";
put@1 " # PRIOR Beth ";
put@1 " eth_be[ki] ~ dnorm(mueth[ki],tau_eth)";
put@1 " s1[ki] ~ dnorm(0,0.01) ";
put@1 " u1[ki] ~ dnorm(0,0.01) ";
put@1 " }";
put@1 " # AGE ";
put@1 " for( aa in 1 : 6) {";
put@1 " age_be[aa] ~ dnorm(muage[aa],tau_age)";
put@1 " n1[aa] ~ dnorm(0,0.01) ";
put@1 " }";
put@1 "# PRIORS SEX";
put@1 "sex_be ~ dnorm(sexpre,tau_sex)";
put@1 "s2 ~ dnorm(0,0.01) ";
put@1 "u2 ~ dnorm(0,0.01) ";
put@1 "n2 ~ dnorm(0,0.01) ";
put@1 " # PACIFIC STRATA ";
put@1 " beta_str ~ dnorm(0.0,tau_str) ";
put@1 " # LOCAL AREA SAMPLE UNIT";
put@1 " for( s in 1 : 2) {";
put@1 " for( j in 1 : 1260) {";
put@1 " beta_psu[j,s] <- beta_3 + beta_str*(s-1) ";
put@1 " }";
put@1 " }";
%if (&part = 2) %then %do;
put@1 "# PART II SELECTION ";
put@1 " pre_co[1] ~ dnorm(pre_sub0[1],tau_sub1) ";
put@1 " for( q in 2 : 6) {";
put@1 " pre_co[q] ~ dnorm(pre_sub0[2],tau_sub2) ";
put@1 " }";
put@1 " for( phh in 7 : 11) {";
put@1 " pre_co[phh] ~ dnorm(pre_sub0[3],tau_sub3) ";
put@1 " }";
%end;
put@1 " # HYPERPARAMETER for Local area Sample Unit";
put@1 " beta_3 ~ dnorm(0,tau_3) ";
put@1 " # COVARIATES";
%do j=1 %to &nco; %let lvl=nlevel&j.;
put@1 " cov_b&j ~ dnorm(covpre&j,tau_le&j) ";
put@1 "sigma.tau_le&j~ dunif(0,10)";
put@1 "tau_le&j<-1/(sigma.tau_le&j*sigma.tau_le&j)";
%end;

```



```

put@1 " # OTHER IMPUTATION PRIORS      ";
put@1 " s0 ~ dnorm(0,0.01)      ";
put@1 " n0 ~ dnorm(0,0.01)      ";
put@1 " u0 ~ dnorm(0,0.01)      ";
put@1 "# OTHER VARIANCE PRIORS";
put@1 "sigma.tau_0~ dunif(0,sigmax)";
put@1 "tau_0<-1/(sigma.tau_0*sigma.tau_0)";
put@1 "sigma.tau_eth~ dunif(0,sigmax_eth)";
put@1 "tau_eth <-1/(sigma.tau_eth*sigma.tau_eth)";
put@1 "sigma.tau_age~ dunif(0,sigmax_age)";
put@1 "tau_age <-1/(sigma.tau_age*sigma.tau_age)";
put@1 "sigma.tau_sex~ dunif(0,sigmax_sex)";
put@1 "tau_sex <-1/(sigma.tau_sex*sigma.tau_sex)";
put@1 "sigma.tau_str~ dunif(0,sigmax)";
put@1 "tau_str <-1/(sigma.tau_str *sigma.tau_str )";
put@1 "sigma.tau_pre~ dunif(0,sigmax)";
put@1 "tau_pre <-1/(sigma.tau_pre*sigma.tau_pre)";
put@1 "sigma.tau_sub1~ dunif(0,sigmax)";
put@1 "tau_sub1 <-1/(sigma.tau_sub1 *sigma.tau_sub1 )";
put@1 "sigma.tau_sub2~ dunif(0,sigmax)";
put@1 "tau_sub2 <-1/(sigma.tau_sub2 *sigma.tau_sub2 )";
put@1 "sigma.tau_sub3~ dunif(0,sigmax)";
put@1 "tau_sub3 <-1/(sigma.tau_sub3 *sigma.tau_sub3 )";
put@1 "sigma.tau_3~ dunif(0,sigmax)";
put@1 "tau_3<-1/(sigma.tau_3*sigma.tau_3)";
put@1 "}";

run;
%mend logistcoset;

/*****
/*
/* WinBugs OUTPUT PROCESSING CODE TO PRODUCE TABULATED RESULTS
/*
/*
/*****/
%macro MainModel(modcode,dep,nchain,nparm,nsim,pt,slct,nthin,
                var,dsout,
                title=Table 4.1 output Nov-2011
                );

%do j=1 %to &nchain;
%modelout(dis=&dep.,chain=&j.,thin=&nthin.,
          part=&pt.,
          selector = &slct.,
          logfile=Model&modcode._out_&dep.,
          modelfile=mo&modcode.T1,
          datafile1=d1&modcode.T1,
          datafile2=d2&modcode.T1,
          initsfile=in&modcode.T1,
          batchfile=TE&modcode.T1);*,modeltype=logistic);
%end;

/*****
***** GELMAN RUBIN MONITORING *****
*****
/*define constants */
data allco (where=(thin=0));
set %do j=1 %to &nchain;
NZMHS.mod&modcode._&dep._coda&j.(in=in&j.)%end;
;
%do j=1 %to &nchain; if in&j. then Chain=&j.;%end;
index=_N_;
thin=mod(index,&nthin.);
run;
data allpi;
set %do j=1 %to &nchain;
NZMHS.mod&modcode._&dep._chain&j._est(in=in&j.)%end;
;

```

```

        %do j=1 %to &nchain; if in&j. then Chain=&j.;%end;
run;
%let sim=%eval(&nsim./&nthin.);
%jkge1m(allpi, 4,
        pi1 pi2 pi3 pi4,&sim,alpha=.001,nc=&nchain.);
data mGelmanRubin1(label='Gelman-Rubin Diagnostics');
    set _mGelman_Ests;
run;
data GelmanRubin1(label='Gelman-Rubin Diagnostics');
    merge _Gelman_Parms _Gelman_Ests;
run;
%jkge1m(allco, &nparm,
        eth_be_1 eth_be_2 eth_be_3 eth_be_4 age_be_1
        age_be_2 age_be_3 age_be_4 age_be_5 age_be_6 sex_be beta_str
beta_3
        %if &pt=2 %then %do; %do j=1 %to 11; pre_co_&j %end;%end;
        ,&sim,alpha=.001,nc=&nchain.);
data mGelmanRubin2(label='Gelman-Rubin Diagnostics');
    set _mGelman_Ests;
    Co_R_max=R_max;co_r_&nparm.=R_&nparm.;
    drop R_max R_&nparm.;
run;
data GelmanRubin2(label='Gelman-Rubin Diagnostics');
    merge _Gelman_Parms _Gelman_Ests;
run;
data GelmanRubin;
    set GelmanRubin1 GelmanRubin2;
run;
data NZMHS.mod&modcode._&dep.mGelRubn;
    merge mGelmanRubin1 mGelmanRubin2;
run;

*****
***** GEWEKE COMPUTATIONS *****
*****
%let brn = %eval(&brn_no./&nthin.);
data simco;
    set NZMHS.mod&modcode._&dep._codal(in=in&j. firstobs=&brn.);
run;
data simpi;
    set NZMHS.mod&modcode._&dep._chain1_est(in=in&j. firstobs=&brn.);
run;
%gwekeco(input=simco,burn=&brn.,nsm=&sim.,nprm=&nparm.);
%gwekepi(input=simpi,burn=&brn.,nsm=&sim.,nprm=&nparm.);

data geweke_out;
    set geweke_pi geweke_co;
run;

*****
***** Credible Regions for estimates *****
*****
%let plt_no = %eval(&nsim-5000);
data convl0;
    set simpi;
    array ethnic pi1-pi4;
    do i=1 to 4;
        keep indx label coeff;
        indx=_N_;
        label="0 pi"||put(i,ethtxt.);
        coeff=ethnic(i);
        output;
    end;
run;
data convl1;
    set simco;
    array ethnic eth_be_1-eth_be_4;
    do i=1 to 4;

```

```

keep indx label coeff;
  indx=_N_;
  label="1 "||put(i,ethtxt.);
  coeff=ethnic(i);
  output;
end;
run;
data conv12;
  set simco;
  array age age_be_1-age_be_6;
  do j=1 to 6;
    keep indx label coeff;
    indx=_N_;
    label=put(j,agetxt.);
    coeff=age(j);
    output;
  end;
run;
data conv13;
  set simco;
  keep indx label coeff;
  indx=_N_;
  label="4 Female";
  coeff=sex_be;
run;
data conv14;
  set simco;
  keep indx label coeff;
  indx=_N_;
  label="63 Strata ";
  coeff=beta_str;
run;
data conv15;
  set simco;
  keep indx label coeff;
  indx=_N_;
  label="64 Sample unit";
  coeff=beta_3;
run;
data conv_test2;
  set conv10-conv15;
run;
run;
run;
  proc sort data=conv_test2;
    by label;run;
  proc means noprint data=conv_test2;
    by label;
    var coeff;
    output out=pimean n=n mean=mean var=var std=std;
  run;
data pi_coeffs;
  set pimean;
  keep label n cell;
  lcl=(mean-1.645*std);ucl=(mean+1.645*std);
  if substr(label,1,1)="0" then do; mean = mean*100;lcl=lcl*100;ucl=
ucl*100;
  cell = trim(left(put(mean, f8.2)))||" (" ||
    trim(left(put(lcl, f8.2))) ||", "||
    trim(left(put(ucl, f8.2))) ||")" ;end;else do;
  cell = trim(left(put(mean, f8.3)))||" (" ||
    trim(left(put(lcl, f8.3))) ||", "||
    trim(left(put(ucl, f8.3))) ||")" ;end;
run;
%if &pt=2 %then %do;
data conv16;
  set simco;
  array prtii pre_co_1-pre_co_11;
  do k=1 to 11;

```

```

keep indx label coeff;
  indx=_N_;
  label=put(k,seltxt.);
  coeff=prtii(k);
  output;
end;
run;

proc sort data=convl6;
  by label;run;
proc means noprint data=convl6;
  by label;
  var coeff;
  output out=ptii n=n mean=mean var=var std=std LCLM=lclm
UCLM=uclm;
run;
data ptiimean;
  set ptii;
  keep label n cell;
  lcl=(mean-1.645*std);ucl=(mean+1.645*std);
  cell = trim(left(put(mean, f8.3)))||" (" ||
  trim(left(put(lcl, f8.3))) ||", "||
  trim(left(put(ucl, f8.3))) ||")" ;
run;
data pi_all;
  set pi_coeffs ptiimean;
run;
%end;%else %do;
data pi_all;
  set pi_coeffs;
run;
%end;
data NZMHS.mod&modcode._&dep._diagnostic;
  set pi_all;
  set GelmanRubin;
  set Geweke_out;
  keep label n cell Between_chain Within_chain R gew_z gew_p;
run;

*****
***** Predictive posterior check graph *****
*****
%coda2sas(out=NZMHS.mod&modcode._yrep_&dep.,chain=&path.\WinBugs14\NZMHS\Mod
el&modcode._yrep_&dep._codal.txt,codaind=&path.\WinBugs14\NZMHS\Model&modcod
e._yrep_&dep._codaindex.txt);
data yrep_000;
set NZMHS.mod&modcode._yrep_&dep;
if yrep_mean>mean(yobs_mean) then pyrep=1;else pyrep=0;
if yrep_mean>mean(yobs_mean) then pyrep2=1;else pyrep2=0;
pyrep3=mean(yobs_mean);
run;
proc sql;
create table yrep_001 as select
"ALL" as index,
mean(yobs_mean) as ref1
from yrep_000
group by index;
create table yrep_002 as select
"ALL" as index,
yobs
from BA10;
create table yrep_003 as select
b.index,
a.ref1,
%if &pt=2 %then ref1; %else b.yobs; as y_obs
from yrep_001 a right join yrep_002 b
on a.index=b.index;
quit;
data yrep_004;

```

```

set yrep_003;
run;
proc sql;
create table yrep_005 as select
index,
mean(y_obs) as ref
from yrep_004
group by index;
create table yrep_006 as select
"ALL" as index,
yrep_mean,
yobs_mean
from yrep_000;
create table yrep_007 as select
b.index,
b.yrep_mean,
a.ref
from yrep_005 a join yrep_006 b
on a.index=b.index;
quit;
data yrep_008;
set yrep_007;
if yrep_mean>ref then pyrep=1;else pyrep=0;
run;

proc means noprint data=yrep_008;
var yrep_mean;
output out=repmean1 n=n mean=mean var=var std=std;
run;
proc means noprint data=yrep_008;
var ref;
output out=repmean2 mean=obsmean;
run;
proc means noprint data=yrep_008;
var pyrep;
output out=repmean3 sum=pval;
run;
data NZMHS.mod&modcode._&dep._repmean4;
set repmean1;
set repmean2;
set repmean3;
keep RepDist YObs_Mean pr_yrep;
lcl=(mean-1.645*std);ucl=(mean+1.645*std);
RepDist = trim(left(put(mean*100, f8.2)))||" (" ||
trim(left(put(lcl*100, f8.2))) ||", "||
trim(left(put(ucl*100, f8.2))) ||")" ;
YObs_Mean=put(obsmean*100, f8.2);
pr_yrep=put(pval/&nsim., f8.4);
run;

/*****
/***** Chapter table output for any mental disorder *****/
*****/
proc sort data = NZMHS.mod&modcode._&dep._chain1_results out=combined;
by xvar Adjlabel varname cellnum;
run;
proc transpose data = combined out=table_a_pt1;
var cell;
by xvar Adjlabel varname cellnum;
id yvar;
run;
data tableA1;
set table_a_pt1;
keep xvar Adjlabel varname CkI;
where varname in ("Pi") and xvar = "ALLxxxx";
run;
data tableA2;
set table_a_pt1;
keep xvar Adjlabel varname NCP NZM OTH;

```

```

        where varname in ("R1") and xvar = "ALLxxxx";
run;
data tableA;
    merge tableA1 tableA2;
    by xvar Adjlabel;
run;
data tableB1;
    set table_a_pt1;
    keep xvar Adjlabel varname CkI;
    where varname = "Pi" and xvar ^= "ALLxxxx";
run;
data tableB2;
    set table_a_pt1;
    keep xvar Adjlabel varname NCP NZM OTH;
    where varname = "R1" and xvar ^= "ALLxxxx";
run;
data tableB;
    merge tableB1 tableB2;
    by xvar Adjlabel;
run;
data tableC;
    set table_a_pt1;
    keep xvar Adjlabel varname CkI NCP NZM OTH;
    where varname = "R2" and xvar ^= "ALLxxxx";
run;
data NZMHS.mod&modcode._&dep._TableA;
    set tableA tableB tableC;
run;
%if &dep=Any12 %then %do;%end; %else
%if &dep=AnyLT %then %do;%end; %else %do;
proc sort data = combined;
    by varname cellnum;
run;
proc transpose data = combined(where=(xvar<>"ALLxxxx")) out=table_d_pt1;
    var cell;
    by varname cellnum;
    id yvar;
run;
data tableD1;
    set table_d_pt1;
    keep DEP x16to19x xxMalex;
    where varname = "Pi";
    Dep="&dep.";
run;
data tableD2;
    set table_d_pt1;
    keep DEP x20to34x x35to44x x45to54x x55to64x xx65_xx Femalex;
    where varname = "R1";
    Dep="&dep.";
run;
data tableD;
    merge tableD1 tableD2;
    by DEP;
run;
data NZMHS.mod&modcode._&dep._TableD;
    set tableD;
run;
%end;

/*****
/***** Series plots by Disorder *****/
/*****/
data conv31;
    set simp1;
    keep index Cook_Island Other_Pacific NZ_Maori NMNP ACook_Island
AOther_Pacific ANZ_Maori ANMNP ;
    Cook_Island= pi1; Other_Pacific= pi2; NZ_Maori= pi3; NMNP= pi4;
    ACook_Island= pi5; AOther_Pacific= pi6; ANZ_Maori= pi7; ANMNP= pi8;

```

```

run;
data conv71;
  set simp1;
  keep demog index pi;
  demog = "1 Cook Islands";
  pi = pi1;
  run;
data conv72;
  set simp1;
  keep demog index pi;
  demog = "2 Other Pacific";
  pi = pi2;
  run;
data conv73;
  set simp1;
  keep demog index pi;
  demog = "3 NZ Maori";
  pi = pi3;
  run;
data conv74;
  set simp1;
  keep demog index pi;
  demog = "4 NMNP";
  pi = pi4;
  run;
data conv75;
  set simp1;
  keep demog index pi;
  demog = "1 Cook Islands";
  pi = pi5;
  run;
data conv76;
  set simp1;
  keep demog index pi;
  demog = "2 Other Pacific";
  pi = pi6;
  run;
data conv77;
  set simp1;
  keep demog index pi;
  demog = "3 NZ Maori";
  pi = pi7;
  run;
data conv78;
  set simp1;
  keep demog index pi;
  demog = "4 NMNP";
  pi = pi8;
  run;
data conv_test2;
  set conv71 conv72 conv73 conv74;
run;
proc sort data=conv_test2;
by demog;run;
data conv_test3;
  set conv75 conv76 conv77 conv78;
run;
proc sort data=conv_test3;
by demog;run;
ods rtf file = "&Tabpath.\Model&modcode._&dep. coefficient Tables.rtf";

/*****
/***** Plot posterior prevalence comparison and summary Stats *****/
/*****/
proc print data=NZMHS.mod&modcode._&dep._tableA noobs label split='\';
  title1 "&title., created on &sysdate.";
  var xvar varname Adjlabel CkI NCP NZM OTH;
  label

```

```

        xvar = "Group"
        varname = "variable"
        Adjlabel="Adjustment"
        CkI ="Cook Isl\\Unadjusted"
        NCP ="Non CI\\Pacific\\Unadjusted"
            NZM = "NonPacific\\Maori\\Unadjusted"
        OTH ="Non Maori\\non Pacific\\Unadjusted"
    ;
run;
proc sgplot data=simpi (rename=(pi4=NMNP pi3=NZ_Maori pi2=Other_Pacific
pi1=Cook_Island));* noautolegend;
    title "Unadjusted prevalenc of &dep. by Ethnicity";
    /*Create the histogram and density plots. */
    Histogram NMNP;
    Histogram NZ_Maori;
    Histogram Other_Pacific/Transparency=.5;
    Histogram Cook_Island/Transparency=.5;
    keylegend / location=outside position=bottomleft;
    Density NMNP;
    Density NZ_Maori;
    Density Other_Pacific/Transparency=.5;
    Density Cook_Island/Transparency=.5;
run;
proc sgpanel data=conv_test2;
panelby demog;
    series x=index y=pi;
run;
proc sgplot data=simpi (rename=(pi8=NMNP pi7=NZ_Maori pi6=Other_Pacific
pi5=Cook_Island));* noautolegend;
    title "Adjusted prevalenc of &dep. by Ethnicity";
    /*Create the histogram and density plots. */
    Histogram NMNP;
    Histogram NZ_Maori;
    Histogram Other_Pacific/Transparency=.5;
    Histogram Cook_Island/Transparency=.5;
    keylegend / location=outside position=bottomleft;
    Density NMNP;
    Density NZ_Maori;
    Density Other_Pacific/Transparency=.5;
    Density Cook_Island/Transparency=.5;
run;
proc sgpanel data=conv_test3;
panelby demog;
    series x=index y=pi;
run;
proc sgplot data=NZMHS.mod&modcode._&dep.mGelRubn;
    title "Multivariate diagnostic plot for coefficients";
    series x=series y=co_R_max;
    series x=series y=co_R_&nparm.;
run;
proc sgplot data=yrep_008;
    title "Posterior Predictive distribution";
    /*Create the histogram and density plots. */
    histogram yrep_mean;
    refline ref/axis=x legendlabel="Observed Mean" lineattrs=(thickness=4pt);
    keylegend / location=outside position=bottomleft;
run;
    proc print data=NZMHS.mod&modcode._&dep._repmean4;run;
    proc print data=NZMHS.mod&modcode._&dep._diagnostic;
    run;

ods rtf close;

%mend MainModel;

/*****
/*****      COMBINE WinBugs OUTPUT WITH OBSERVED DATA FOR      *****/
/*****/

```



```

/*****          PROCESSING RESULTS          *****/
/*****          *****/
%macro modelout(dis=&dep.,chain=&j.,thin=&nthin.,
    part=&pt.,
        selector = &slct.,
    logfile=Model&modcode._out_&dep.,
    modelfile=mo&modcode.T1,
    datafile1=d1&modcode.T1,
    datafile2=d2&modcode.T1,
    initsfile=in&modcode.T1,
    batchfile=TE&modcode.T1);*,modeltype=logistic);

proc sort data=nzmhsdat.BAZ00;
by nzmeshbl;run;
data BA10;
    merge nzmhsdat.BAZ00 (in = x1)
        nzmhsdat.BAZ02;
        by nzmeshbl;
if x1 &agesel;
keep ivnum eth wgt2 sex age pst lau age4 yobs &selector. ;

/**          Diagnosis VARIABLES          **/

anyLT=any_mental_LT;
any12 = any_mental_12;
SEV12 = severe;
MOD12 = moderate;
MLD12 = mild;
COM12 = MH_comb12;
CO12 = ALL_comb12;
DD12 = DD_comb12;
COMLT = MH_combLT;
COLT = ALL_combLT;
DDL12 = DD_combLT;
if (chronic = 1 and any_mental_12 = 1) then mph12 = 1; else mph12 = 0;
if (chronic = 1 and any_mental_LT = 1) then mphLT = 1; else mphLT = 0;

/**          design VARIABLES          **/

%if &neth.=3 %then %do; eth=put(ethnic4,noMaor.);%end;
lau = psuI;
pst = ssu-1;
pt2 = partII + 1;
eth = ethnic4;
sex = gender-1;
age = age6;
%if (&part. = 2) %then %do;
    if partII = 1 then yobs = "NA";
        else/* choose dependent variable*/
            yobs = put(&dep.,numtxt.);
                %end; %else %do;
                    yobs = &dep.; %end;
wgt2=wgt_person5;

/*****          part II selection variable          *****/

if PH100_1 = 1 then select = 1;
else if PH102>0 then select = PH102+1;
else if PH108>0 then select = PH108+6;
run;

%codas2sas(out=NZMHS.Mod&modcode._&dis._coda&chain.,chain=&path.\WinBugs14\NZ
MHS\Mod&modcode._out_&dis._coda&chain..txt,codaind=&path.\WinBugs14\NZMHS\
Mod&modcode._out_&dis._codaindex.txt);

data work.out;
    set BA10;
keep ivnum wgt2 eth sex age pst age4 &selector.;

```

```

run;
data work.conv(where=(thin=0));
    set NZMHS.Mod&modcode._&dep._coda&chain.;
    index=_N_;
thin=mod(index,&thin.);
run;

%if (&dis.=anyLT) %then %do; %prevt1(pt=2,chain=&chain.); %end;
%else %if (&dis.=any12) %then %do; %prevt1(pt=2,chain=&chain.); %end;
%else %do; %prevres(pt=&part.,chain=&chain.); %end;

%mend modelout;

/*****
/*****      CALCULATE POSTERIOR PREVALENCE AND RR      *****/
/*****/
%macro prevres(pt,chain);
proc SQL;
create table BA11 as select
    eth,sex,age,age4,%if &pt=2 %then %do;select,%end;
    pst,
    sum(wgt2) as wgt,
    count(*) as freq
from work.out
group by eth,sex,age,age4,%if &pt=2 %then %do;select,%end;
    pst;
quit;
data BA12;
    set BA11;
    %if &pt=2 %then %do;presel =select;%end;
run;/**/
Proc IML;
    start pred_marg;
        logitpi = x*t(b);
        ones_lp = J(nrow(x),nrow(y),1);
        p2 = (exp(logitpi)/(ones_lp+exp(logitpi)));
        wp2 = p2;
    finish pred_marg;

    use work.conv(drop=thin index &yrep.);
    read all var _ALL_ into x;
%if (&pt = 2) %then %do;
    use BA12;
    read all var {age eth sex pst age4 presel} into y;
use BA12;
    read all var {wgt} into w;
        ci = I(&neth);
        b0 = t(1:nrow(x));
        b1 = design(y[,1]);
        b2 = J(nrow(y),1,1);
        b3 = y[,4];
        b4 = design(y[,2]);
        b6 = design(y[,6]);
        b7 = y[,3];
        b7b = design(y[,3]);
        b8 = design(y[,1]);
    b = b1||b2||b3||b4||b6||b7;
    run pred_marg;
    pi_all = wp2;
    ewgt = t(w)*b4;
    ewgt2 = b4#w;
    pi_u = pi_all*ewgt2/ewgt;
%do e=1 %to &neth;
    ee = J(nrow(y),1,1)*ci[&e.,];
    b = b1||b2||b3||ee||b6||b7;
    run pred_marg;
    pi_adj_&e. = wp2*w/&nsamp.;
    %if (&e=1) %then %do;

```

```

        swgt = t(w)*b7b;
        swgt2 = b7b#w;
        pi_s = wp2*swgt2/swgt;
        awgt = t(w)*b8;
        awgt2 = b8#w;
        pi_a = wp2*awgt2/awgt;
        %end;
    %end;
%end;%else %do;
    use BA12;
    read all var {age eth sex pst age4} into y;
    use BA12;
    read all var {wgt} into w;
    ci = I(&neth);
    b0 = t(1:nrow(x));
    b1 = design(y[,1]);
    b2 = J(nrow(y),1,1);
    b3 = y[,4];
    b4 = design(y[,2]);
    b7 = y[,3];
    b7b = design(y[,3]);
    b8 = design(y[,1]);
    b = b1||b2||b3||b4||b7;
    run pred_marg;
    pi_all = wp2;
    ewgt = t(w)*b4;
    ewgt2 = b4#w;
    pi_u = pi_all*ewgt2/ewgt;
%do e=1 %to &neth;
    ee = J(nrow(y),1,1)*ci[&e.,];
    b = b1||b2||b3||ee||b7;
    run pred_marg;
    pi_adj_&e = wp2*w/&nsamp.;
    %if (&e=1) %then %do;
        swgt = t(w)*b7b;
        swgt2 = b7b#w;
        pi_s = wp2*swgt2/swgt;
        awgt = t(w)*b8;
        awgt2 = b8#w;
        pi_a = wp2*awgt2/awgt;
        %end;
    %end;
%end;
    sp_pred = b0||pi_u%do e=1 %to &neth;||pi_adj_&e. %end;||pi_s||pi_a;
    create conv02 from sp_pred;
    append from sp_pred;

quit;
data conv03;
    set conv02;
    index = COL1;
%local t; %let t = 1;
%do e=1 %to &neth.; %let tz = &t; %let t = %eval(&t+1);
    ethu&e = COL&t.;
    pi&tz = ethu&e;
    r&tz = ethu&e/ethu1;
    s&tz = 99;
    lbl&tz = "eth&e._u";
%end;
%do e=1 %to &neth.; %let tz = &t; %let t = %eval(&t+1);
    etha&e = COL&t.;
    pi&tz = etha&e;
    r&tz = etha&e/etha1;
    s&tz = etha&e./ethu&e.;
    lbl&tz = "eth&e._a";
%end;
%do s=1 %to 2; %let tz = &t; %let t = %eval(&t+1);
    pi_s&s. = COL&t.;
    pi&tz = pi_s&s.;

```

```

        r&tz = pi_s&s./pi_s1;
        s&tz = 99;
        lbl&tz = "sex&s._a";
    %end;
    %do a=1 %to &nage; %let tz = &t; %let t = %eval(&t+1);
        pi_a&a. = COL&t.;
        pi&tz = pi_a&a.;
        r&tz = pi_a&a./pi_a1;
        s&tz = 99;
        lbl&tz = "age&a._a";
    %end;
drop COL1-COL&t;
run;

proc sort data = conv03;
    by index;
run;
data NZMHS.mod&modcode._&dep._chain&chain._est;
set conv03;
run;
proc datasets nolist;
    delete temp;
run ; quit;
proc sql;
create table temp
(
    kurtosis    Num ,
    label       Char(16),
    lbl         Char(5),
    max         Num,
    mean        Num,
    median      Num,
    min         Num,
    n           Num,
    p2_5        Num,
    p97_5       Num,
    range       Num,
    skewness    Num,
    std         Num,
    var         Num
);
quit;

%do i=1 %to &t;
    proc univariate noprint data=conv03;
        by lbl&i;
        var pi&i ;
        output out=pi&i(rename = (lbl&i.=lbl)) n=n mean=mean var=var
std=std min=min max=max
                                range=range pctlpts=2.5 median=median pctlpts=97.5
                                kurtosis=kurtosis skewness=skewness pctlpre=p    ;
    run;
    proc univariate noprint data=conv03;
        by lbl&i;
        var r&i ;
        output out=r&i (rename = (lbl&i.=lbl)) n=n mean=mean var=var
std=std min=min max=max
                                range=range pctlpts=2.5 median=median pctlpts=97.5
                                kurtosis=kurtosis skewness=skewness pctlpre=p    ;
    run;
    proc univariate noprint data=conv03;
        by lbl&i;
        var s&i ;
        output out=s&i (rename = (lbl&i.=lbl)) n=n mean=mean var=var
std=std min=min max=max
                                range=range pctlpts=2.5 median=median pctlpts=97.5
                                kurtosis=kurtosis skewness=skewness pctlpre=p    ;
    run;

```

```

        data pi&i; set pi&i;length label $16; label = "pi_"||lbl;run;
        data r&i; set r&i;length label $16; label = "r1_"||lbl;run;
        data s&i; set s&i;length label $16; label = "r2_"||lbl;run;
    data temp ;
        set temp pi&i r&i s&i;
    run;
%end;
proc datasets nolist;
    delete pil-pi&i r1-r&i s1-s&i;
run ; quit;

data statpi;
    set temp ;
    where substr(label,1,2) = "pi";
    varname = "Pi";
    xvar = substr(label,4,4); Adjlabel = substr(label,9,1);
    xvar = trim(put(xvar,$ex2txt.));
    yvar = trim(put(xvar,$extxt.));
    mpct = mean*100;
    lpct = p2_5*100;
    upct = p97_5*100;
    length cell $16.;
    cellnum = 1;
    /**
    /** Cell value: The percentage.
    /**/
    cell = trim(left(put(mpct, f8.1)))||" (" ||
        trim(left(put(lpct, f8.1))) ||
        "-" ||
        trim(left(put(upct, f8.1))) ||
        ")" ;
run;
data statrr4;
    set temp ;
    where substr(label,1,2) = "r1";
    varname = "R1";
    xvar = substr(label,4,4); Adjlabel = substr(label,9,1);
    xvar = trim(put(xvar,$ex2txt.));
    yvar = trim(put(xvar,$extxt.));
    length cell $16.;
    probrr = 1-cdf('NORMAL',1,mean,std);
    cellnum = 2;
    /**
    /** Cell value: The percentage.
    /**/
    cell = trim(left(put(mean, f8.4)))||" (" ||
        trim(left(put(probrr, f8.4))) ||
        ")" ;
run;
data statrr5;
    set temp ;
    where substr(label,1,2) = "r2";
    varname = "R2";
    xvar = substr(label,4,4); Adjlabel = substr(label,9,1);
    xvar = trim(put(xvar,$ex2txt.));
    yvar = trim(put(xvar,$extxt.));
    length cell $16.;
    probrr = 1-cdf('NORMAL',1,mean,std);
    cellnum = 3;
    /**
    /** Cell value: The percentage.
    /**/
    cell = trim(left(put(mean, f8.4)))||" (" ||
        trim(left(put(probrr, f8.4))) ||
        ")" ;
run;
data NZMHS.mod&modcode._&dep._chain&chain._results;
    set statpi statrr4 statrr5;

```

```

    yvaris = trim(yvar)||left(trim(adjlabel));
run;
%mend prevres;

/*****
/*****      CALCULATE THE BROOKES-GELMAN-RUBIN R STATISTICS      *****/
/*****
%macro JKgelm( /*-----*/
/*
/*
/* name of the data set that stores the posterior*/
/* samples from multiple runs of MCMC.          */
/* the number of parameters in the model.        */
/* the names of the parameters.                  */
/* the number of simulations.                     */
/* the number of the Markov chains, with a default */
/* value of 3.                                     */
/* the alpha significance level.                  */
/*-----*/
);

Uses modified code from a Macro developed for SAS v9.2
%mend;

/*****
/*****      CALCULATE THE CEWEKE STATISTICS      *****/
/*****
%macro gwekeco(burn,nsm,nprm,input);
%let gw2=%eval(&nsm.-&burn-1000);
data all2;
    set &input.(in=in1 obs=1000)
        &input.(in=in2 firstobs=&gw2.);
    if in1 then Chain=1;
    if in2 then Chain=2;
run;
%do e=1 %to &neth.;
    proc univariate noprint data=all2;
        by chain;
        var eth_be_&e.;
        output out=p&e n=n mean=mean var=var std=std;
    run;
    %end;
%do a=1 %to &nage.;%let ee=%eval(&neth.+&a.);
    proc univariate noprint data=all2;
        by chain;
        %if &cov.=migrn %then var age_be; %else var age_be_&a.;
        output out=p&ee. n=n mean=mean var=var std=std;
    run;
    %end;%let ee=%eval(&neth.+ &nage. + 1);
    proc univariate noprint data=all2;
        by chain;
        var sex_be;
        output out=p&ee. n=n mean=mean var=var std=std;
    run;%let ee=%eval(&neth.+ &nage. + 2);
    proc univariate noprint data=all2;
        by chain;
        var beta_str;
        output out=p&ee. n=n mean=mean var=var std=std;
    run;%let ee=%eval(&neth.+ &nage. + 3);
    proc univariate noprint data=all2;
        by chain;
        var beta_3;
        output out=p&ee. n=n mean=mean var=var std=std;
    run;
%if &pt=2 %then %do;
    %do p=1 %to 11; %let ee=%eval(&p+&neth.+ &nage. + 3);
        proc univariate noprint data=all2;
            by chain;
            var pre_co_&p.;

```

```

        output out=p&ee. n=n mean=mean var=var std=std;
    run;
    %end;%end;
%let e1=%eval(&neth.+ &nage. + 3);
%do j=1 %to &e1.;
    %gewtrans(&j.);
%end;
%if &pt=2 %then %do;
%let e2=%eval(&e1.+1);%let e3=%eval(&e1.+11);
    %do j=&e2. %to &e3.;
        %gewtrans(&j.);
    %end;
%end;%else %let e3=%eval(&e1.);
data geweke_co;
    set geweke1-geweke&e3.;
run;
%mend gwekeco;
%macro gwekepi(burn,nsm,nprm,input);
%let gw2=%eval(&nsm.-&burn-1000);
data all2;
    set &input.(in=in1 obs=1000)
        &input.(in=in2 firstobs=&gw2.);
    if in1 then Chain=1;
    if in2 then Chain=2;
run;
%if &nco.=1 %then %do;
    %do e=1 %to &nlevell.;
        proc univariate noprint data=all2;
            by chain;
            var pi&e.;
            output out=p&e n=n mean=mean var=var std=std;
        run;
        %gewtrans(&e.);
    %end;
data geweke_pi;
    set geweke1-geweke&nlevell.;
run;
    %end;%else %do;
    %do e=1 %to &neth.;
        proc univariate noprint data=all2;
            by chain;
            var pi&e.;
            output out=p&e n=n mean=mean var=var std=std;
        run;
        %gewtrans(&e.);
    %end;
data geweke_pi;
    set geweke1-geweke4;
run;
    %end;
%mend gwekepi;

%macro gewtrans(rj);
proc transpose data=p&rj. out=mpi&rj.; var mean; id chain; run;
proc transpose data=p&rj. out=spi&rj.; var var; id chain; run;
data geweke&rj.;
    set mpi&rj. (rename=(_1=stmn _2=finmn));
    set spi&rj. (rename=(_1=stvar _2=finvar));
    gew_z=abs(stmn-finmn)/sqrt((finvar+stvar)/2);
    gew_p=2*cdf('normal',-gew_z);
run;
%mend gewtrans;

```

Service use models Code

```

/*****

```



```

%let nco=1;
%global neth;
%let neth=3;
%global yref;
%let yref=5337;
%mainmodel(modcode=D21,dep=AnyLT,nchain=3,log=cox-D01 summary,
            pt=2,
            nparm=18,
            nsim=5000,
            brn_no=2000,
            nthin=1,
            title=Table 5.5 output JUN2013);

***** ANY ANXIETY DISORDER ONLY *****;
** D02 - lifetime risk: anxiety disorder, no covar, no service ****;
%global nco;
%let nco=0;
%global neth;
%let neth=4;
%global yref;
%let yref=3379;
%mainmodel(modcode=D02,dep=AnxLT,nchain=3,log=cox-D02 summary,
            pt=2,
            nparm=16,
            nsim=10000,
            brn_no=5000,
            nthin=1,
            title=Table 5.5 output JUN2013);

*** D22 - lifetime risk: anxiety disorder, nzborn, no service *****;
%global nco;
%let nco=1;
%global neth;
%let neth=3;
%global yref;
%let yref=3379;
%mainmodel(modcode=D22,dep=AnxLT,nchain=3,log=cox-D22 summary,
            pt=1,
            nparm=18,
            nsim=10000,
            brn_no=5000,
            nthin=1,
            title=Table 5.5 output JUN2013);

***** ANY MOOD DISORDER ONLY *****;
*** D06 - lifetime risk: mood disorder, no covar, no service *****;
%global nco;
%let nco=0;
%global neth;
%let neth=4;
%global yref;
%let yref=2772;
%mainmodel(modcode=D06,dep=MoodLT,nchain=3,log=cox-D06 summary,
            pt=1,
            nparm=16,
            nsim=2000,
            brn_no=1000,
            nthin=1,
            title=Table 5.5 output JUN2013);

*** D26 - lifetime risk: Mood disorder, nzborn, no service *****;
%global nco;
%let nco=1;
%global neth;
%let neth=3;
%global yref;
%let yref=2772;
%mainmodel(modcode=D26,dep=MoodLT,nchain=3,log=cox-D26 summary,

```

```

        pt=1,
        nparm=16,
        nsim=10000,
        brn_no=5000,
        nthin=1,
        title=Table 5.5 output JUN2013);

/*****
/*****      PREAMBLE PROGRAMME TO SET UP DATA AND RUN MODEL      *****/
/*****
%macro modelout(dep,set,cond,
                part,
                        selector,
                        logfile,
                                modelfile,
                                datafile1,
                                datafile2,
                                initsfile,
                                batchfile,
                                modeltype);

/*****      Generate other text files of code for WinBugs      *****/
%modelset(&dep,&set.,&cond.,&part.,&selector,&logfile.,&modelfile.,&datafile
1.,&datafile2.,&initsfile.,&batchfile.);

/*****      Create a text file of model code for WinBugs      *****/
%&modeltype.set;

/*create a .bat file and run Winugs code*/
DATA _NULL_;
    FILE "&path.\WinBUGS14\&batchfile..bat";
    PUT "&path.\WinBUGS14\WinBUGS14.exe" ' ' "/PAR &batchfile..txt";
    PUT 'exit';
RUN;
Run WinBUGS in SAS X windows
DATA _NULL_;
    X call "C:\users\jesse\My Documents\WinBUGS14\modelrun.bat";
    RUN;

*****;
** Format the log file with posterior survival probabilities ;
*****;
data _null_;
    retain i j 0;
    infile "&path./WinBUGS14/nzmhs/&logfile..txt" expandtabs trunccover;
    length text $200;
    input text $ 1-200;
    if scan(text,1)="node" then i=_n_;
    call symput("i",i+1);
    if upcase(scan(text,1))="SAVE" then j=_n_;
    call symput("j",j-1);
    run;

data results;
    infile "&path./WinBUGS14/nzmhs/&logfile..txt" firstobs=&i obs=&j
expandtabs trunccover;
    length param $20;
    input param $ mean sd MCerr lowCR median uppCR start sample;
    rep=5;
    run;

*****;
** Write stats to SAS dataset;
*****;
proc Sql;
    create table NZMHS.&modelfile.out (label="WINBUGS: &title.")
    (

```

```

        param char(20) label="Node or parameter",
            mean num(8) label="Mean",
    sd num(8) label="Standard Error",
        MCerr num(8) label="Model Error",
        lowCR num(8) label="CR lower limit",
        median num(8) label="Median",
        uppCR num(8) label="CR upper limit",
        start num(8) label="Starting run for estimator",
        sample num(8) label="Number of samples generated"
    );
quit;

proc append base=NZMHS.&modelfile.out data=results(drop=rep);
run;
PROC Print DATA=NZMHS.&modelfile.out;run;

PROC EXPORT DATA=NZMHS.&modelfile.out
    OUTFILE= "C:\users\jesse\My Documents\PHD\Chapter 5 treatment
seeking\Analyses\5_2 Onset of first service\HB &modelfile. &title..xls"
    DBMS=EXCEL5 LABEL REPLACE;
run;

%mend modelout;

/*****
Generate other text files of code for WinBugs *****/
/*****
%macro modelset(dep,set,cond,
    part,
        selector,
        logfile,
        modelfile,
        datafile1,
        datafile2,
        initsfile,
        batchfile);
****
** Print out data in column format;
****
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint
symbolgen mlogic;
title1 ' ';

filename fileout2 "&path.\WinBUGS14\&batchfile..txt";
data _null_;
    file fileout2;
    put@1 "display('log')"; /*log file*/
    put@1 "check('&dir.&modelfile..txt')"; /* model code */
    put@1 "data('&dir.&datafile1..txt')"; /* data code */
    put@1 "data('&dir.&datafile2..txt')"; /* constants code */
    put@1 "compile(3)"; /* compile model step */
    /*put@1 "inits(1,&dir.&initsfile..txt')"; set initial values */
    put@1 "gen.inits()"; /* generate initial values */
    put@1 "set(age_b0)";
    put@1 "set(beta_str)";
    put@1 "set(beta_3)";
    %if (&nco>0) %then %do;
    put@1 "set(cov_be)";%end;
    put@1 "set(dL0)";
    put@1 "set(eth_be)";
    %if (&part = 2) %then %do;
    put@1 "set(pre_sub0)";%end;
    put@1 "set(sex_b0)";
    put@1 "set(y_rep)";
    put@1 "update(&modruns.)";
    put@1 "coda(*, '&dir.&logfile._coda')";
    put@1 "stats(*)"; /* print statistical summary */
    put@1 "save('&dir.&logfile..txt')"; /* output */

```

```

    put@1 "quit()"; /* output */
run;
proc printto; run;
%mend modelset;

/*****
**      Cox regression model code      *****/
/*****/

%macro coxset;
FILENAME model "&path./WinBUGS14/nzmhs/&modelfile..txt";
data _null_;
    file model;
    put@1 "model";
    put@1 "{";
    put@1 "# Set up data";
    put@1 "    for(i in 1:N) {";
    put@1 "        for(j in 1:T) {";
    put@1 "            # risk set = 1 if obs.t >= t";
    put@1 "                Y[i,j] <- step(obst[i] - t[j] + eps)";
    put@1 "            # counting process jump = 1 if obs.t in [ t[j], t[j+1] )";
    put@1 "            #                i.e. if t[j] <= obs.t < t[j+1]";
    put@1 "                dN[i, j] <- Y[i, j] * step(t[j] + 1 -
obst[i] - eps) * fail[i]";
    put@1 "            }";
    put@1 "        }";
    put@1 "    # Model ";
    put@1 "        for(j in 1:T) {";
    put@1 "            for(i in 1:N) {";
    put@1 "                dN[i, j] ~ dpois(Idt[i, j])
# Likelihood";
    put@1 "                Idt[i, j] <- Y[i, j] * exp(eth_be[eth[i]] +
sex_be[sex[i]] + age_be[age[i]] );
    %if (&covar1. ne) %then %do; put@1 "                + cov_be*cov[i]";
%end;
    %if (&part >= 2) %then %do; put@1 "                + pre_co[slct[i]] ";
%end;
    put@1 "                + beta_psu[psu[i],ssu[i]]) * dL0[j] # Intensity
";
    put@1 "            } ";
    put@1 "            dL0[j] ~ dgamma(mu[j], c)";
    put@1 "            mu[j] <- dL0.star[j] * c # prior mean hazard";
    put@1 "            dL0.star[j] <- r * (t[j] + 1) - t[j]);";
    put@1 "        } ";
    put@1 "    } ";
%if (&nco. > 0) %then %do;
    put@1 "    # COVARIATES";
    put@1 "    for( cc in 1 : &nlevell) {";
    put@1 "        cov_b1[cc] ~ dnorm(covpre1[cc],tau_le1) ";
    put@1 "    }";
    put@1 "sigma.tau_le1~ dunif(0,10)";
    put@1 "tau_le1<-1/(sigma.tau_le1*sigma.tau_le1)";
%end;
    put@1 "    # AGE ";
    put@1 "    for( aa in 1 : 6) {";
    put@1 "        age_be <- muage0";
    put@1 "        muage0 ~ dnorm(0,tau_age)";
    put@1 "    }";
    put@1 "# PRIORS SEX";
    put@1 "    for( sx in 1 : 6) {";
    put@1 "        sex_be[sx] <- sex0";
    put@1 "        sex0 ~ dnorm(sexpre,tau_sex)";
    put@1 "    # LOCAL AREA SAMPLE UNIT";
    put@1 "    for( s in 1 : 2) {";
    put@1 "        for( j in 1 : 1260) {";
    put@1 "            beta_psu[j,s] <- beta_3 + beta_str*(s-1) ";
    put@1 "        }";
    put@1 "    }";
%if (&part = 2) %then %do;

```

```

put@1 "# PART II SELECTION ";
put@1 " pre_co[1] ~ dnorm(pre_sub0[1],tau_sub1) ";
put@1 " for( q in 2 : 6) {";
put@1 " pre_co[q] ~ dnorm(pre_sub0[2],tau_sub2) ";
put@1 " }";
put@1 " for( phh in 7 : 11) {";
put@1 " pre_co[phh] ~ dnorm(pre_sub0[3],tau_sub3) ";
put@1 " }";
%end;
put@1 " # HYPERPARAMETER for Cluster";
put@1 " beta_3 ~ dnorm(0,tau_3) ";
put@1 " # PACIFIC STRATA ";
put@1 " beta_str ~ dnorm(0.0,tau_str) ";
put@1 " c <- 0.1";
put@1 " r <- 0.1 ";
put@1 "# VARIANCE PRIORS";
put@1 "sigma.tau_0~ dunif(0,sigmax)";
put@1 "tau_0<-1/(sigma.tau_0*sigma.tau_0)";
put@1 "sigma.tau_eth~ dunif(0,sigmax_eth)";
put@1 "tau_eth <-1/(sigma.tau_eth*sigma.tau_eth)";
put@1 "sigma.tau_age~ dunif(0,sigmax_age)";
put@1 "tau_age <-1/(sigma.tau_age*sigma.tau_age)";
put@1 "sigma.tau_sex~ dunif(0,sigmax_sex)";
put@1 "tau_sex <-1/(sigma.tau_sex*sigma.tau_sex)";
put@1 "sigma.tau_str~ dunif(0,sigmax)";
put@1 "tau_str <-1/(sigma.tau_str *sigma.tau_str )";
put@1 "sigma.tau_pre~ dunif(0,sigmax)";
put@1 "tau_pre <-1/(sigma.tau_pre*sigma.tau_pre)";
put@1 "sigma.tau_sub1~ dunif(0,sigmax)";
put@1 "tau_sub1 <-1/(sigma.tau_sub1 *sigma.tau_sub1 )";
put@1 "sigma.tau_sub2~ dunif(0,sigmax)";
put@1 "tau_sub2 <-1/(sigma.tau_sub2 *sigma.tau_sub2 )";
put@1 "sigma.tau_sub3~ dunif(0,sigmax)";
put@1 "tau_sub3 <-1/(sigma.tau_sub3 *sigma.tau_sub3 )";
put@1 "sigma.tau_3~ dunif(0,sigmax)";
put@1 "tau_3<-1/(sigma.tau_3*sigma.tau_3)";
put@1 "}";
run;
%mend coxset;

/*****
/***** Data setup for COX REGRESSIONS *****/
/*****/
%macro bcoxsetup(dep=,cond=,tons=,tcen=,coxno=,s=,trt=);

data BAW0 %if (&tons = ts) or (&tons = tr) %then %do; (where = (&dep.LT=1
%if (&dep.=any) or (&dep.=anx) %then %do; and (partii ne 1) and (tons1 ne
.) %end; ))%end;;
set nzmhsdat.Baz00;
keep ivnum partII eth age6 gender tons1 &tcen. &dep.LT &dep._ond &covar1.
&trt. select hhld5 &tons._&s. r_any a_any age &dep._recd psu ssu
wgt_person5 strata clust_var idesign;
%if (&cond. = 3) %then %do;
%if &tons = as %then %do;
if (ar_&s = as_&s) and (as_&s < 99) and (&dep.LT = 1) then do;
tons1 = as_&s; tcen1 = 1; trt = 2;
end; else do;
tons1 = age; tcen1 = 0; trt = 0;
end;
%end; %else
%if &tons = ts %then %do;
if (tr_&s = ts_&s) and (ts_&s < 99) and (&dep.LT = 1) then do;
tons1 = ts_&s; tcen1 = 1; trt = 2;
end; else do;
tons1 = age-&dep._ond; tcen1 = 0; trt = 0;
end;
%end; %else
%if &tons = ar %then %do;

```

```

        if 0 =< ar_&s < 99 and (&dep.LT = 1) then do;
            tons1 = ar_&s; tcen1 = 1; trt = 1;
        end; else do;
            tons1 = age; tcen1 = 0; trt = 0;
        end;
    %end; %else %do;
        if 0 =< tr_&s < 99 and (&dep.LT = 1) then do;
            tons1 = tr_&s; tcen1 = 1; trt = 1;
        end; else do;
            tons1 = age-&dep._ond; tcen1 = 0; trt = 0;
        end;
    %end;
%end; %else %do;
    if &dep._ond > 0 and (&dep.LT = 1) then do;;
        tons1 = &dep._ond; tcen1 = 1;
    end; else do;
        tons1 = age; tcen1 = 0;
    end;
%end;
if hhld=6 then hhld5 = 5; else hhld5 = hhld;
idesign = age6 + 6*(gender-1);
run;
proc sort data = BAW0 out=BAW2;
by eth gender age6 select hhld5 psu ssu &covar1 tons1 tcen1;

options pagesize=32767 nodate nocenter nonumber formdlim=' ' mprint symbolgen
mlogic;
title1 ' ';
filename dataw2 "&path./WinBUGS14/nzmhs/dl&modcode..txt";
proc printto file=dataw2 new;
    run;

proc print data=BAW2 noobs label width=min style=data[cellwidth=8];
    label eth='eth[]' age6='age[]' gender='sex[]' psu = 'psu[]' ssu='ssu[]'
        %if (&dep.=any) or (&dep.=anx) %then %do; select='slct[]' %end;
        %if (&covar1=) %then %do; %end;%else %do; &covar1.='cov[]' %end;
        %if (&trt=) %then %do;%end;%else %do; &trt.='tx[]' %end;
        tons1="obst[]" tcen1="fail[]";
    var eth age6 gender psu ssu %if (&dep.=any) or (&dep.=anx) %then %do;
select %end;
        %if (&covar1=) %then %do; %end;%else %do; &covar1.%end; &trt. tons1
tcen1;
run;

proc printto; run;

data _null_ ;
    file dataw2 mod;
    put@1 "END";
    put @1 " ";
    run;
%mend bcoxsetup;

%macro MainModel(modcode,dep,nchain,nparm,nsim,pt,slct,nthin,
    var,dsout,
    title=Table 4.1 output Nov-2011
);
/*****
*****
***** As for prevalence models *****
*****
*****/
%mend MainModel;

```

Cox Regression Models with Competing Risks Code

```

/*****
/*
/*          COMPETING RISKS MODELS CODE          *
/*
/*****
/*****
/*****      CONTROL PROGRAMME TO SET UP DATA AND RUN MODEL      *****/
/*****

%global despri;
%let despri=mueth=c(.234,-
.118,.426,0),sexpre=.426,muage=c(.778,.852,.602,.426,.101,0),;
%global subpri;
%let subpri=pre_sub0=c(1.204,.426,0),;
%global covpri;
%let covpri=;
%global sigpri;
%let sigpri=sigmax=1,sigmax_eth=.5,sigmax_age=.5,sigmax_sex=.5;
%global desint;
%let
desint=be0=1,beta_str=1,beta_3=0,eth_be=c(0,0,0,0),sex_be=.5,age_be=c(1,1,1,
1,0,0);
%global subint;
%let subint=pre_co=c(1,.5,.5,.5,.5,.5,0,0,0,0,0),;
%global modruns; %let modruns=10000;/* number of model runs;*/

%global path; %let path=C:\Users\kokje41p\Documents;
%global runpath; %let runpath=C:\Users\kokje41p\Documents;
%global dir; %let dir=nzmhs/;%global input;%let
input=NZMHSdat.PHD_trh_curf_v6;
/*****
/*****      RUN HIERARCHICAL COX REGRESSION ANALYSES      *****/
/*****
*****          ANY MENTAL DISORDER ONLY          *****/

*** 001 - lifetime risk: any disorder, no covar, no service *****;
*****      AS FOR COX REGRESSION MODEL      *****/

*** CR02 - lifetime risk: any disorder, no covar, with trt *****/
%global nco;
%let nco=0;
%global neth;
%let neth=4;
%global yref;
%let yref=2256;
%mainmodel(modcode=CR02,dep=AnyLT,nchain=3,log=cox-CR02 summary,
pt=2,
nparm=16,
nsim=10000,
brn_no=5000,
nthin=1,
title=Table 5.5 output JUN2013);

** CR03 - lifetime risk: any disorder, no covar, CR02 + recovery **;
%global nco;
%let nco=0;
%global neth;
%let neth=4;
%global yref;
%let yref=3996;
%mainmodel(modcode=CR03,dep=AnyLT,nchain=3,log=cox-CR03 summary,
pt=2,
nparm=16,
nsim=10000,
brn_no=5000,

```

```

        nthin=1,
        title=Table 5.5 output JUN2013);
** CR04 - lifetime risk: any disorder, no covar with MH spec tx **;
%global nco;
    %let nco=0;
%global neth;
    %let neth=4;
%global yref;
    %let yref=1633;
%mainmodel(modcode=CR04,dep=AnyLT,nchain=3,log=cox-CR04 summary,
    pt=1,
        nparm=16,
        nsim=10000,
        brn_no=5000,
        nthin=1,
        title=Table 5.5 output JUN2013);

/*****
/*****  SETUP FOR WinBugs CODE FOR COMPETING RISK ANALYSES  *****/
/*****/
    %global despri;
    %let despri=mueth=c(.234,-
.118,.426,0),sexpre=.426,muage=c(.778,.852,.602,.426,.101,0),;
    %global subpri;
    %let subpri=pre_sub0=c(1.204,.426,0),;
    %global covpri;
    %let covpri=;
    %global sigpri;
    %let sigpri=sigmax=1,sigmax_eth=.5,sigmax_age=.5,sigmax_sex=.5;
    %global desint;
    %let
desint=be0=1,beta_str=1,beta_3=0,eth_be=c(0,0,0,0),sex_be=.5,age_be=c(1,1,1,
1,0,0);
    %global subint;
    %let subint=pre_co=c(1,.5,.5,.5,.5,.5,0,0,0,0,0),;
    %global modruns;    %let modruns=10000;/* number of model runs;*/

%global title; %let title= output JAN-2013;
%global path; %let path=C:\Users\kokje4lp\Documents;
%global runpath; %let runpath=C:\Users\kokje4lp\Documents;
%global dir; %let dir=nzmhs/;%global input;%let
input=NZMHSdat.PHD_trh_curf_v6;

/*****
*****          ANY MENTAL DISORDER ONLY          *****/
** CR01 = cD01 - lifetime risk: any disorder, no covar, no trt **;

*** CR02 - lifetime risk: any disorder, no covar, trt *****/
%global modcode;
    %let modcode=CR02;
%global nco;
    %let nco=0;
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=12992,T=93,eps = 1.0E-10,";
    PUT
"t=c(4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
, ";
    PUT
"30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,
";

```



```

        PUT
"55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,
";
        PUT "80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,98) ";
        PUT ") ";
RUN;
%macro multsurv2(covar1);
    %bcoxsetup(dep=any,cond=3,tons=as,tcen=tcen1,coxno=1,s=any,trt=);
    %modelout(dep=AnyLT,set=93,cond=3,
        part=2,
            selector=select,
            logfile=Cox-&modcode. AnyLT,
            modelfile=coxpt2,
            datafile1=d1&modcode.,
            datafile2=d2&modcode.,
            initsfile=inc&modcode.,
            batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv2;
%multsurv2(covar1=);

** CR03 - lifetime risk: any disorder, no covar, trt+recovery **;
%global modcode;
    %let modcode=CR03;
options pagesize=32767 nodate nocenter nonumber formdlm='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=12992,T=93,eps = 1.0E-10,";
    PUT
"t=c(4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
, ";
    PUT
"30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,
";
    PUT
"55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,
";
    PUT "80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,98) ";
    PUT ") ";
RUN;
%macro multsurv3(covar1);
    %bcoxsetup(dep=any,cond=3,tons=ar,tcen=tcen1,coxno=1,s=any,trt=);
    %modelout(dep=anyLT,set=93,cond=3,
        part=2,
            selector=select,
            logfile=Cox-&modcode. AnyLT,
            modelfile=coxpt2,
            datafile1=d1c&modcode.,
            datafile2=d2c&modcode.,
            initsfile=inc&modcode.,
            batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv3;
%multsurv3(covar1=);

** CR04 - lifetime risk: any disorder, no covar plus MH spec tx **;
%global modcode;
    %let modcode=CR04;
options pagesize=32767 nodate nocenter nonumber formdlm='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=12992,T=93,eps = 1.0E-10,";

```

```

        PUT
        "t=c(4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
        , ";
        PUT
        "30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,
        ";
        PUT
        "55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,
        ";
        PUT "80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,98) ";
        PUT ") ";
RUN;
%macro multsurv4(covar1);
    %bcoxsetup(dep=any,cond=3,tons=as,tcen=tcen1,coxno=1,s=mh,trt=);
    %modelout(dep=substLT,set=75,cond=3,
        part=2,
        selector=select,
        logfile=Cox-&modcode.anyLT,
        modelfile=coxpt2,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv4;
%multsurv4(covar1=);
*** CR11 - time to treatment: any disorder, no covar plus tx *****;
%global modcode;
    %let modcode=CR11;
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=4907,T=79,eps = 1.0E-10,";
    PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
    PUT
    "21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
    PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,
    ";
    PUT "64,65,66,67,68,69,70,71,72,73,74,75,77,79,82,83), ";
    PUT ") ";
RUN;
%macro multsurv11(covar1);
    %bcoxsetup(dep=any,cond=3,tons=ts,tcen=tcen1,coxno=1,s=any,trt=);
    %modelout(dep=AnyLT,set=79,cond=3,
        part=2,
        selector=select,
        logfile=Cox-&modcode.AnyLT,
        modelfile=coxpt2,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv11;
%multsurv11(covar1=);

/** CR12 - time to treatment: any disorder, no covar plus tx+r */
%global modcode;
    %let modcode=CR12;
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";

```

```

        PUT "list(N=4907,T=79,eps = 1.0E-10,";
        PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
        PUT
"21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
        PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,
";
        PUT "64,65,66,67,68,69,70,71,72,73,74,75,77,79,82,83), ";
        PUT ") ";
RUN;
%macro multsurv12(covar1);
    %bcoxsetup(dep=any,cond=3,tons=tr,tcen=tcen1,coxno=1,s=any,trt=);
    %modelout(dep=AnyLT,set=79,cond=3,
        part=2,
        selector=select,
        logfile=Cox-&modcode. AnyLT,
        modelfile=coxpt2,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv12;
%multsurv12(covar1=);

/** CR13 - time to treatment: any disorder, no covar plus MH tx **/
    %global modcode;
    %let modcode=CR13;
options pagesize=32767 nodate nocenter nonumber formdlim='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=4907,T=59,eps = 1.0E-10,";
    PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
    PUT
"21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
    PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,58,63,65), ";
    PUT ") ";
RUN;
%macro multsurv13(covar1);
    %bcoxsetup(dep=any,cond=3,tons=ts,tcen=tcen1,coxno=1,s=mh,trt=);
    %modelout(dep=AnyLT,set=79,cond=3,
        part=2,
        selector=select,
        logfile=Cox-&modcode. AnyLT,
        modelfile=coxpt2,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv13;
%multsurv13(covar1=);

*** CR20 - lifetime risk: any disorder, NZBorn, no service *****;
%global modcode;
%let modcode=CR20;
%global nco;
%let nco=1;
options pagesize=32767 nodate nocenter nonumber formdlim='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=12992,T=93,eps = 1.0E-10,pre_sub0=c(1.204,.426,0), ";

```

```

        PUT
        "t=c(4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
        , ";
        PUT
        "30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,
        ";
        PUT
        "55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,
        ";
        PUT "80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,98) ";
        PUT ") ";
RUN;
%macro multsurv20(covar1);
    %bcoxsetup(dep=any,cond=2,tons=tons1,tcen=tcen1,coxno=1,s=,trt=);
    %modelout(dep=AnyLT,set=93,cond=2,
        part=2,
        selector=select,
        logfile=Cox-&modcode. AnyLT,
        modelfile=coxpt2co,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv20;
%multsurv1(covar1=nzborn);

*** CR21 - time to treatment: any disorder, NZBorn plus tx *****;
%global modcode;
    %let modcode=CR21;
options pagesize=32767 nodate nocenter nonumber formdlm='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
    FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
    PUT "list(N=3752,T=79,eps = 1.0E-10,pre_sub0=c(1.204,.426,0),";
    PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
    PUT
    "21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
    PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,
    ";
    PUT "64,65,66,67,68,69,70,71,72,73,74,75,77,79,82,83), ";
    PUT ") ";
RUN;
%macro multsurv21(covar1);
    %bcoxset2(dep=any,cond=3,tons=ts,tcen=tcen1,coxno=1,s=any,trt=);
    %modelout(dep=AnyLT,set=79,cond=3,
        part=2,
        selector=select hhld,
        logfile=Cox-&modcode. AnyLT,
        modelfile=coxpt2co,
        datafile1=d1c&modcode.,
        datafile2=d2c&modcode.,
        initsfile=inc&modcode.,
        batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv21;
%multsurv21(covar1=nzborn);

/**** CR22 - time to treatment: any disorder, NZBorn plus tx+r *****/
%global modcode;
    %let modcode=CR22;
options pagesize=32767 nodate nocenter nonumber formdlm='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;

```

```

FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
PUT "list(N=3752,T=79,eps = 1.0E-10,pre_sub0=c(1.204,.426,0),";
PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
PUT
"21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,
";
PUT "64,65,66,67,68,69,70,71,72,73,74,75,77,79,82,83), ";
PUT ") ";
RUN;
%macro multsurv22(covar1);
  %bcoxset2(dep=any,cond=3,tons=tr,tcen=tcen1,coxno=1,s=any,trt=);
  %modelout(dep=AnyLT,set=79,cond=3,
    part=2,
    selector=select hhld,
    logfile=Cox-&modcode. AnyLT,
    modelfile=coxpt2co,
    datafile1=d1c&modcode.,
    datafile2=d2c&modcode.,
    initsfile=inc&modcode.,
    batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv22;
%multsurv22(covar1=NZBORN);

/**** CR23 - time to treatment: any disorder, NZBorn plus MH tx *****/
  %global modcode;
  %let modcode=CR23;
options pagesize=32767 nodate nocenter nonumber formdlm='' mprint symbolgen
mlogic;
title1 ' ';
filename data2 "&path./WinBUGS14/nzmhs/d2&modcode..txt";
proc printto; run;
DATA _NULL_;
  FILE "&path./WinBUGS14/nzmhs/d2&modcode..txt";
  PUT "list(N=3752,T=59,eps = 1.0E-10,pre_sub0=c(1.204,.426,0),";
  PUT "t=c(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20, ";
  PUT
"21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42, ";
  PUT "43,44,45,46,47,48,49,50,51,52,53,54,55,56,58,63,65), ";
  PUT ") ";
RUN;
%macro multsurv23(covar1);
  %bcoxset2(dep=any,cond=3,tons=ts,tcen=tcen1,coxno=1,s=mh,trt=);
  %modelout(dep=AnyLT,set=79,cond=3,
    part=2,
    selector=select hhld,
    logfile=Cox-&modcode. AnyLT,
    modelfile=coxpt2co,
    datafile1=d1c&modcode.,
    datafile2=d2c&modcode.,
    initsfile=inc&modcode.,
    batchfile=TEc&modcode.,modeltype=cox);
%mend multsurv23;
%multsurv23(covar1=NZBORN);

/*****
** bcoxset, modeout, modelset MainModel as for COX REGRESSIONS ****
*****/

/*****
***** Data setup for COX REGRESSIONS *****
*****/
%macro bcoxset2(dep=,cond=,tons=,tcen=,coxno=,s=,trt=);

data BAW0 %if (&tons = ts) or (&tons = tr) %then %do; (where = (&dep.LT=1
  %if (&dep.=any) or (&dep.=anx) %then %do; and (partii ne 1) and (tons1 ne
.) %end; ))%end;;
set nzmhsdat.Baz00;

```

```

keep ivnum partII eth age6 gender tons1 &tcen. &dep.LT &dep._ond &covar1.
&trt. select hhld5 &tons._s. r_any a_any age &dep._recd psu ssu
wgt_person5 strata clust_var idesign;
%if &covar1=NZBORN %then %do; where eth ne 4;;%end;
%if (&cond. = 3) %then %do;
%if &tons = as %then %do;
if (ar_&s = as_&s) and (as_&s < 99) and (&dep.LT = 1) then do;
tons1 = as_&s; tcen1 = 1; trt = 2;
end; else do;
tons1 = age; tcen1 = 0; trt = 0;
end;
%end; %else
%if &tons = ts %then %do;
if (tr_&s = ts_&s) and (ts_&s < 99) and (&dep.LT = 1) then do;
tons1 = ts_&s; tcen1 = 1; trt = 2;
end; else do;
tons1 = age-&dep._ond; tcen1 = 0; trt = 0;
end;
%end; %else
%if &tons = ar %then %do;
if 0 =< ar_&s < 99 and (&dep.LT = 1) then do;
tons1 = ar_&s; tcen1 = 1; trt = 1;
end; else do;
tons1 = age; tcen1 = 0; trt = 0;
end;
%end; %else %do;
if 0 =< tr_&s < 99 and (&dep.LT = 1) then do;
tons1 = tr_&s; tcen1 = 1; trt = 1;
end; else do;
tons1 = age-&dep._ond; tcen1 = 0; trt = 0;
end;
%end;
%end; %else %do;
if &dep._ond > 0 and (&dep.LT = 1) then do;;
tons1 = &dep._ond; tcen1 = 1;
end; else do;
tons1 = age; tcen1 = 0;
end;
%end;
if hhld=6 then hhld5 = 5; else hhld5 = hhld;
idesign = age6 + 6*(gender-1);
run;
proc sort data = BAW0 out=BAW2;
by eth gender age6 select hhld5 psu ssu &covar1 tons1 tcen1;

options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';
filename dataw2 "&path./WinBUGS14/nzmhs/dl&modcode..txt";
proc printto file=dataw2 new;
run;

proc print data=BAW2 noobs label width=min style=data[cellwidth=8];
label eth='eth[]' age6='age[]' gender='sex[]' /*wgt_person5='wgt[]'*/
psu = 'psu[]' ssu='ssu[]' %if (&dep.=any) or (&dep.=anx) %then
%do; select='slct[]' %end;
%if (&covar1=) %then %do; %end;%else %do; &covar1.='cov[]' %end;
%if (&trt=) %then %do;%end;%else %do; &trt.='tx[]' %end;
tons1="obst[]" tcen1="fail[]";
var eth age6 gender psu ssu /*wgt_person5*/ %if (&dep.=any) or
(&dep.=anx) %then %do; select %end;
%if (&covar1=) %then %do; %end;%else %do; &covar1.%end; &trt. tons1
tcen1;
run;

proc printto; run;

data _null_ ;

```

```

file dataw2 mod;
put@1 "END";
put @1 " ";
run;
%mend bcoxset2;

```

Aggregate MHINC data with non-response category model

```

*****;
***** WinBugs Model MHINC data regression model *****;
***** for age-sex adjustment Person Years analysis *****;
***** with aggregate data *****;
*****;
/*****
/*      Ethnicity, dep, and sex      *
/*      eta = observed + lambda*missing      *
/*      lambda ~ dbeta + f(delta:random component)      *
/*      pi ~ dbeta(eta, N-eta)      *
/*****
%macro TFLEBayset(N_cat,
    subcat,
        nmds=1,
        input=pac.client_data, /*input data*/
        title=Macro output,
        dir=NZMHS\,
        datafile1=data1,
        datafile2=data2,
        initsfile=ini,
        modelfile=model05,
        logfile=log,
        batchfile=batch,
        dsout=WBoutSAS
    );
data ppp01;
    set pacdat.popdat3;
    if ethnicity = "CIS" then eth = 1;else
    if ethnicity = "NCP" then eth = 2;else
    if ethnicity = "NPM" then eth = 3;else
    if ethnicity = "OTH" then eth = 4;
    agp = age;
run;
data FTS01;
    set &input.;
    DEPQ=substr(nzdep5,1,1)*1;
    yrQ=substr(year,4,1)*1;
    agp = agecode;
run;
proc sql;
    create table ppp02 as select
        agp as age,
        gendQ-1 as sex,
        eth,
        sum(pop) as Np
    from ppp01
        where YrQ = 6
        and eth ne .
        group by 1,2,3 ;
    create table ppp03 as select
        agp as age,
        gender1-1 as sex,
        ethgrp as eth,
        count(master_encrypted_hcu_id) as Dobs
    from FTS01
        where DepQ ne .
        group by 1,2,3;
quit;
data ppp03;

```

```

set ppp03;
if eth=. then eth=0;
run;
proc sort data = ppp03;
    by yr age sex eth;
run;
proc sort data = ppp02;
    by yr age sex eth;
run;
data BaZ10;
    do a=1 to 12;
        do s=0 to 1;
            do e=0 to 4;
                age = a;
                sex = s;
                eth = e;
                output;
            end;
        end;
    end;
run;
proc sort data = BaZ10;
    by yr age sex eth;
run;
data BA10;
    merge BaZ10 (in = x1)
          ppp02
          ppp03;
    by age sex eth;
    if x1;
    keep age sex eth Dobs Nyr;
    if Dobs = . then Dobs = 0;
    if NP = . then Nyr = 1;
    if NP<1 then Nyr=1; else
        if NP<Dobs then Nyr = Dobs+1; else
            Nyr = NP;
run;
*****;
** Print out data in column format;
*****;
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';

filename &datafile1. "&runpath./WinBUGS14/nzmhs/&datafile1..txt";
proc printto file=&datafile1. new;
    run;
proc print data=BA10 noobs label;
    label age='age[]' sex='sx[]' eth='eth[]' Dobs='D[]' Nyr='eta0[]'
        ;
    var age sex eth Dobs Nyr;
run;
proc printto; run;
data _null_ ;
    file &datafile1. mod;
    put@1 "END";
    put @1 " ";
run;
*****;
** run model in winbugs and output freq,          ;
** unadjusted and adjusted predicted marginals ;
*****;

*****;
** Write batch file;
*****;

```



```

options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint
symbolgen mlogic;
title1 ' ';

filename fileout2 "&runpath./WinBUGS14/&batchfile..txt";
data _null_;
  file fileout2;
  put@1 "display('log')"; /*log file*/
  put@1 "check('&dir.&modelfile..txt')"; /* model code */
  put@1 "data('&dir.&datafile1..txt')"; /* data code */
  * put@1 "data('&dir.&datafile2..txt')"; /* constants code */
  put@1 "compile(3)"; /* compile model step */
  put@1 "inits(1,'&dir.&initsfile.a.txt')"; /* set initial values */
  put@1 "inits(2,'&dir.&initsfile.b.txt')"; /* set initial values */
  put@1 "inits(3,'&dir.&initsfile.c.txt')"; /* set initial values */
  put@1 "gen.inits()"; /* generate initial values */
  put@1 "update(5000)";
  put@1 "set(eta)";
  put@1 "update(&runs.)";
  put@1 "save('&dir.&logfile..txt')"; /* output */
  put@1 "quit()"; /* output */
;
run;
proc printto; run;

%Logstc_HB_model125(&nmds.,&N_cat.);
%model125_ini();
*****;
** Execute the WinBUGS run in batch mode ;
*****;
DATA _NULL_; /*create a .bat file to run WinBUGS*/
  FILE "&runpath./WinBUGS14/&batchfile..bat";
  PUT "C:\users\Jesse\My Documents\WinBUGS14\WinBUGS14.exe" ' ' /PAR
  &batchfile..txt";
  PUT 'exit';
RUN;

options xmin noxwait;
  DATA _NULL_;Run WinBUGS in SAS X windows
  X CALL "C:\users\Jesse\My Documents\WinBUGS14/&batchfile..bat";
  RUN;
*****;
** Read in log file of batch run which includes ;
** stats for Gibbs Sampler ;
** Calculate new priors for the mean parameters ;
** mu[1] and mu[2]. Using tau=1/variance ;
*****;

data _null_;
  retain i j 0;
  infile "C:\users\Jesse\My Documents\WinBUGS14/&dir&logfile..txt"
expandtabs trunccover;
  length text $200;
  input text $ 1-200;
  if scan(text,1)="node" then i=_n_;
  call symput("i",i+1);
  if upcase(scan(text,1))="SAVE" then j=_n_;
  call symput("j",j-1);
  run;

data results;
  infile "C:\users\Jesse\My Documents\WinBUGS14/&dir&logfile..txt"
firstobs=&i obs=&j expandtabs trunccover;
  length param $20;
  input param $ mean sd MCerr lowCR median uppCR start sample;
  rep=5;
  run;
*****;

```

```

** Write stats to SAS dataset;
*****;
proc sql;
  create table pac.&dsout. (label="WINBUGS: &title.")
  (
    param char(20) label="Node or parameter",
    mean num(8) label="Mean",
    sd num(8) label="Standard Error",
    MCerr num(8) label="Model Error",
    lowCR num(8) label="CR lower limit",
    median num(8) label="Median",
    uppCR num(8) label="CR upper limit",
    start num(8) label="Starting run for estimator",
    sample num(8) label="Number of samples generated"
  );
quit;

proc append base=pac.&dsout. data=results(drop=rep);
run;

PROC EXPORT DATA= pac.&dsout.
  OUTFILE= "C:\Users\Jesse\My Documents\PHD\Chapter 9 Use of Mental
Health Services\Analyses\8_1 first service\output\&title._log.xls"
  DBMS=EXCEL2000 REPLACE;
RUN;

%mend TFLEBayset;

*****;
***** WinBugs Model MHINC data regression model *****;
***** for age-sex adjustment Person Years analysis *****;
***** with aggregate data *****;
*****;
/*****
/* Ethnicity, age and sex *
/* eta = observed + lambda*missing *
/* lambda ~ dbeta + f(delta:random component) *
/* pi ~ dbeta(eta, N-eta) *
*****/
%macro TFU3Bayset(N_cat,
  subcat,
  nmms=1,
  input=pac.client_data, /*input data*/
  title=Macro output,
  dir=NZMHS\,
  datafile1=data1,
  datafile2=data2,
  initsfile=ini,
  modelfile=model05,
  logfile=log,
  batchfile=batch,
  dsout=WBoutSAS
);
data ppp01;
  set pacdat.popdat3;
  if ethnicity = "CIS" then eth = 1;else
  if ethnicity = "NCP" then eth = 2;else
  if ethnicity = "NPM" then eth = 3;else
  if ethnicity = "OTH" then eth = 4;
  agp = put(age,redag.)*1;
run;
data FTS01;
  set &input.;
  DEPQ=substr(nzdep5,1,1)*1;
  yrQ=substr(year,4,1)*1;
  agp = put(agecode,redag.)*1;
run;
proc sql;

```

```

create table ppp02 as select
    DepQ as nzdep5,
    agp as age,
    gendQ-1 as sex,
    eth,
    sum(pop) as Np
from ppp01
    where YrQ < 9
    and eth ne .
    group by 1,2,3,4 ;
create table ppp03 as select
    DepQ as nzdep5,
    agp as age,
    gender1-1 as sex,
    ethgrp as eth,
    count(master_encrypted_hcu_id) as Dobs
from FTS01
    where DepQ ne .
    %if &subcat ne %then %do; and &subcat. = "1" %end;
    group by 1,2,3,4;
quit;
data ppp03;
set ppp03;
if eth=. then eth=0;
run;
proc sort data = ppp03;
    by age sex nzdep5 eth;
run;
proc sort data = ppp02;
    by age sex nzdep5 eth;
run;
data BaZ10;
    do d=1 to 5;
        do a=1 to 6;
            do s=0 to 1;
                do e=0 to 4;
                    nzdep5 = d;
                    age = a;
                    sex = s;
                    eth = e;
                    output;
                end;
            end;
        end;
    end;
run;
proc sort data = BaZ10;
    by nzdep5 age sex eth;
run;
data ppp03;
set ppp03;
if eth=. then eth=0;
run;
proc sort data = ppp03;
    by nzdep5 age sex eth;
run;
proc sort data = ppp02;
    by nzdep5 age sex eth;
run;

data BA10;
    merge BaZ10 (in = x1)
        ppp02
        ppp03;
    by nzdep5 age sex eth;
    if x1;
    keep nzdep5 age sex eth Dobs Nyr;
    if Dobs = . then Dobs = 0;

```

```

        if NP = . then Nyr = 1;
        if NP<1 then Nyr=1; else
            if NP<Dobs then Nyr = Dobs+1; else
                Nyr = NP;
run;
*****;
** Print out data in column format;
*****;
options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint symbolgen
mlogic;
title1 ' ';

filename &datafile1. "&runpath./WinBUGS14/nzmhs/&datafile1..txt";
proc printto file=&datafile1. new;
    run;
proc print data=BA10 noobs label;
    label nzdep5='dep[]' age='age[]' sex='sx[]' eth='eth[]' Dobs='D[]'
    Nyr='eta0[]'
    ;
    var nzdep5 age sex eth Dobs Nyr;
run;
proc printto; run;
data _null_ ;
    file &datafile1. mod;
    put@1 "END";
    put @1 " ";
    run;
*****;
** run model in winbugs and output freq,          ;
** unadjusted and adjusted predicted marginals ;
*****;

*****;
** Write batch file;
*****;

options pagesize=32767 nodate nocenter nonumber formdlm=' ' mprint
symbolgen mlogic;
title1 ' ';

filename fileout2 "&runpath./WinBUGS14/&batchfile..txt";
data _null_;
    file fileout2;
    put@1 "display('log')"; /*log file*/
    put@1 "check('&dir.&modelfile..txt')"; /* model code */
    put@1 "data('&dir.&datafile1..txt')"; /* data code */
    * put@1 "data('&dir.&datafile2..txt')"; /* constants code */
    put@1 "compile(3)"; /* compile model step */
    put@1 "inits(1,'&dir.&initsfile.a.txt')"; /* set initial values */
    put@1 "inits(2,'&dir.&initsfile.b.txt')"; /* set initial values */
    put@1 "inits(3,'&dir.&initsfile.c.txt')"; /* set initial values */
    put@1 "gen.inits()"; /* generate initial values */
    * put@1 "update(1000)";
    put@1 "set(pi)";
    put@1 "set(eta)";
    put@1 "set(beta_dep)";
    put@1 "set(beta_eth)";
    put@1 "set(beta_age)";
    put@1 "set(beta_sex)";
    put@1 "set(eta_rep)";
    put@1 "update(&runs.)";
    put@1 "coda(*, '&dir.&logfile._pi_coda')";
    put@1 "stats(*)"; /* print statistical summary */
    put@1 "save('&dir.&logfile..txt')"; /* output */
    put@1 "quit()"; /* output */
    ;
run;
proc printto; run;

```

```

%Logstc HB_model100(&nmds., &N_cat.);
%model15_ini();
*****;
** Execute the WinBUGS run in batch mode          ;
*****;
DATA _NULL_; /*create a .bat file to run WinBUGS*/
    FILE "&runpath./WinBUGS14/&batchfile..bat";
    PUT "C:\users\Jesse\My Documents\WinBUGS14\WinBUGS14.exe" ' ' "/PAR
    &batchfile..txt";
    PUT 'exit';
RUN;
%mend TFU3Bayset;
/*****
/*          Ethnicity, age and sex                      *
/*          eta = observed + lambda*missing              *
/*          lambda ~ dbeta + f(delta:random component)   *
/*          pi ~ dbeta(eta, N-eta)                      *
*****/
/*****
/*          Ethnicity, age and sex                      *
/*          eta = observed + lambda*missing              *
/*          lambda ~ dbeta + f(delta:random component)   *
/*          pi ~ dbeta(eta, N-eta)                      *
*****/
%macro CFU3Bayset(N_cat,
    subcat,
                nmds=1,
    input=pac.client_data, /*input data*/
    title=Macro output,
    dir=NZMHS\,
    datafile1=data1,
    datafile2=data2,
    initsfile=ini,
    modelfile=model105,
    logfile=log,
    batchfile=batch,
    dsout=WBoutSAS
);
PROC IMPORT OUT= pp21
    DATAFILE= "H:\PHD\Chapter 9 Use of Mental Health Services\Analyses\8_1
first service\output\Eta zero.xls"
    DBMS=EXCEL2000 REPLACE;
    RANGE="model03";
    GETNAMES=YES;
run;
proc Sql;
    create table pp23 (label="DepAgeSexEthIndex")
    (
        i char(1) label="ethnic group",
        j char(3) label="covariate",
        mean num label="eta"
    );
quit;
proc append Base = pp23 data = pp21;
data pp10;
    do d=1 to 5;
        do a=1 to 6;
            do s=0 to 1;
                do e=1 to 4;
                    nzdep5 = d;
                    age = a;
                    sex = s;
                    eth = e;
                    output;
                end;
            end;
        end;
    end;
end;

```

```

        end;
run;
data ppp02;
    set pp10;
    set pp23 (rename=(mean=NP));
run;
data FTS01;
    set &input.;
    DEPQ=substr(nzdep5,1,1)*1;
    yrQ=substr(year,4,1)*1;
    agp = put(agecode,redag.)*1;
run;
proc sql;
    create table ppp03 as select
        DepQ as nzdep5,
        agp as age,
        gender1-1 as sex,
        ethgrp as eth,
        count(master_encrypted_hcu_id) as Dobs
    from FTS01
        where DepQ ne .
    %if &subcat ne %then %do; and &subcat. = "1" %end;
    group by 1,2,3,4;
quit;
data ppp03;
set ppp03;
if eth=. then eth=0;
run;
proc sort data = ppp03;
    by age sex nzdep5 eth;
run;
proc sort data = ppp02;
    by age sex nzdep5 eth;
run;
data BaZ10;
    do d=1 to 5;
        do a=1 to 6;
            do s=0 to 1;
                do e=0 to 4;
                    nzdep5 = d;
                    age = a;
                    sex = s;
                    eth = e;
                    output;
                end;
            end;
        end;
    end;
run;
proc sort data = BaZ10;
    by nzdep5 age sex eth;
run;
data ppp03;
set ppp03;
if eth=. then eth=0;
run;
proc sort data = ppp03;
    by nzdep5 age sex eth;
run;
proc sort data = ppp02;
    by nzdep5 age sex eth;
run;

data BA10;
    merge BaZ10 (in = x1)
        ppp02
        ppp03;
    by nzdep5 age sex eth;

```

```

        if x1;
        keep nzdep5 age sex eth Dobs Nyr;
        if Dobs = . then Dobs = 0;
        if NP = . then Nyr = 1;
        if NP<1 then Nyr=1; else
            if NP<Dobs then Nyr = Dobs+1; else
                Nyr = NP;
run;
*****;
** Print out data in column format;
*****;
options pagesize=32767 nodate nocenter nonumber formdlim=' ' mprint symbolgen
mlogic;
title1 ' ';

filename &datafile1. "&runpath./WinBUGS14/nzmhs/&datafile1..txt";
proc printto file=&datafile1. new;
    run;
proc print data=BA10 noobs label;
    label nzdep5='dep[]' age='age[]' sex='sx[]' eth='eth[]' Dobs='D[]'
    Nyr='eta0[]'
    ;
    var nzdep5 age sex eth Dobs Nyr;
run;
proc printto; run;
data _null_ ;
    file &datafile1. mod;
    put@1 "END";
    put @1 " ";
run;
*****;
** run model in winbugs and output freq,          ;
** unadjusted and adjusted predicted marginals ;
*****;

*****;
** Write batch file;
*****;

options pagesize=32767 nodate nocenter nonumber formdlim=' ' mprint
symbolgen mlogic;
title1 ' ';

filename fileout2 "&runpath./WinBUGS14/&batchfile..txt";
data _null_;
    file fileout2;
    put@1 "display('log')"; /*log file*/
    put@1 "check('&dir.&modelfile..txt')"; /* model code */
    put@1 "data('&dir.&datafile1..txt')"; /* data code */
    * put@1 "data('&dir.&datafile2..txt')"; /* constants code */
    put@1 "compile(3)"; /* compile model step */
    put@1 "inits(1,'&dir.&initsfile.a.txt')"; /* set initial values */
    put@1 "inits(2,'&dir.&initsfile.b.txt')"; /* set initial values */
    put@1 "inits(3,'&dir.&initsfile.c.txt')"; /* set initial values */
    put@1 "gen.inits()"; /* generate initial values */
    * put@1 "update(1000)";
    put@1 "set(pi)";
    put@1 "set(eta)";
    put@1 "set(beta_dep)";
    put@1 "set(beta_eth)";
    put@1 "set(beta_age)";
    put@1 "set(beta_sex)";
    put@1 "set(eta_rep)";
    put@1 "update(&runs.)";
    put@1 "coda(*, '&dir.&logfile. pi coda')";
    put@1 "stats(*)"; /* print statistical summary */
    put@1 "save('&dir.&logfile..txt')"; /* output */
    put@1 "quit()"; /* output */

```

```

;
run;
proc printto; run;

%Logstc_HB_model100(&nmds., &N_cat.);
%model15_ini();
*****;
** Execute the WinBUGS run in batch mode ;
*****;
DATA _NULL_; /*create a .bat file to run WinBUGS*/
FILE "&runpath./WinBUGS14/&batchfile..bat";
PUT "C:\users\Jesse\My Documents\WinBUGS14\WinBUGS14.exe" ' "/PAR
&batchfile..txt";
PUT 'exit';

RUN;
%mend CFU3Bayset;
/*****
**
** Poison model with conjugate priors
**
*****/
%macro Logstc_HB_model105(nmds, nlevel);
FILENAME model "&runpath./WinBUGS14/nzmhs/&modelfile..txt";
data _null_;
file model;
put@1 "model";
put@1 "{";
put@1 "
for (i in 1 : &nlevel.){";
put@1 "
D_mis[i] <- D[5*(i-1)+1]+1";
put@1 "
D_obs[i] <- sum(D[5*(i-1)+2:5*(i-1)+5]);";
put@1 "
for (j in 1 : 4) {";
put@1 "
eta[i,j] <- D_mis[i]*D[5*(i-1)+j+1]/D_obs[i];";
put@1 "
eta[i,j] ~ dpois(mu[i,j]);";
put@1 "
log(mu[i,j]) <- log(eta0[5*(i-1)+j+1])
";
put@1 "
+ beta_yr[yr[5*(i-1)+j+1]] + ";
put@1 "
beta_age[eth[5*(i-1)+j+1], age[5*(i-1)+j+1]]
";
put@1 "
+ beta_sex * sx[5*(i-1)+j+1] +
beta_eth[eth[5*(i-1)+j+1]] ";
put@1 "
%if &nmds = 1 %then %do; put@1 "
+ beta_dep[eth[5*(i-1)+j+1], dep[5*(i-1)+j+1]] "; %end;
put@1 "
pi[i,j] <- mu[i,j]/eta0[5*(i-1)+j+1]
";
put@1 "
}";
put@1 "
}";
put@1 "
for (j in 1 : 4) {";
put@1 "
for (i in 1 : &nlevel.){";
put@1 "
eta_tmp1[i,j] ~ dpois(mu[i,j]);";
put@1 "
}";
put@1 "
eta_tmp2[j] <- sum(eta_tmp1[,j]);";
put@1 "
}";
put@1 "
eta_rep <- sum(eta_tmp2[]);";
put@1 "
for( n in 1 : 8) {";
put@1 "
beta_yr[n] ~ dnorm(0.0,1.0E-1)";
put@1 "
arr_yr[n] <- exp(beta_yr[n])/exp(beta_yr[1]);";
put@1 "
}";
put@1 "
for (e in 1 : 4) {";
put@1 "
beta_eth[e] ~ dnorm(0.0,1.0E-1)";
put@1 "
betha[e] <- beta_eth[e] + sum(beta_age[e,]);";
put@1 "
%if &nmds = 1 %then %do; put@1 "
+ sum(beta_dep[e,])
"; %end;
put@1 "
arr_eth[e] <- exp(betha[e])/exp(betha[1]);";
put@1 "
for( n in 1 : 6) {";
put@1 "
beta_age[e,n] ~ dnorm(0.0,1.0E-1)";
put@1 "
arr_age[e,n] <-
exp(beta_age[e,n])/exp(beta_age[e,1]);";
put@1 "
}";
put@1 "
%if &nmds = 1 %then %do;
put@1 "
for( n in 1 : 5) {";
put@1 "
beta_dep[e,n] ~ dnorm(0.0,1.0E-1)";
put@1 "
arr_dep[e,n] <-
exp(beta_dep[e,n])/exp(beta_dep[e,1]);";

```


[illegible]

```

                                5,4,3,2,1,0), .Dim = c(4,6)),      ";
PUT "beta_sex =0,              ";
PUT "beta_eth = c(0.5,0.5,2,1) ";
PUT ")                          ";
RUN;
%mend model04_ini;

%macro MainModel(modcd,nchain,nparm,nsim,nthin,
                var,
                title=Table 4.1 output Nov-2011
                );

%do j=1 %to &nchain.;
%coda2sas(out=pac.Mod&modcd._coda&j.,chain=C:\Users\kokje41p\Documents\WinBU
GS14\NZMHS\log&modcd._pi_coda&j..txt,codaind=C:\Users\kokje41p\Documents\Win
BUGS14\NZMHS\log&modcd._pi_codaindex.txt);
%end;
*****
*****          OUTPUT CALCULATED AS FOR OTHER CHAPTERS          *****
*****
%mend MainModel;

```