Selected psychosocial variables associated with eating a heart healthy diet in a sample of 50 year old Cantabrians: a pilot study

by

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Preamble to Thesis

The Canterbury Health Ageing and Lifecourse (CHALICE) study is a multidisciplinary longitudinal study of fifty year olds living in the Canterbury District Health Board (CHDB) area. Study planning started in 2009 and participant recruitment and data collection commenced in August 2010. Baseline recruitment and data collection are planned to continue over a period of five years. Data collection involves self-completed questionnaires, a face to face interview of 4-6 hours duration, lifestyle diaries and diagnostic tests. CHALICE focuses on well-being, healthy eating, healthy hearts, healthy brains and healthy ageing. Longitudinal follow up of participants is planned for every five years and also a brief annual postal, email or phone questionnaire.

This pilot study uses CHALICE data from the first 81 participants interviewed, of which 63 returned a completed food diary. This study focuses on healthy eating and the psychosocial variables that may influence eating patterns.

As part of this thesis the candidate:

- trained study interviewers on how to educate study participants to complete an accurate estimated food and beverage diary.
- developed an interactive resource for study interviewers to use when educating study participants about the food and beverage diary.
- observed several full study participant interviews (all seven modules).
- administered module 7 (the food and nutrition section) of the study to selected study participants.
- checked all returned food diaries and provided study interviewers with specific questions to ask the study participants to gain additional detail.
- participated in weekly CHALICE study meetings and was involved in refinement of study implementation, interviews, feedback letters to participants and development of additional questionnaires.

- assisted with designing and constructing the database that houses the CHALICE raw data (Progeny 7) and was involved in problem solving data entry and data retrieval issues.
- entered all of the raw data relevant to this thesis into the study database and nutrient analysis programme.

It was planned that this MSc project would focus on results of the first 100 CHALICE participants. However, participant recruitment was affected by the two recent Canterbury/Christchurch earthquakes. The first earthquake occurred two weeks after recruitment had started and delayed interviewing for two weeks. The second earthquake occurred towards the end of data collection for this thesis, affecting food diary return rates. As a result the sample size of the pilot study was less than originally planned, but the candidate has undertaken additional exploratory analyses on the data collected.

Abstract

Background: Cardiovascular disease (CVD) is the main cause of death of New Zealanders after cancer and the prevalence increases dramatically with increasing age. Consumption of a heart healthy diet may improve modifiable CVD risk factors. For the purpose of this research a heart healthy diet is defined as a diet in which total fat contributes less than 35 % of total energy (% TE), saturated fat contributes less than 10 % TE, dietary fibre intake is greater than 25 g per day, fruit intake is more than two servings per day and vegetable intake is more than 3 servings per day. Some international and New Zealand research has assessed the association between selected psychosocial factors and dietary intake, but limited research has assessed the association between multiple psychosocial factors and the consumption of heart healthy dietary patterns in 50 year old men and women. This is a pilot study, the aim of which is to develop and investigate hypotheses which may be tested with a larger sample.

Hypotheses:

1. That the dietary intake of 50 year old men and women from Canterbury does not meet heart healthy dietary guidelines

2. That positive attitudes and beliefs around a link between food intake and risk of disease are associated with consumption of a heart healthier diet

3. That higher barriers to eating healthily are associated with consumption of a less heart healthy diet

4. That greater education, household income and standard of living (measured using the Economic Living Standard Index Short Form ($ELSI_{SF}$))are associated with a heart healthier diet

5. That a greater knowledge of food composition (sugar, fat, salt and fibre content) is associated with a heart healthier diet

Methods: This is an observational study of a random sample of 50 year olds currently living in the Canterbury District Health Board area. The data is that of the first 63 CHALICE study participants of which 30 were male and 33 female. Quantitative data were collected questionnaires examining demographics, measures of standard of living, health beliefs, attitudes and barriers to healthy eating administered during a face-to-face interview, a 4 day estimated food and beverage diary and anthropometric measurements. Hyothesis for this thesis were based around the health belief model (HBM), cognitive behavioural therapy (CBT) and social cognitive theory (SCT). Data were analysed using multiple regression and principal component analysis.

Findings: Fifty year old men and women in Canterbury do not eat a heart healthy diet, defined as a moderate fat, low saturated fat, high fibre, fruit and vegetable diet. Participants' knowledge of the national food and nutrition guidelines and basic knowledge of the sugar, fat, fibre and salt content of common foods is poor. Ninety percent of participants believed that heart attacks, high blood pressure and type 2 diabetes mellitus are totally or sometimes preventable. Standard of living was inversely associated with consumption of total fat as a % TE. Education was inversely associated with consumption of saturated fat as a % TE and positively associated with dietary fibre intake and knowledge of food composition was positively associated with vegetable intake. Principal component analysis revealed that there was an association between consumption of a "higher CVD risk" dietary pattern in people with a "comfortable" or "good/very good" standard of living who had poor knowledge of food composition and a lower level of education; only the level of education was associated with consumption of a "CVD protective" dietary pattern. The association was strongest for those with a "comfortable" standard of living.

Conclusion: The results indicate that this sample of Canterbury 50 year olds do not consume a heart healthy diet that could assist to reduce their risk of developing CVD.

Psychosocial variables appear to be associated with dietary intake. More educated participants who enjoy a higher standard of living consume healthier diets than less educated participants and an increased knowledge of food composition is associated with a lower score for the "higher CVD risk" dietary pattern – lower in saturated fat and higher in fruit, vegetables and dietary fibre. These results suggest that it is important to develop public health interventions to make cheaper healthier food available to everyone and show the public how to incorporate these foods into meals. Nutritionists and dietitians can also assist with increasing people's basic nutrition knowledge which in turn may help reduce the incidence of CVD.

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Winsome Parnell, it is always good to have a fresh set of eyes look over your work, especially those of someone who is so experienced in the field of New Zealanders' dietary intakes.

This project was not possible without the CHALICE research team led by Professor Peter Joyce. Special thanks must go to the study interviewers Janet Spittlehouse, Anna Thorpe, Esther Vierck and Julia Martin for interviewing the study participants and following up on vague or incomplete food diaries and questionnaires. Also their support and companionship throughout the year made working on the CHALICE project a joy.

Last, but not least, my office colleagues from the VIDARIS study who have been a welcome break from my studies and made the office a productive working environment which has helped me to finish my thesis in a timely manner.

Table of contents

List of Figures

List of Tables

List of Abbreviations

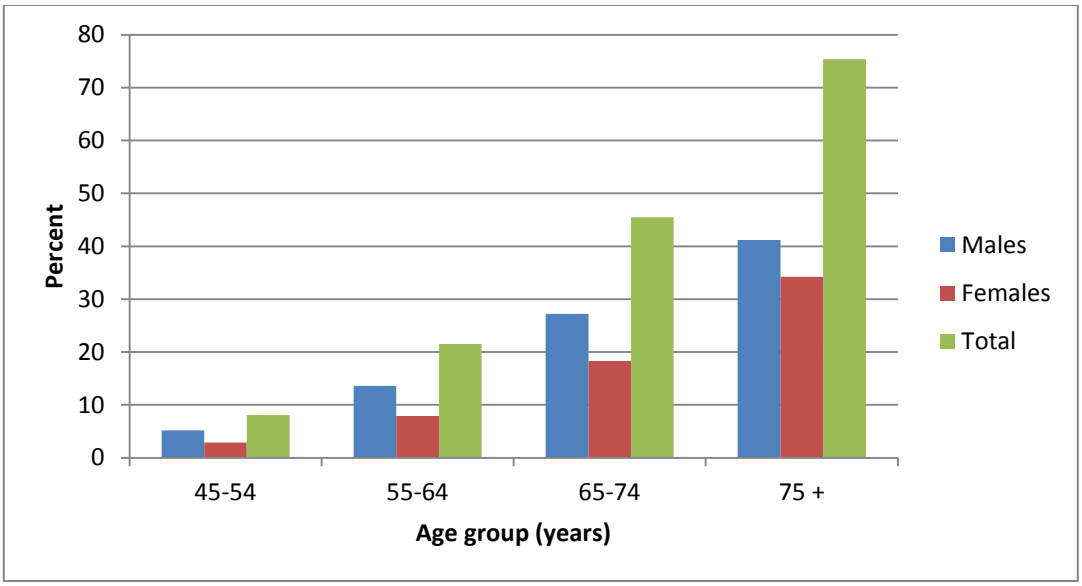
BMI	body mass index
CHALICE	Canterbury health, aging and life-course
CBT	cognitive behavioural theory
CDHB	Canterbury District Health Board
CHD	coronary heart disease
chol	cholesterol
CVD	cardiovascular disease
DASH	Dietary Approaches to Stop Hypertension
ECG	echocardiogram
$ELSI_{SF}$	economic living standards index short form
EU	European Union
HBM	health belief model
HDL	high density lipoprotein
HHD	heart healthy diet
IHD	ischaemic heart disease
LDL	low density lipoprotein
MI	myocardial infarction
NNS	National Nutrition Survey
NZ	New Zealand
PCA	principal component analysis
PUFA	polyunsaturated fatty acid
SAFA	saturated fatty acid
SCT	social cognitive theory
SES	socio-economic status
RCT	Randomised controlled trial
RR	relative risk
Type 2 DM	Type 2 diabetes mellitus
US	United States
WHO	World Health Organisation
95% CI	95% confidence interval
% TE	percentage of total energy

1.0 Introduction

A heart healthy diet and psychosocial correlates.

Cardiovascular disease (CVD), including ischaemic heart disease (IHD) and cerebrovascular disease, is the main cause of death of New Zealanders after cancer (Ministry of Health, 2010b). It is also the main cause of death in many other developed countries; in 2006 CVD accounted for 36% of all Australian deaths (Australian Institute of Health and Welfare, 2009) and 35% of all deaths in the United Kingdom (Allender, Peto, Scarborough, Kaur, & Rayner, 2008). The New Zealand Health Survey (Ministry of Health, 2007) shows that the prevalence of CVD (including IHD and cerebrovascular disease) increases dramatically with increasing age. As can be seen in Figure 1.0.1 approximately 8% of 45-55 year olds had been diagnosed with CVD compared with almost 22% of 55-65 year olds.

Figure 1.0.1: Diagnosed CVD for adults, by age group and gender (unadjusted prevalence)



Note: Adapted from 2006/07 New Zealand Health Survey

In NZ deaths attributable to CVD (excluding cerebrovascular disease) have been as high as 700 per 100,000 for 45-65 year olds in 1970, but in 2000 mortality rates had decreased to 200 per 100,000. Age-standardised mortality rates for cerebrovascular disease have also decreased significantly over the last 30 years (Hay, 2004). Decreasing rates of CVD are likely to be due to a number of factors including decreasing rates of smoking (Beaglehole, Dobson, Hobbs, Jackson, & Martin, 1989), decreasing population cholesterol concentrations due to dietary changes and the use of pharmaceuticals (for example, statins), (Beaglehole, et al., 1989) and other medical advances (Beaglehole, 1986; Neutze & White, 1987).

The risk of developing CVD is associated with a variety of non-modifiable and modifiable factors. Non-modifiable risk factors include family history of CVD, increasing age and male gender. Modifiable risk factors for developing CVD include smoking, high blood pressure, high blood cholesterol, overweight, poor glycaemic control (diabetes mellitus) and physical inactivity (World Health Organisation, 2003). Although a healthy diet and the associated nutrients are not listed as risk factors by the World Health Organisation, they are known to influence many of these modifiable risk factors (World Health Organisation, 2003).

A heart healthy diet is an internationally well-established eating pattern that includes the consumption of particular foods that have been shown to affect markers of CVD, risk factors for CVD and/or CVD outcomes (Graham et al., 2007; Lichtenstein, 2006; National Heart Foundation of Australia; National Heart Foundation of New Zealand). A heart healthy diet typically includes high intakes of fruit, vegetables, whole grain foods, fish and seafood, lean meat and poultry, low fat dairy products, nuts and seeds and low consumption of high sodium products.

Diet also plays an important role in the prevention and management of overweight and obesity. The proportions of overweight and obese people in NZ and the Western world continue to increase, as does the incidence of Type 2 diabetes mellitus (Ministry of Health, 2004, 2007; Russell, Parnell, & Wilson, 1999). During the last 30 years New Zealanders have reduced the amount of fat as a percentage of total energy intake they consume but

their total energy intake has significantly increased and they are consuming more energy from energy dense low nutrition foods such as carbonated drinks, chocolate and other confectionary (Russell, et al., 1999). The heart healthy diet can modify a number of other CVD risk factors. The heart healthy diet has been shown to reduce total and LDL cholesterol concentrations (Liu et al., 1999; Skeaff et al., 2005), improves hypertension (Sacks et al., 2001), promotes weight control, delays onset of type 2 diabetes mellitus and improves glycaemic control (Diabetes Prevention Programme Research Group, 2002).

Previous public health campaigns have targeted non-nutrition related modifiable risk factors (for example Smoke free workplaces, quit smoking support programmes and media campaigns, and Green Prescription). The quit smoking campaigns (in addition to other anti-smoking initiatives) have been associated with reducing rates of cigarette smoking, although it has taken a generation to change consumer perceptions and has required environmental intervention as well. It is likely that diet related public health campaigns would also take time to change consumer perceptions and behaviours. The reducing incidence of cigarette smoking and dietary changes are likely to affect health outcomes into the future.

Aspects of the heart healthy diet have been used in public health campaigns to increase New Zealanders' awareness of the role of nutrition in reducing CVD risk factors (for example the *5 + a day* fruit and vegetable campaign (5+ A Day Charitable Trust). The Tick programme, managed by the Heart Foundation NZ, is designed to encourage food manufacturers to produce foods lower in sodium. The aim of the programme is to help reduce New Zealanders sodium intake from processed foods. Reducing sodium intake is associated with a reduction in blood pressure; hypertension is a CVD risk factor (Todd et al., 2010).

Historically the NZ diet is not a heart healthy diet (Arroll, Beaglehole, Jackson, & Scragg, 1991; Paulin, McNab, Simpson, Gillies, & Spears, 1988) despite public health messages reinforcing the benefits of such a diet. Some aspects of the NZ diet are improving; total fat and saturated fat consumption have decreased since 1977 (Russell, et al., 1999) but fruit and vegetable intake and fibre consumption are still below the recommended intakes for

prevention of chronic disease (New Zealand Guidelines Group, 2009; Russell, et al., 1999). There is also evidence that a proportion of New Zealanders want to adopt healthier dietary habits including eating more fruit and vegetables and eating less food overall (Russell, et al., 1999). The reasons behind consumption of an unhealthy diet have been investigated internationally but not thoroughly in NZ (AlQuaiz & Tayel, 2009; Beydoun & Wang, 2008; Koikkalainen, Lappalainen, & Mykkanen, 1996; Russell, et al., 1999; Welch, McNaughton, Hunter, Hume, & Crawford, 2008). Common reasons for not choosing healthy foods include: lack of time, the high price of food, lack of willpower, regularly eating out and taste perceptions. There is also some evidence that self-perception as a 'healthy eater' (Noureddine & Stein, 2009; Sudo et al., 2009) and a strong belief in the link between diet and disease preventability (Patterson, Kristal, Lynch, & White, 1995) are associated with consumption of a more healthy diet. However, it should not be assumed that people who believe that they are 'healthy eaters' always consume a healthy diet. One large European study (Kearney & McElhone, 1999) assessed barriers to eating healthy food in addition to how participants viewed their diet. This study revealed that 70% of the combined European Union sample of 14,331 believed that they already ate a healthy diet and did not believe that they needed to make dietary changes. This view varied geographically, 47% of the Finnish sample agreed with this statement compared with 87% of Italians. This view may be associated with the traditional diet of their countries and how closely it matches a protective heart healthy dietary profile. Perceived barriers to eating healthy foods also varied geographically within the European Union (Kearney & McElhone, 1999).

NZ research in this area (Ashfield-Watt, 2006; Russell, et al., 1999) often focuses on difficulties associated with consuming more fruit and vegetables or lower fat foods, and/or people's perception of these foods. Recent NZ research by Mainvil et al has resulted in the production of questionnaires to measure fruit and vegetable consumption and factors associated with these (Mainvil, Lawson, Horwath, McKenzie, & Hart, 2010) but there is no NZ research available that investigates the possible psychological or social reasons (other than socio-economic status and ethnicity) for not eating a heart healthy diet. Therefore, it is important to investigate the relationship between psychosocial factors and consumption of a heart healthy diet in New Zealanders in order to identify possible areas for intervention.

The Canterbury Health, Ageing and Lifestyle Course study (CHALICE) is a longitudinal study of wellbeing, healthy eating, healthy hearts, healthy brains and healthy ageing of 50 year olds in the Canterbury District Health Board region. CHALICE assesses a range of factors that impact on health, wellbeing, ageing and the development of diseases such as CVD, hypertension, diabetes, dementia, infections, bowel cancer and depression. Factors assessed include diet, lifestyle, attitudes, personality, social factors and genetics. The dietary assessment includes completion of a four day food and beverage diary and a household food inventory, as well as assessment of perceived barriers to healthy eating, healthy and unhealthy habits, knowledge of food composition and food beliefs. The 50 year old study group is a unique cohort chosen primarily because at age 50 men and women are more likely to take an interest in their future health as they, and their peers, start being diagnosed with health conditions including hypertension, hypercholesterolemia, overweight and heart problems. Also, the NZ population is ageing which is associated with an increased incidence of chronic diseases; learning more about how a population ages and their attitudes towards this process will aid future planning of resources.

The aim of the wider CHALICE study is to investigate the determinants of physical and mental wellbeing and the protective factors that guard against the development of disease.

The aim of this thesis is to investigate associations between attitudes and beliefs about disease, perceived barriers and facilitators to healthy eating and how dietary intake compares with a heart healthy diet.

These will be investigated using the HBM, CBT and SCT as a framework. The HBM has previously been used to explain disease prevention behaviours (Janz & Becker, 1984). The HBM model is composed of three sections: individual perceptions, modifying factors and likelihood of action which are split into seven elements: perceived susceptibility to disease, perceived seriousness of disease, demographic variables, psycho-social variable, cues to action, perceived benefits of preventative action and perceived barriers to preventative action (Janz & Becker, 1984). Ideas around attitudes and beliefs about health and preventative health behaviours fit well around the HBM, due to its broad categories. SCT and CBT are often used in research into complex health behaviours such as eating habits.

2.0 Literature Review

What is a heart healthy diet, what is the evidence that supports the consumption of a heart healthy diet for CVD risk reduction and have New Zealanders traditionally consumed a heart healthy diet?

2.1 Components of a heart healthy dietary pattern

A heart healthy diet is an eating pattern that includes the regular consumption of particular foods that have been shown to reduce risk factors and markers for CVD and/or CVD outcomes. It is also an eating pattern that restricts the consumption of some foods that have been shown to detrimentally affect markers of and risk factors for CVD. The body of literature around the heart healthy diet is enormous and it is outside the scope of this thesis to review it all. Therefore, the focus of this section of the literature review is on the main macronutrients and foods that are included in international heart healthy dietary guidelines: dietary fat, saturated fat, fruit and vegetables and dietary fibre.

2.1.1 Dietary fat

Dietary fat was the first nutrient to be linked with CVD. The link between dietary fat consumption and CVD was first discussed and researched in the early 1950s by Ancel Keys (Keys, 1952). Keys hypothesised that serum cholesterol played an important role in the development of atherosclerosis, and that dietary cholesterol intake did not have a significant influence on serum cholesterol levels, but that dietary fat probably influenced serum cholesterol levels.

Since the 1950s, research has focused on emulating diets of countries that have traditionally low rates of CVD and investigating how dietary fat intake affects the development of CVD. The following sections briefly discuss how different types of fats affect CVD risk factors for, and incidence of, CVD.

2.1.1.1 Total fat

In 1952 (Keys, 1952) Ancel Keys concluded that dietary fat intake played a role in the development of CVD and it was recommended that total fat should contribute not more than 25-30% of total energy. Further work by Keys et al. in the Seven Countries Study (Keys et al., 1986) (summarised in Table 2.1) documented dietary intake between the years 1961-1965 and again between the years 1975-1977. Dietary intake was assessed by weighed seven day food records. At this time dietary fat consumption varied considerably throughout the world, as did the incidence of CVD. The percent energy from total fat of participants in each of the cohorts varied from 9.0% to 38.0% and was not strongly correlated with incidence or death rate from CHD. This was one of the first studies to show that total fat intake did not appear to influence CHD outcomes but that the type of fat consumed was more important. By the 1980s there was substantial evidence that total fat was not as important as first thought. Although NZ national recommendations (Truswell, 1987) still encouraged a reduction in total fat, this was to discourage overconsumption of energy rather than to reduce CVD risk.

A recent meta-analysis of eight prospective cohort studies from North America and Europe published between 1991 and 2006 found there to be no association between CHD mortality or CHD events and total fat intake (Skeaff & Miller, 2009). When lower total fat diets (23-30% TE) were compared with higher total fat diets (38-47% TE) the relative risk of death from CHD was 0.94 (95% CI: [0.74, 1.18], $p = 0.583$) and relative risk of a CHD event was 0.93 (95% CI: [0.84, 1.03], $p = 0.177$).

Table 2.1: Studies of dietary fat and CVD or CHD

Study name	Number of participants	Study design	Conclusions	Candidate's rationale for inclusion of study in literature review
Seven Countries Study (Keys, et al., 1986).	15 cohorts from 7 countries, total 11,579 males aged 40-59 years. Seven countries: US, Finland, Netherlands, Italy, Yugoslavia, Greece, Japan.	Multi-centre longitudinal cohort study, started in 1959. 5, 10 and 15 year follow-up of death rates.	Age, blood pressure, serum cholesterol and smoking explained 80% of variance in death rate from CHD. % TE from saturated fat positively associated with CHD death rate.	One of the first epidemiological studies to link dietary fat with CVD.
Finnish Mental Hospital Study (Miettinen, Turpeine, Elosuo, Paavilai, & Karvonen, 1972).	Approximately 1,000 men and 1,500 women median age 50 years, from two mental hospitals near Helsinki, Finland.	Dietary intervention ran from 1959-1965 in one hospital and then from 1965-1971 in the second hospital. Total follow-up 12 years.	In men a low SAFA high PUFA diet was significantly associated with lower CHD mortality. In women CHD mortality was lower but not significantly.	One of the first intervention studies to substitute PUFA for SAFA and examine effect on mortality from CHD.

Oslo Diet-Heart Study (Leren, 1970).	412 men aged 30-64 years from Oslo, Norway.	Recruitment from 1956-1958. 11 year follow-up of deaths from all causes.	Significantly lower MI mortality in low SAFA (8.5% TE), high PUFA (20.7% TE) diet group. Lower total chol in diet group.	One of the first secondary prevention intervention studies to show positive effect of a low SAFA diet on CVD outcomes.
DASH (Dietary approaches to stop hypertension) trial (Obarzanek et al., 2001).	436 men and women from US mean age 44.6years, 60% African American.	Randomised controlled feeding trial of 8 weeks on either control diet, high fruit and vegetable diet or DASH diet.	DASH diet resulted in reduction in LDL and HDL chol but no change in total to HDL chol ratio.	One of the first RCTs to show that a heart healthy, low sodium diet effectively reduces blood pressure and also positively affects chol concentrations.

US, United States; CHD, coronary heart disease; CVD, cardiovascular disease; SAFA, saturated fatty acids; PUFA, polyunsaturated fatty acids; MI, myocardial infarction; LDL, low-density lipoprotein; HDL, high-density lipoprotein; RCTs, randomised controlled trials.

As a result of the weak link between total fat intake and CHD risk, most current international population based guidelines recommend restricting total fat intake, but not to very low levels (Lichtenstein, 2006; Ministry of Health, 2003; NHMRC, 2006; World Health Organisation, 2003). As mentioned previously, restricted fat recommendations were primarily designed to encourage weight control rather than reduce CVD risk. The World Health Organisation (WHO) and the American Heart Association recommend a total fat intake of less than 35% of total energy (Lichtenstein, 2006; World Health Organisation, 2003). Most guidelines focus on practical population guidelines that will result in beneficial reductions of total fat. For example, the NZ guidelines (Ministry of Health, 2003) state "Eat well by including a variety of nutritious foods from each of the four major food groups each day"; "include lean meat, poultry, seafood, eggs or alternatives"; "prepare foods or choose pre-prepared foods, drinks and snacks with minimal added fat, especially saturated fat".

2.1.1.2 Saturated fat

Saturated fats are fatty acids which are linked together by single carbon bonds. The main sources of saturated fat in the diet are animal fats, coconut oil and palm kernel oil. There are many types of saturated fats and foods often contain a combination of fats with a dominant fatty acid. For example, butter fat is comprised of butyric acid (C4:0), caproic acid (C6:0) and myristic acid (C14:0) whereas cocoa butter in chocolate is mainly stearic acid (C18:0) (Mahan & Escott-Stump, 2000). Some fatty acids (eg myristic acid) influence CVD risk more than others (eg stearic acid) (Mann & Truswell, 2002), however this literature review will not discuss the physiological actions of individual saturated fatty acids.

It is generally accepted that a high intake of saturated fat is associated with raised low-density lipoprotein (LDL) cholesterol and that high concentrations of LDL cholesterol are associated with a higher risk of CVD (Mann & Truswell, 2002). The Seven Countries Study (Keys, et al., 1986) showed that while total fat intake was not associated with increased CHD rates, the percentage energy from saturated fat (2.9-23.7% TE) was positively correlated with death from CHD after 5, 10 and 15 years of follow up.

If a reduction of saturated fat intake can reduce the primary incidence of CHD, could dietary change after a CVD event reduce the risk of another CVD event? The Oslo Diet-Heart Study (Leren, 1970) was one of the first studies to examine this possibility (summarised in Table 2.1). The study compared a low saturated fat (8.5% TE from saturated fat and 20.7% TE from polyunsaturated fat) diet, with a regular saturated and polyunsaturated fat diet (control group diet composition not published). After five years in the trial those in the low saturated fat diet group had lower total cholesterol concentrations. After 11 years of follow up mortality from myocardial infarction was significantly reduced in the low saturated fat group (32 deaths versus 57 deaths, $p = 0.004$), but total CHD mortality was not significantly less ($p = 0.097$).

A primary prevention intervention trial (DASH) (summarised in Table 2.1) compared a low saturated fat (7.0% TE), moderate polyunsaturated fat (8% TE), high fibre diet, with a control diet (14% TE from saturated fat) and a high fibre diet (13% TE from saturated fat) (Obarzanek, et al., 2001). The trial was an eight week randomised controlled feeding trial. The DASH trial confirmed earlier results that a low saturated fat diet (7.0% TE) resulted in reduced total cholesterol concentrations. Additionally, the low saturated fat diet also reduced LDL cholesterol and HDL cholesterol (more-so in those with high HDL cholesterol at base-line) in both African-American and non-African American men and women. High total and LDL cholesterol are risk factors for CVD; the results supported following a low saturated fat diet to reduce risk of CVD.

Intervention studies have suggested that diets with less than 10% TE from saturated fat are linked with a reduction in CVD risk and/or incidence of CHD. However a 2010 meta-analysis (Siri-Tarino, Sun, Hu, & Krauss, 2010a) suggested that saturated fat intake is not associated with an increased risk of CVD. The meta-analysis included 24 prospective epidemiological studies from North America, Europe, Israel and Japan. The studies followed up a total of 347, 747 subjects for 5-23 years and compared fatal and total CHD and fatal and total stroke with dietary intake. The mean percentage energy from saturated fat in the meta-analysis studies was greater than 10% TE, and in many cases the lowest quintile of saturated fat intake was also greater than 10% TE. Most of the dietary

intervention research that has shown a link between saturated fat intake and CVD has used a low saturated fat diet in which saturated fat contributes less than 10% TE.

Research is now focused on which nutrients/foods have the most favourable effect on CVD risk when substituted for saturated fat in the diet. Intervention studies have either replaced saturated fat energy with refined carbohydrate foods, high fibre carbohydrate foods or alternative fats. The replacement of saturated fat energy with refined carbohydrate energy has been shown to have an unfavorable result on lipid profiles: triglycerides increase, LDL particles become smaller and denser, and HDL cholesterol decreases (Siri-Tarino, Sun, Hu, & Krauss, 2010b). Conversely, the DASH trial (Obarzanek, et al., 2001) replaced saturated fat energy with high fibre carbohydrate foods including fruit, vegetables, legumes and wholegrain foods. This resulted in significantly reduced total, LDL and HDL cholesterol concentrations. Triglyceride levels did not significantly change and, despite HDL levels decreasing, the total cholesterol to HDL cholesterol ratio did not change significantly.

Replacement of saturated fat in the diet with polyunsaturated fat has also had a beneficial effect on cholesterol profiles, risk of coronary events and death. A recent pooled analysis of 11 cohort studies (Jakobsen et al., 2009) from America, Europe and Israel that were conducted between 1963 to 1993 found that if saturated fat energy was replaced with energy from polyunsaturated fat the risk of coronary events and coronary deaths was significantly reduced, whereas replacing saturated fat with monounsaturated fat did not result in a lower risk of CHD.

Results from The Finnish Mental Hospital (Miettinen, et al., 1972) Study intervention study supports the results of longitudinal cohort studies (summarised in Table 2.1). This study used a cholesterol lowering diet that was exactly the same as the control diet in all aspects, apart from the polyunsaturated to saturated fatty acid ratio. A high polyunsaturated to saturated fatty acid ratio was achieved by substituting standard cow's milk with a soybean oil/skim milk emulsion and using a high polyunsaturated fat margarine in place of butter or the standard low polyunsaturated margarine. The polyunsaturated to saturated fat ratio of the control diet was 0.22-0.29 compared with 1.42-1.78 in the intervention diet. The substitution of polyunsaturated fat for saturated fat resulted in lower total cholesterol

(although cholesterol fractions were not reported), lower total mortality and lower mortality from CHD in men. Mortality from CHD in women was also lower but not significantly different from the control group. The authors attributed this to the transfer of chronically ill female patients (for reasons not related to the intervention study and who may have been at increased risk of death) out of the hospital during one of the follow up periods.

International guidelines recommend restricting saturated fat intake. The WHO and the American Heart Association (AHA) specify that saturated fat intake should comprise less than 7-10% of total energy (Lichtenstein, 2006; World Health Organisation, 2003). The Australian and NZ nutrient reference values recommend that saturated fat should contribute less than 10% TE to the diet to reduce the risk of CVD and obesity (NHMRC, 2006). The NZ food and nutrition guidelines (Ministry of Health, 2003) provide food based recommendations that encourage the consumption of foods that are lower in saturated fat, for example: "Prepare foods or choose pre-prepared foods, drinks and snacks with minimal added fat, especially saturated fat".

2.1.1.3 Dietary fat consumption in New Zealand

Historically, New Zealanders have consumed a diet high in fat, particularly saturated fat. This was probably due to a food supply including beef and sheep meat and dairy products such as full fat milk and butter. Therefore dietary fat intake was mainly from animal sources: meat, dairy products and animal fats such as lard and dripping (Birkbeck, 1979). By the 1990's sources of fat intake had increased. In 1997 dietary fat intake was comprised of a variety of sources from butter and margarine, fried foods, meat, dairy products and processed foods (Russell, et al., 1999).

In the 1970s Birkbeck et al conducted the first national nutrition survey. Three hundred and thirty-four people from across NZ and of various age groups were selected. Dietary intake was assessed by 24 hour recall. Results of this survey showed dietary fat intake contributed approximately 40% TE and saturated fat contributed approximately 18% TE to the diets of 50-59 year olds (Birkbeck, 1979). The 1970s New Zealand dietary guidelines focused on encouraging New Zealanders to reduce their intake of animal based (saturated)

fats (The Royal Society of New Zealand, 1971). The Royal Society of NZ recommended that all New Zealanders should reduce intake of dietary fat towards 30% TE and that people with high cholesterol levels should limit cholesterol intake, reduce intake of saturated fat and substitute polyunsaturated fats, rather than carbohydrates, for saturated fat in the diet.

While dietary guidelines have not changed substantially since the 1970s, many New Zealanders are still not meeting them. The second NNS was conducted in 1989 as part of the Life in New Zealand survey (Howarth, Parnell, & Birkbeck, 1991). They surveyed 1702 people from across NZ using a 24 hour dietary recall. Total fat intake of 45-64 year olds was lower than that of 50-59 year olds in 1979; 37% TE versus 40% TE, respectively. Saturated fat contribution to total energy intake had decreased from 18% TE in the 1970s to 15% TE in 1989.

The next National Nutrition Survey (NNS) was conducted in 1997 using similar methods to the 1989 survey (Russell, et al., 1999). It showed that total fat intake of 45-64 year olds had decreased further to 35% TE and that saturated fat intake had also reduced over the last 20 years from 18% TE to 15% TE.

Table 2.2 summarises the results of NZ national samples and smaller NZ samples where dietary intake of middle aged New Zealanders was assessed. Dietary fat intake of New Zealanders is slowly coming into line with dietary guidelines; fat is contributing less to total energy intake and energy from saturated fat has also been decreasing.

In summary:

- Changing the percentage total energy from fat does not seem to alter CVD risk factors as much as other dietary components
- Reducing saturated fat intake to approximately 10% TE reduces LDL cholesterol levels.
- Replacement of saturated fat energy with refined carbohydrate energy increases triglycerides, small LDL particles and lowers HDL cholesterol. Replacement of saturated fat energy with high fibre carbohydrates lowers total, LDL and HDL cholesterol but does not increase triglyceride levels.

Table 2.2: Results of New Zealand research that has assessed the composition of older adults' diets

Study	Method of dietary analysis	Total surveyed	Year of survey	Age	Total fat (% of total energy)	Saturated fat (% of total energy)	Candidate's rationale for inclusion of study of literature review
1997 NZ NNS (Russell, et al., 1999)	24hr recall and FFQ	1255 (88% NZ European)	1997	45-64yrs	35%	15%	National survey with large sample size
Employed Europeans (Metcalf, Scragg, Tukuitonga, & Dryson, 1998)	FFQ	4451 (100% NZ European)	1988-1990	40-64yrs	37%	15%	NZ survey of dietary intake with large sample size
Life in New Zealand Survey (Howarth, et al., 1991)	24hr recall	1702 (93% NZ European)	1989	46-64yrs	37%	15%*	National survey with large sample size
Auckland Study (Arroll, et al., 1991)	7 day food record (validation study)	113 (ethnicity not reported)	1988	50-66yrs	32%	16%	Study of dietary intake of older adults living in an urban area
Timaru study (Paulin, et al., 1988)	7 day recall	181 (99.6% NZ European)	1985	50-54yrs	38%	18%	South Canterbury study of 50 year olds dietary intake in the 1980s

1977 NZ NNS (Birkbeck, 1979)	24hr recall	334 (88% NZ European)	1977	50-59yrs	40%	18%	First national survey of dietary intake

NZ, New Zealand; NNS, national nutrition survey; FFQ, food frequency questionnaire.

Note: Percentage of total energy calculated from saturated fat intake (g/day) and total energy intake (kJ/day).

2.1.2 Fruit and vegetables

Since the early 1990s New Zealanders have been encouraged to consume *5+ a day* serves of fruit and vegetables to prevent chronic disease (Ashfield-Watt, 2006). This recommendation is based on results of a 1990 WHO report that recommended intakes of more than 400g per day of fruit and vegetables as this level of intake has been shown to reduce incidence of CVD (WHO Study Group, 1991). Since this time various bioactive compounds (flavonoids, phytoestrogens, phenolics, lycopene, vitamin C, folate, beta-carotene) in fruit and vegetables have been investigated showing that some may be responsible for this decreased risk (Kris-Etherton et al., 2002). Research has also assessed the strength of the association between fruit and vegetable consumption and CVD risk factors and outcomes. This fruit and vegetable section of the literature review will focus mainly on the evidence for total fruit and vegetable consumption impacting on CVD risk factors and outcomes.

One of the characteristics of a heart healthy diet is high intakes of fruit and vegetables, typically 5 or more servings per day. The Seven Countries Study is one of the first epidemiological studies to link traditional dietary patterns with incidence of CHD. There were large differences in the dietary composition of the study cohorts; average fruit intake varied from 1.0g per day in Yugoslavia to 464g per day in Greece; average vegetable intake varied from 104g per day in Finland to 260g per day in Rome, Italy (Kromhout et al., 1989). Analysis of CHD mortality 25 years after enrolment into the study (Menotti et al., 1999) found that consumption of vegetables (excluding potatoes) was inversely related to death from CHD (linear correlation coefficient: -0.228, 95% CI: [-0.646, 0.309]) but fruit consumption was not (0.118, 95% CI: [-0.404, 0.577]). When all vegetables were combined in one group the inverse relationship with CHD death was stronger (-0.519, 95% CI: [-0.801, 0.014]). The region with the highest mortality rate from CHD (268 deaths per 1000 in East Finland), had one of the lowest fruit and vegetable (excluding potatoes) intakes (148g per day), whereas Crete in Greece had a high fruit and vegetable intake (653g per day) and the lowest CHD death rate: 25 per 1000 (Kromhout, et al., 1989; Menotti, et al., 1999).

Since the 1990s approximately 15 prospective cohort studies have assessed the specific effect of fruit and vegetable intake on CVD risk. In the Women's Health Study (Liu et

al., 2000) dietary intake of fruit and vegetables was assessed by a semi-quantitative food frequency questionnaire of 39,127 women. Mean intakes were 2.2 servings per day of fruit and 3.9 servings per day of vegetables. They noted that women with the highest intakes of fruit and vegetables tended to be older and displayed more health conscious behaviours. The relative risk of CVD and MI (adjusted for age and treatment) was significantly lower as quintile of intake increased for the all fruit and vegetable group (Table 2.3) and the all fruit group, but not for the vegetable group. The relationship was stronger when women who reported having diabetes, a history of hypertension or a history of high cholesterol levels were removed from the analysis. Authors suggested this could be due to women purposefully increasing fruit and vegetables intake if they were diagnosed with conditions that increased their CVD risk.

Another large prospective cohort study undertook a similar dietary analysis (Hung et al., 2004), and found similar results to the Women's Health Study. The study combined results from the Nurses' Health Study and the Health Professionals Follow-up Study to calculate multivariable adjusted relative risks for CVD, cancer and major chronic disease. There was an inverse association between the intake of fruit and vegetables (excluding potatoes) and CVD ($p < 0.001$ for trend) but no association with cancer and a weak association with major chronic disease. As with the Nurses' Health Study, there was a stronger association between all fruit intake and CVD (0.87, 95% CI: [0.80, 0.94]) than all vegetable intake and CVD (0.93, 95% CI: [0.86, 1.00]) (Table 2.3).

Fruit and vegetable intakes of more than 5 servings per day appear to be associated with lower risk of CVD, but how does fruit and vegetable consumption impact on CVD risk factors?

Higher concentrations of LDL cholesterol are a risk factor for CVD. The impact of fruit and vegetable consumption on LDL cholesterol has been investigated. A large cohort study (Djousse et al., 2004) calculated fruit and vegetable intakes from a food frequency questionnaire. LDL concentration was found to be inversely related to fruit and vegetable intake in both men and women, after adjusting for multiple variables including education and type of fat intake (Table 2.4). In this study, as observed in the Women's Health Study (Liu, et al., 2000) and the 1997 NZ NNS (Russell, et al., 1999),

older men and women tended to consume more fruit and vegetables than younger adults.

Intervention trials have shown similar reductions in cholesterol concentrations from diets containing larger amounts of fruit and vegetables (Table 2.4). One of these trials is the DASH trial (Obarzanek, et al., 2001) (summarised in Table 2.3). The trial assessed the impact of a heart healthy diet with 5 servings of fruit and fruit juices and 4 servings of vegetables per day on blood cholesterol levels. As discussed previously, the high fruit and vegetable, low saturated and total fat and low cholesterol diet resulted in significantly reduced total, LDL and HDL cholesterols independent of race and baseline cholesterol concentrations. The HDL reduction was more prevalent in participants with high LDL concentrations at baseline. Moreover, the trial had another dietary intervention group which consumed a high fruit and vegetable diet with higher intakes of whole grain foods and lower sugar intake but with the same fat and macronutrient composition as the control diet. Lipid profiles of the fruit and vegetable group were not significantly different from the control group after the 8 week trial. This study suggests that a total dietary approach results in the most CVD prevention benefits.

Table 2.3: Studies of the impact of fruit and vegetable consumption on CVD risk

Study	Number of participants	Fruit and vegetable intake * (servings per day)	Relative risk of CVD [95% CI]	Notes	Candidate's rationale for inclusion of study in literature review
Women's Health Study (Liu, et al., 2000)	39,127 women Follow-up 5 years	2.6 4.1 5.5 7.1 10.2	1.0 0.60 [0.34, 1.06] 0.57 [0.32, 1.01] 0.76 [0.46, 1.28] 0.33 [0.17, 0.64]	Excluded women with diabetes, hypertension, hypercholesterolemia. Adjusted for age and treatment.	Very large sample size longitudinal observational study of women with outcome of CVD events
Nurses' Health Study & Health Professionals' Follow up Study (Hung, et al., 2004)	71,910 women 37,725 Men Follow-up 12-14 years	1-3 3-5 >5	Pooled data 0.93 [0.86, 1.00] 0.87 [0.80, 0.94] 0.88 [0.81, 0.95]	$p < 0.001$ for trend	Very large sample size, longitudinal observational study of men and women with outcome of incidence of CVD
PRIME study (Dauchet, Amouyel, Hercberg, & Dallongeville, 2006)	5,982 French men 2,105 Northern Irish men Follow-up 5 years	France – mean 2.42 1.09 2.10 3.73 Northern Ireland - mean 1.86 1.00 2.07 3.55	France 1.00 0.48 [0.27, 0.87] 0.86 [0.51, 1.44] Northern Ireland 1.00 0.39 [0.18, 0.80] 0.56 [0.25, 1.28]	$p = 0.60$ for trend $p < 0.02$ for trend	Large sample size, longitudinal observational study of men with outcome of acute coronary events Lower fruit and vegetable servings per day than other studies

CVD, cardiovascular disease; CI, confidence interval; PRIME study, Prospective Epidemiological Study of Myocardial Infarction.

Note: most studies assumed one serving was equivalent to 80g

Table 2.4: Studies of the impact of fruit and vegetable consumption on total and LDL cholesterol concentrations

Study	Number of participants	Fruit and vegetable intake * (servings per day)	Total cholesterol (mmol/L)	LDL cholesterol (mmol/L)	Candidate's rationale for inclusion of study in literature review
DASH trial (Obarzanek, et al., 2001).	436 adults	Control: 3.6 DASH diet: 9.6 Fruit and veg: 8.6	-0.37, 95% CI: [-0.60, -0.18] -0.08, 95% CI: [-0.36, 0.14]	-0.29, 95% CI: [-0.44, -0.09] -0.04, 95% CI: [-0.28, 0.15]	Intervention study that shows effect of a dietary pattern on CVD risk factor
National Heart, Lung and Blood Institute Family Heart Study (Djousse, et al., 2004)	4,466 adults	Quartiles 0-1.9 2.0-2.9 3.0-3.9 > 4.0	(Total cholesterol not reported)	Men Women 3.36 3.35 3.35 3.22 3.26 3.21 3.17 3.11 $p < 0.0001$ for trend	Large observational study that shows inverse relationship between fruit and vegetable consumption and LDL cholesterol levels

DASH trial, Dietary Approaches to Stop Hypertension; CI, confidence interval; CVD, cardiovascular disease; LDL, low-density lipoprotein;

Note: most studies assumed one serving was equivalent to 80g

The general trend reported in the literature is that a higher intake of fruit and vegetables appears to be associated with more favourable lipid profiles and lower risk of CVD. Although the results from the PRIME study (conducted in France and Northern Ireland) (Dauchet, et al., 2006) are not as convincing as other results, this may be due to the shorter follow up period and the lower intakes of fruit and vegetables compared with the US studies.

Evidence from a meta-analysis of nine cohort studies from the US and Finland supports the hypothesis that higher fruit and vegetable consumption is associated with lower CVD risk (Dauchet, et al., 2006). It was concluded that there was an inverse relationship between fruit and vegetable intake and risk of CHD; as fruit and vegetable intake increased the relative risk of CHD decreased. It was suggested that there is a dose response and that for every extra serving of fruit consumed risk of CHD decreases by 7% and that for every extra serving of total fruit and vegetables risk decreases by 4%. A similar trend was seen between the risk of stroke and fruit and vegetable consumption (He, Nowson, & MacGregor, 2006). Relative risk of stroke decreased when servings of fruit and vegetables consumed were more than 5 per day compared with only 3-5 per day. This trend was seen in most of the cohort studies included in the meta-analysis. A pooled analysis which categorised fruit and vegetables into different food groups showed that the inverse association was stronger between fruit intake and risk of stroke (3-5 servings per day: 0.89, 95% CI: [0.82, 0.98]), than vegetable intake and risk of stroke (3-5 servings per day: 0.93, 95% CI: [0.82, 1.06]).

Most international dietary guidelines recommend increasing fruit and vegetable intake to at least 2 servings of fruit and 3 servings of vegetables per day (Ministry of Health, 2003) or more than 400g per day (World Health Organisation, 2003). Large cohort studies have shown that higher intakes of fruit and vegetables, greater than 5 servings per day, appear to provide greater reductions in CVD risk. As a result of this evidence specific CVD prevention dietary guidelines often recommend closer to 8 servings of fruit and vegetables per day in conjunction with other CVD protective dietary practices (Lichtenstein, 2006; National Heart Foundation of Australia; New Zealand Guidelines Group, 2009). However

such a high intake of fruit and vegetables may not be achievable for all sectors of a population.

2.1.2.1 Fruit and vegetable consumption in New Zealand

How do the fruit and vegetable intakes of New Zealanders compare with recommended dietary guidelines? Since the 1990s when the *5 + a day* public health campaign was launched to raise awareness of the important role that fruit and vegetables play in disease prevention one would expect that fruit and vegetable intake would have increased. The first New Zealand nutrition survey in 1977 reported on intakes of nutrients present in fruit and vegetables, such as vitamin C and vitamin A, rather than intake of fruit and vegetable *per se*. This practice reflected the nutrition guidelines of the time. The 1989 nutrition survey was on the variety of fruit and vegetables eaten more than how much fruit or vegetables were eaten or nutrient intakes. As the NZ food and nutrition guidelines changed, the 1997 NNS reported on the number of servings of fruit and vegetables consumed, to allow comparison with the national guidelines. NZ fruit and vegetable consumption was last published in 2007 as part of the NZ Health Survey.

The NZ Health Surveys only give an indication of how frequently the population states that they eat fruit and vegetables, whereas the 1997 NNS data provided a more accurate measure of how much fruit and vegetables the population does eat. The NZ Health Surveys results from 2002 to 2006 show a trend towards increasing frequency of fruit consumption and decreasing frequency of vegetable consumption for the whole population for both males and females (Ministry of Health, 2007). The 1997 NNS results also reflect this trend of increasing frequency of fruit consumption and decreasing frequency of vegetable consumption. Table 2.4 describes the results of the NZ Health Surveys and the 1997 NNS.

In summary:

- Greater consumption of fruit and vegetables appears to be associated with a reduced relative risk of developing CVD.
- The relationship appears to be stronger between fruit rather than vegetable intakes.
- People who consumed more fruit and vegetables tend to have lower LDL cholesterol concentrations.
- National and international guidelines recommend that the general population should aim to consume at least five servings per day of fruit and vegetables.

Table 2.5: Results of New Zealand national surveys of fruit and vegetable consumption

	Method of dietary analysis	Age group (number of respondents)	% eating 3+ a day of vegetables *	% eating 2+ a day of fruit	Candidate's rationale for inclusion of study in literature review
NZ NNS 1997 (Russell, et al., 1999)	Food frequency questionnaire	45-64 year olds (585)	Males 72% Females 78%	Males 36% Females 60%	Nationwide survey of intake
		All ages (1,904)	Males 62% Females 73%	Males 56% Females 34%	
NZ Health Survey 2002/2003 (Ministry of Health, 2004)	2 questions **	45-54 year olds (2,115)	Males 67% Females 74%	Males 46% Females 65%	Nationwide survey of intake
		All ages (12,929)	Males 63% Females 71%	Males 43% Females 64%	
NZ Health Survey 2006/2007 (Ministry of Health, 2007)	2 questions **	45-54 year olds (1,729)	Males 62% Females 73%	Males 50% Females 71%	Nationwide survey of intake
		All ages (12,488)	Males 56% Females 69%	Males 50% Females 68%	

NZ, New Zealand; NNS, national nutrition survey.

Note: * Includes potato and potato hot chips in the total number of vegetable servings

Note: ** "How many servings of fruit and vegetables do you typically eat per day?"

2.1.3 Dietary fibre

Dietary fibre refers to the non-digestible part of carbohydrate foods such as fructo-oligosaccharides, cellulose, hemicellulose, fructans, gums and algal polysaccharides (Mann & Truswell, 2002). Dietary fibres are further classified into soluble or insoluble fibre. Sources of soluble fibre in the diet include legumes, oats, fruit and psyllium. Insoluble fibre is mainly found in the stems and seeds of fruit and vegetables, whole grains, bran and mature vegetables (Mahan & Escott-Stump, 2000). Soluble and insoluble fibres are managed differently in the body and may affect CVD risk factors differently.

Lower LDL cholesterol levels are associated with a reduced risk of CVD. The association between a high fibre intake and lower LDL cholesterol concentrations has been well-established and is widely accepted. Evidence of this relationship is summarized below.

A meta-analysis, of placebo controlled intervention trials with psyllium husk (soluble fibre) supplements, investigated the change in cholesterol profiles of hypercholesterolemic men and women (Anderson et al., 2000). All of the eight studies included in the meta-analysis supplemented a low fat diet with 10.2 g per day of psyllium husk (Metamucil) for at least eight weeks. The increased soluble fibre intake significantly lowered total and LDL cholesterol ($p < 0.0001$) compared with the placebo supplement and a low fat diet. The authors noted that the change varied between age groups. This meta-analysis confirms the link between soluble fibre from psyllium husk (Metamucil) and reduced blood cholesterol concentration.

Another intervention trial (that used food sources of fibre rather than a fibre supplement) found similar changes in cholesterol profiles. The DASH dietary intervention trial, as mentioned earlier, showed that reducing saturated fat intake and replacing the saturated fat energy with high fibre carbohydrate foods had a favourable effect on total and LDL blood cholesterol levels without a significant change in the total cholesterol to HDL cholesterol ratio (Obarzanek, et al., 2001). Physiologically, dietary fibre is thought to bind bile acids, cholesterol and fatty acids in the gut which are then excreted in the stool (Anderson, et al., 2000; Vahouny, 1982). This binding is thought to have flow on effects for lipoprotein

synthesis and hence blood cholesterol concentrations (Anderson, et al., 2000; Vahouny, 1982).

A prospective cohort study (Lairon et al., 2005) of French men and women compared the effect on cholesterol profiles of a high fibre with low fibre diets (summarised in Table 2.6). A higher fibre intake was found to be associated with lower total cholesterol levels (p = 0.01), lower triglyceride (p = 0.01) and higher homocysteine concentrations (p = 0.01); LDL and HDL cholesterol were not measured. A strong relationship between soluble fibre intake and lower total cholesterol was not seen, but this study only compared fibre intake with total cholesterol of more or less than 240 mg/dl (6.2 mmol/L) and not with a sliding scale (as in the psyllium husk supplement studies). Interestingly, participants in the higher fibre intake quintiles, particularly for insoluble fibre, were more likely to have an ideal waist-to-hip ratio and body mass index (BMI) than those in the lower intake quintiles.

A high fibre diet has been linked to an improved cholesterol profile, but does it affect CVD risk?

Results from the Nurses' Health Study (Wolk et al., 1999) suggest that a higher dietary fibre intake is associated with a lower relative risk of non-fatal MI (0.57, 95% CI: [0.42, 0.77]), fatal CHD (0.41, 95% CI: [0.21, 0.70]) and all CHD events (0.53, 95% CI: [0.40, 0.69]). The study stratified fibre intake into sources of fibre: cereal, vegetable or fruit fibre. The relative risk of CHD by type of fibre only showed a significant relationship between long-term intake of cereal fibre (which is mainly comprised of insoluble fibre) and CHD. An increase in daily cereal fibre intake from 3.1 g per day to 7.7 g per day resulted in a 37% reduction of CHD risk or a relative risk of 0.63, 95% CI: [0.49, 0.81]. The model was adjusted for other types of fibre, carbohydrates, dietary folate, vitamin B6, vitamin C, vitamin E, beta carotene and magnesium.

The Women's Health Study (Liu et al., 2002) ran a similar analysis to the Nurses' Health Study but endpoints included all CVD incidents. Again, as dietary intake of fibre increased, the relative risk of CVD decreased. The relationship was stronger for insoluble fibre than soluble fibre when adjusted for age and treatment: 0.69, 95% CI: [0.54, 0.89]

compared with 0.74, 95% CI: [0.57, 0.96]. This study also compared cereal, vegetable and fruit fibre but found no significant relationship between cereal or vegetable fibre and CVD risk and a weak relationship between fruit fibre and CVD ($p = 0.04$). When the incidence of MI was analysed separately the relationship with dietary fibre intake was stronger with MI than with CVD.

It should be noted that in both of the female cohort studies described above (Liu, et al., 2002; Wolk, et al., 1999), women who consumed greater amounts of dietary fibre were more likely to be of ideal body weight, less likely to be current smokers, exercised more, consumed less saturated fat and consumed more dietary folate. All of these characteristics are also related to CVD risk. When they were used to determine risk in a multivariate model there was still a trend for decreasing relative risk of CHD (0.77, 95% CI: [0.57, 1.04]) or CVD (0.79, 95% CI: [0.58, 1.09]) with increasing dietary fibre intake although the results were no longer statistically significant.

A pooled analysis of dietary fibre and the risk of CHD (which included the two previously mentioned studies) further confirmed the inverse association (Pereira et al., 2004). The pooled multivariate relative risk of CHD (including dietary and non-dietary lifestyle factors) was 0.88, 95% CI: [0.83, 0.94] and relative risk of death from CHD was 0.81, 95% CI: [0.72, 0.92]. An analysis of cereal, fruit and vegetable fibre was also conducted and similar results to the studies previously mentioned were found: no relationship between vegetable fibre intake and CHD events or death. Relative risk of CHD death was associated with cereal fibre (0.75, 95% CI: [0.63, 0.91]) and fruit fibre (0.70, 95% CI: [0.55, 0.89]), and there was a weak relationship between fruit fibre and CHD events ($p = 0.04$).

In summary, there is convincing evidence from intervention trials that higher soluble fibre intake is associated with more favourable cholesterol profiles and a lower relative risk of CVD. The evidence for cereal fibre over fruit fibre or *vice versa* is not consistent. However, longitudinal cohort studies support a relationship between insoluble fibre and CHD and CVD risk. There has been much discussion as to whether it is the wider risk profile of people who consume higher amounts of dietary fibre that influences CVD risk,

but when many of these potential confounders were removed (overweight and smoking) the inverse relationship was just as strong, if not stronger (Liu, et al., 2002).

2.1.3.1 Dietary fibre consumption in New Zealand

The Australia/New Zealand adequate intake for dietary fibre is 30 g per day for males and 25 g per day for females (NHMRC, 2006). On average, as shown in Table 2.7, New Zealanders do not have an adequate dietary fibre intake. However, their dietary fibre intake is comparable with that of participants in international studies (dietary fibre intakes are summarised in Table 2.6). Of those surveyed in the 1997 NZ NNS only those at the 90th dietary intake percentile were consuming 25-30 g of dietary fibre per day. A fibre intake of 22-29 g for men and 22-26 g per day for women has been shown, in the previously mentioned studies, to result in improved lipid profiles and lower relative risk of CHD or CVD. As a result, NZ public health messages encourage New Zealanders to eat more whole grain foods, eat more fruit and vegetables and eat a variety of foods including legumes (Ministry of Health, 2003).

Table 2.6: Fibre consumption of participants in international studies

Study	Dietary assessment	Sample size	Year of study	Age (years)	Fibre intake (g/day) Males (median)	Highest vs lowest quintile (g/day) - male	Fibre intake (g/day) Females (median)	Highest vs lowest quintile (g/day) - female	Candidates rationale for inclusion of study in literature review
French adults (Lairon, et al., 2005)	Six 24 hour dietary recalls over 2 years	2,532 men 3,429 women	Started 1994-1995	Men 52.1 (mean) Women 47.2 (mean)	Total: 19.4 Insoluble:15.6 Soluble: 3.8	Total fibre: Highest: 27.3 Lowest: 16.0	Total: 18.7 Insoluble: 12.7 Soluble: 3.7	Total fibre: Highest: 22.0 Lowest: 13.4	Large sample size, mean age around 50 years old
Women's Health study (Liu, et al., 2002)	Semi-quantitative food frequency questionnaire	39,876 women	1993	Women: 46-64	N/A	N/A	Total: 18.2 Insoluble: 14.2 Soluble: 5.6	Total fibre: Highest: 26.3 Lowest: 12.5	Very large sample size, including 50 year olds
Nurses' Health Study (Wolk, et al., 1999)	Semi-quantitative food frequency questionnaire	68,782 women	1984	Women: 37-64	N/A	N/A	Total: 15.8 Insoluble: 11.3 Soluble: 4.5	Total fibre: Highest: 23.7 Lowest: 10.6	Very large sample size, including 50 year olds
Pooled analysis (Pereira, et al., 2004)	Food frequency questionnaire and diet history	91,058 men 245,186 women	1966-1993	Median across studies: 47-61	Intake range: 17.1-29.7	N/A	Intake range: 13.0-19.9	N/A	Very large sample size due to pooling, includes 50 year olds

Table 2.7: Historic dietary fibre consumption in New Zealand over time

Study	Method of dietary analysis	Number surveyed	Year of survey	Age (years)	Fibre intake (g/day) Males (median)	Fibre intake (g/day) Females (median)	Candidate's rationale for inclusion of study in literature review
Middle aged South Islanders (Paulin, et al., 1988)	7 day food recall	181	1985	50-54	Total: 29 Quintiles not reported	Total: 20 Quintiles not reported	Survey of 50 year olds fibre intakes
Life in NZ survey, 1989 (Howarth, et al., 1991)	24 hour recall	11,000	1989	All ages	Total: 22 Highest quintile: 40 Lowest quintile: 10	Total: 19 Highest quintile: 36 Lowest quintile: 8	First nationwide survey of New Zealanders fibre intakes
1997 NZ NNS (Russell, et al., 1999)	24 hour recall	1,255	1997	All ages	Total: 23 Highest quintile: 33 Lowest quintile: 15	Total: 18 Highest quintile: 26 Lowest quintile: 12	Most recent published survey of New Zealanders fibre intake

NZ, New Zealand; NNS, national nutrition survey

Note: results from the 1977 National Diet Survey are not included because dietary fibre intake was not reported.

2.1.4 International heart healthy guidelines

There is general consensus on the description of a heart healthy diet across Europe, North America, Australia and New Zealand (see Table 2.7).

Current national guidelines across the globe focus on consumption of food rather than nutrients. The guidelines are mostly practical recommendations. Early national dietary guidelines focused on nutrient targets for the population. The 1991 NZ Nutrition Taskforce guidelines (Department of Health, 1991) recommended that carbohydrate should contribute 50-55% TE to the diet, fat should contribute less than 35% TE, and dietary fibre intake should be 25-30 g per day.

In addition to the nutrients and food groups discussed in detail in the previous sections there are other nutrients and foods included in the cardio-protective guidelines. The following food groups are included in the NZ cardiovascular guidelines handbook (New Zealand Guidelines Group, 2009) and the NZ National Heart Foundation five steps to eating for a healthy heart (National Heart Foundation of New Zealand): wholegrain foods, legumes, nuts and seeds, alcohol, high sugar foods. It is outside the scope of this thesis to discuss them all in detail, it is also difficult to collect accurate information regarding usual intake of some of these foods. For the purpose of this thesis the following nutrients will be assessed, using a four day food and beverage diary, to assess heart healthy eating trends of 50 year olds in the CHALICE study:

- Total fat
- Saturated fat
- Fruit intake
- Vegetable intake
- Dietary fibre intake

Table 2.8: International dietary recommendations to reduce incidence of CVD

Recommendation (wording is not identical)	European Society of Cardiology (Graham, et al., 2007)	American Heart Association (Lichtenstein, 2006)	Heart Foundation of Australia (National Heart Foundation of Australia)	Heart Foundation of New Zealand (National Heart Foundation of New Zealand)
Vegetables per day	Encourage intake	4-5 serves	5 serves	4 serves
Fruit per day	Encourage intake	4-5 serves	2 serves	4 serves
Whole grain foods per day	Encourage intake	6-8 serves	Encourage intake	At least 3 serves
Fish and seafood	Encourage intake	Include as part of protein intake	2-3 serves per week	Include as part of protein intake
Dairy products per day	Use low fat products	2-3 serves of low fat products	Moderate intake of low fat, reduced fat products	2-3 serves of low fat products
Nuts and seeds	Not mentioned	4-5 times per week (including legumes)	Include unsalted varieties as a snack	3 or more serves per day (including other fats)
Sodium	Reduce salt intake if BP raised	Choose foods with little or no salt	Use no added salt, low salt, salt reduced products	Choose low salt foods and use only small amounts of salt
Candidate's rationale for inclusion of guidelines in literature review	Internationally recognised guidelines	Internationally recognised guidelines	Guidelines for a population similar to that of NZ	Guidelines most relevant to study population

How can psychosocial variables influence preventative health behaviours such as consuming a heart healthy diet?

2.2 HBM, CBT and SCT

Models have been used to describe and analyse human behaviour since the early 20th century. One of the early and established models used was the health belief model (HBM). The HBM is based on the assumption that individual behaviour depends on two factors: the importance an individual gives a particular objective and how achievable it is to meet that objective (Janz & Becker, 1984). The HBM was developed in the United States of America in the 1950s by social psychologists and has since been applied to explain a variety of behaviours including disease prevention behaviours , for example attending free X-ray screening for tuberculosis (Janz & Becker, 1984).

The HBM is composed of seven elements split into three sections: individual perceptions, modifying factors and likelihood of action (Figure 2.2.1). The elements of the HBM are: perceived susceptibility to disease, perceived seriousness (severity) of disease, demographic variables, psycho-social variables, cues to action, perceived benefits of preventative action and perceived barriers to preventative action. The perceived threat of disease is a result of the interaction between demographic variables, psycho-social variables, perceived susceptibility to and severity of disease and cues to action. Perceived threat of disease and perceived benefits of minus perceived barriers to preventative action directly influence the likelihood of taking recommended preventative health actions. Psycho-social variables are assumed to influence the likelihood of taking recommended preventative health actions through their influence on the constructs of the HBM.

The validity of using the HBM to explain health prevention behaviours was studied extensively during the 1970s and 1980s. A review (Janz & Becker, 1984) of studies conducted between 1974 and 1984 that used the HBM, found that susceptibility to disease, benefits of preventative action and barriers to preventative action, significantly explained the likelihood of adopting the preventative health behaviour. More recently the HBM has been used in conjunction with other cognitive models to further understand health prevention behaviours (Petrovici, Ritson, Petrovici, & Ritson, 2006).

The HBM is not commonly used in the field of nutrition as it is a simplistic model that this not suited to the study of complex health behaviours such as eating habits. CBT and SCT are more commonly used. CBT is based on the philosophy that behaviour is learned and influenced by environmental and internal factors including how people think and feel. Strategies used when applying CBT are: self-monitoring of food intake, thoughts, emotions and behaviours, problem solving, goal setting, rewards and contingency planning, cognitive restructuring, social support, stress management, stimulus control and relapse prevention (Spahn et al., 2010).

A systematic review (Spahn, et al., 2010), of more than 20 randomised controlled trials, showed that there is strong evidence that the use of CBT in nutritional counselling and chronic disease risk factor counselling results in changes in dietary habits. The strongest evidence for the use of the CBT has been for programmes running for longer than 6 months duration (Spahn, et al., 2010).

SCT was developed in the 1970s by Albert Bandura, a Canadian psychologist, by building on various pre-existing social learning theories (Bandura, 1986). SCT focuses on cognitive, socio-environmental and behavioural factors, and how they interact. It has been used to explain behaviour in a range of fields and has more recently been applied to the field of nutrition.

A key construct of SCT is the idea of self-efficacy, which is having confidence to perform a specific behaviour. Self-efficacy is an important determinant of new behaviours and is influenced by four factors: enactive attainment, vicarious learning, verbal persuasion and physiological states (Bandura, 1986). Enactive attainment is acting out an achievement, for example accomplishing small incremental goals. Bandura proposes that this is the most influential factor on self-efficacy. Vicarious learning is achieved through observing others similar to the target group performing the behavior - observing them successfully performing the behaviour increases self-efficacy. Verbal persuasion is providing encouragement or talking someone into believing they are capable of a change. This can be positive or detrimental to self-efficacy depending on how realistic the change is for that person. Physiological arousal is how anxious or stressed a person is about performing a particular behavior; and is

important as experiencing stress or anxiety about a behavior has been shown to reduce self-efficacy (Bandura, 1986).

SCT can be used in nutrition counselling to elicit behaviour change. Strategies used include: peer modelling, skill development, social support, reinforcement, goal setting, stimulus control and motivational interviewing (Spahn, et al., 2010). Some of the strategies used in SCT are similar to those in CBT; however the focus of the strategies is different. The aim of SCT strategies is to improve self-efficacy and this, combined with reinforcement, help to improve the individual's perception of the consequences of the behaviour change.

Much of the nutrition research based on SCT has been conducted with children and adolescents (Ball et al., 2009; van der Horst et al., 2007; Wind et al., 2006). There is some literature on adults to support the use of SCT to change nutrition related behaviours (Annesi, Whitaker, Annesi, & Whitaker, 2010; Spahn, et al., 2010).

The following section examines the research around attitudes and beliefs about health and preventative health behaviours. Whilst it is divided into sections under the various sub sections of the HBM, it also incorporates evidence from studies using CBT and/or SCT.

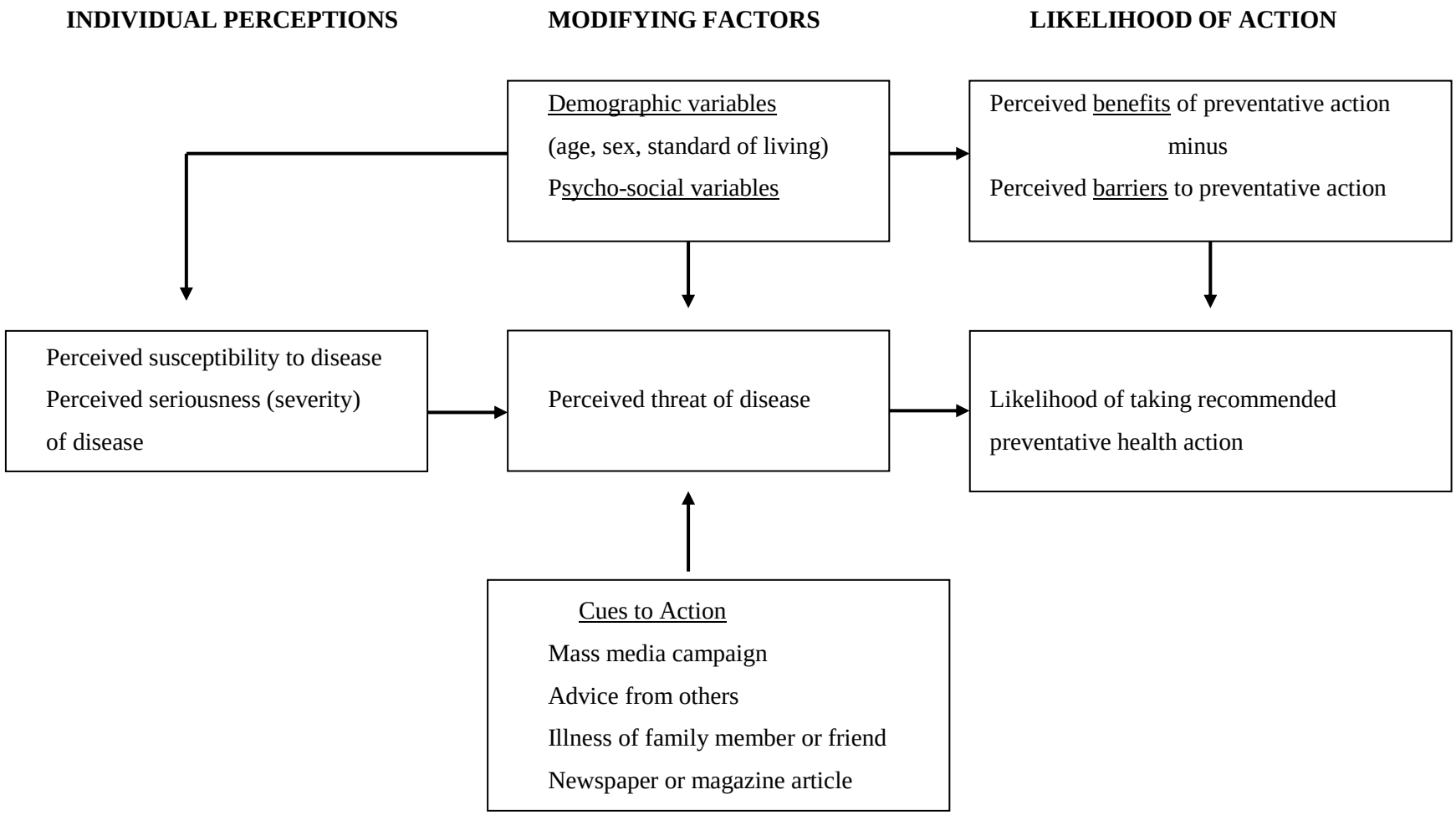


Figure 2.2.1: "Basic Elements of the Health Belief Model"

(Janz & Becker, 1984)

2.2.1 Demographic and social variables

Demographic variables (age, sex, ethnicity and culture) all affect people's beliefs about their susceptibility to disease, their perceived threat of disease and their perceived benefits and barriers to preventative actions. Social variables such as socio-economic status (SES) and level of education often influence dietary intake (Russell, et al., 1999). A US study (Beydoun & Wang, 2008) affirmed that lower SES (which took into account years of education) is associated with lower dietary quality which may be due to a perceived barrier of food price. However, dietary quality was still influenced by the perceived benefit of dietary quality in relation to health benefits even in lower SES groups.

New Zealand and international research usually reports the demographic and social variables of the populations they are studying in relation to nutritional intake; standard of living though, has not been widely used to describe the nutritional intake of populations. The $ELSI_{SF}$ is a relatively new measure of standard of living which takes into account financial and non-financial burdens. The $ELSI_{SF}$ score is calculated based on six items: ownership, social participation, economising behaviours, self-rated standard of living, self-rated satisfaction with standard of living and self-rated adequacy of income. Scores are divided into three categories: "hardship", "comfortable" and "good//very good" standard of living (Jensen, Spittal, & Krishnan, 2005). The $ELSI_{SF}$ score has been associated with health outcomes and health related behaviours independently of income (Ministry of Health, 2010a), for example, those who experience more "hardship" in terms of their standard of living have a higher BMI than those with a "good or very good" standard of living. An analysis of economic data in NZ (Walton, Signal, & Thomson, 2009) compared the 2004 Living Standards Survey results with the 2002 Children's Nutrition Survey results and observed that the percentage of children who were overweight and obese mirrored the percentage of households with children experiencing a "hardship" standard of living. The authors concluded the economic factors may influence dietary intake. No literature was found that compares standard of living (measured using the $ELSI_{SF}$) with adult nutritional intake. Traditionally NZ studies have used the New Zealand socioeconomic index (NZSEI) or the New Zealand deprivation index (NZDep96) in relation to nutritional intake or adequacy. Different measures of SES have tended to show different associations with nutrient intake (Metcalf, Scragg, & Davis, 2006a). The NZ workforce

survey (Metcalf, et al., 2006a) found that those in lower socioeconomic groups (lower NZSEI and education groups) tended to consume less fruit and vegetables than those in high socioeconomic groups.

2.2.2 Perceived susceptibility to disease

There are many avenues through which information on disease susceptibility is delivered: for example, general practitioners, mass media campaigns, website risk calculators, magazines, newspapers, friends and family. Some of these sources of information are more reliable than others. Self-perception of being more susceptible to, or at risk of, heart disease and the perception of having some control over developing heart disease may result in implementing healthy behaviours, such as regular general practitioner check-ups, to minimise controllable heart disease risk factors. The Family Healthware Impact Trial in the US (Wang et al., 2009) assessed perceived risk and perceived control to prevent disease in 2,362 adults between the ages of 35-65 years. Both perceived risk and perceived control were assessed for heart disease, diabetes, stroke, colon cancer and breast and ovarian cancer in females (Table 2.9). Perceived risk was assessed by asking one question, "Compared to most people your age and sex, what would you say your chances are for developing...?" Possible responses were: 1 = much lower than average, 2 = lower than average, 3 = average, 4 = higher than average, 5 = much higher than average. People's perception of their perceived control over the development of specific diseases was also assessed by asking one question, "There's a lot I can do to prevent…" The responses were 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = Agree, 5 = strongly agree. Females tended to perceive they were at greater risk of developing diseases than males but females also felt that they had more control than men over preventing diseases. Both males and females felt that they had a lower than average risk of developing all diseases. Wang et al found that people were more worried about developing cancer than heart disease but perceived developing heart disease to be more controllable than cancer. Research has shown that those who perceive themselves to be susceptible to a severe disease, that can be somewhat prevented through diet, are more likely to make positive dietary changes (Contento & Murphy, 1990).

Susceptibility to disease beliefs have also been studied in relation to demographic and social variables. A Romanian study (Petrovici, et al., 2006) of 485 adults found that respondents with university education believed they were more susceptible to high blood pressure, diabetes, and IHD than those with a technical education. Interestingly those with only primary school education felt more susceptible to all diseases than the university educated respondents. Susceptibility varied with age as well; respondents over 55 years of age felt more susceptible to high blood pressure and IHD than under 34 year olds, but not as susceptible to diabetes as the younger age group. There were also some small gender differences in perception of susceptibility. The authors commented that perceived disease susceptibility does not significantly alter behaviour in Romania due to the generally low incomes, which they felt had a greater effect on behaviour.

Table 2.9: Mean responses from the Family Healthware Impact Trial (Wang, et al., 2009)

Sex	Heart disease	Diabetes	Stroke	Colon cancer
Compared to most people your age and sex, what would you say your chances are for developing…?				
Male	2.62	2.56	2.58	2.68
Female	2.74	2.72	2.68	2.70
Note: 1 = much lower than average to 5 = much higher than average				
There's a lot I can do to prevent…				
Male	4.31	4.00	4.00	3.74
Female	4.35	4.14	4.03	3.82
Note: 1 = strongly disagree to 5 = strongly agree				

Candidates rationale for inclusion of study in literature review: demonstrates perceived risk of disease and perceived control over disease

2.2.3 Perceived benefits of preventative action

Perceived benefits of preventative action require one to have knowledge of what is and is not beneficial for health. For example, a high intake of saturated fat is associated with a higher risk of CVD; therefore the national food and nutrition guidelines

recommend that New Zealanders should consume less saturated fat. However, if one is unaware of this information then following a low saturated fat diet may not be perceived as being beneficial for health. Or, one may not have the knowledge of how to follow a low saturated fat diet. This discrepancy between knowing what is beneficial for health and what it means in practical terms is exemplified in the results of the 1989 Life in NZ Survey (Howarth, et al., 1991). Surveyors asked how 'bad for health' are a group of foods. Compared to university-educated individuals those with only primary school education had as good as, or sometimes better, knowledge of types of foods that were 'very bad' for health: too much junk food, too much fat, too much salt, too much sugar, overeating, not enough fibre, too much alcohol. Knowledge of what these recommendations meant in real food terms was quite different between university and primary school-educated people. When asked which foods contain 'a lot' of fat 20-40% less primary-only educated individuals than university-educated individuals, believed that butter, margarine, processed meats and mild cheese contained a lot of fat. University-educated females estimated fat content of foods more accurately that university-educated males.

Level of nutritional knowledge is not always associated with dietary intake (Worsley, 2002). However nutritional knowledge in conjunction with other psychosocial variables, such as health beliefs, education and/or socioeconomic have been shown to be associated with healthier eating habits in some studies (Abood, Black, & Feral, 2003; Beydoun & Wang, 2008; E. L. Gibson, Wardle, & Watts, 1998; Harnack, Block, Subar, Lane, & Brand, 1997; Patterson, et al., 1995; Ryan & Gates, 1988; Wardle, Parmenter, & Waller, 2000).. A workplace intervention programme (Abood, et al., 2003) of 53 employees who were randomly assigned to an eight week intervention or control group health education programme found that those who received the intervention had significantly increased their knowledge of nutrition and were more aware of the role nutrition plays in the prevention of CVD. Greater knowledge of healthy eating for CVD prevention was associated with a higher fibre intake and a lower intake of total and saturated fat as a % TE ($p < 0.005$).

Greater nutritional knowledge may affect dietary intake of individuals but has also been shown to affect dietary intake of offspring as well (E. L. Gibson, et al., 1998; Variyam, Blaylock, Lin, Ralston, & Smallwood, 1999; Wind, et al., 2006). A study of 92 mothers

found that mothers' nutritional knowledge and beliefs about the benefits of certain foods was associated with their child's nutritional intake (E. L. Gibson, et al., 1998). The investigators used multiple regression analysis to assess which psychosocial variables influenced fruit and vegetable intake. Children's fruit consumption was influenced mainly by mothers' nutritional knowledge, mothers' consumption of fruit and mothers' belief that more fruit and vegetables may reduce their child's risk of cancer (Adj $R^2 = 0.34$, $p = <0.0001$). In adults, women's nutritional knowledge and beliefs about type 2 diabetes management has been shown to affect the dietary intake of their husbands or partners (Beverly, Miller, & Wray, 2008).

2.2.4 Perceived barriers to preventative action

An important element of the HBM is that the perceived benefits of preventative action must outweigh the perceived barriers to preventative action to ensure the uptake of the recommended preventative health action. Therefore, when the barriers outweigh the benefits, there is a low likelihood of implementing the preventative health action, particularly if the perceived threat of disease is low as well.

This association between benefits and barriers to preventative action has been confirmed by research within healthy populations and in populations with a higher risk of disease. A study of barriers to eating a heart healthy diet in 48 Finnish cardiac rehabilitation patients aged 41-82 years old, concluded that social factors, self-control, taste and time were the main barriers to following the nutrition advice given during the cardiac rehabilitation course (Koikkalainen, et al., 1996). Over 40% of respondents felt that they forgot to make positive food decisions while eating with friends or family or eating outside of home, 25% said that they like to not think about what they eating when eating with others. Other important social barriers included lack of support from family to change their eating habits and a desire to eat the same type of food as their friends and colleagues. Self-control was an important factor with this group; 44% felt that having too much food available was a barrier to eating well and 31% felt it was easy to forget about eating well when eating alone. Taste is an interesting barrier to eating well as our taste buds can change over time. In this particular group more than 30% felt that healthy foods did not taste good and that low-fat foods were not appetising. Time is often cited as a barrier to implementing dietary change, but its significance as a barrier

tends to vary with age and stage of life. For this population 33% responded that they do not bother to cook healthy foods and they do not have enough strength to think about food because there are more important issues in their life at the moment. Price was a barrier for some of this group but only after the aforementioned barriers. Just less than 30% believed that a healthy diet costs more and they tended to select food based on its price. In contrast, a study of 485 adult Romanians (Petrovici, et al., 2006) found that the high price of healthy food was a barrier for 78% of respondents and 70% identified "pressure on my budget" as a major barrier to eating healthily. These monetary barriers were the second and third most common barriers after "it is hard to give up the food you like".

One of the most variable barriers is time. Time is more often perceived as a barrier to healthy eating by younger people, people who are more highly educated and by those who work long or irregular hours (Kearney & McElhone, 1999; Welch, et al., 2008). There is some evidence that time as a barrier may vary geographically (Kearney & McElhone, 1999); for example in a Pan European Union study, irregular working hours was only a barrier for 12% of Germans compared with 36% of Italians (Kearney & McElhone, 1999). It is unknown whether this is related to the social conditions of a country or the psyche of the population.

The 1997 NZ NNS investigated the barriers people faced when trying to eat more fruit, vegetables, breads and cereals, and eat less high fat foods. The most common barriers cited by at least 10% of those surveyed to eating more fruit included: "cost", "don't always have them at home", "can't store for long", "not enough time" and "poor quality". The reasons cited for not consuming more vegetables were the same as fruit except that instead of "poor quality" being a barrier "takes too long to prepare" and "don't like" were barriers. There were minimal barriers to eating more breads and cereals. On the other hand there were significant barriers to eating less high fat foods; 47% were "happy with current fat intake", 32% felt that "fat tastes good" and 16% said that "low fat foods are less enjoyable". Other barriers included "convenience" and "lack of willpower".

2.2.5 Cues to action

Cues to action can come from a variety of sources including: mass media campaigns, advice from others, illnesses of family members or friends and newspaper or magazine articles. Mass media campaigns are more often than not funded by corporate companies and often advertise less healthy food and beverages. Government, or not for profit organisation, funded mass media campaigns are less common, particularly in relation to health prevention through consumption of healthy foods.

A variety of methods are often used in public health campaigns. The objective of such campaigns is often to improve the public's perception of a range of preventable health conditions. The success of public health campaigns in changing public perception seems to depend upon the duration of the campaign. An Australian study (B. Smith, Sullivan, Bauman, Powell-Davies, & Mitchell, 1999) concluded that disease prevention education had not positively affected the community's disease prevention beliefs for all diseases. The survey was completed by 1657 respondents from South Western Sydney in 1995, aged 18 years and older; half of the respondents had not completed 10 years of schooling. Of those surveyed, 62% thought that skin cancer was all or mostly preventable, whereas 27% did not know if diabetes was preventable or not (Table 2.10). Australia initiated a sun smart public health campaign in 1980 in an attempt to reduce their high incidence of skin cancer. In 2002 it was estimated that by 70 years of age 64% of people will have had a skin cancer diagnosis (Staples et al., 2006). After 20 years of educating the public most people (62%) believed that skin cancer was mostly preventable [B Smith, 1999]. Public health campaigns targeting type 2 diabetes prevention had not been running for as long as the sun smart campaign (Diabetes Australia) and have not yet been shown to be successful in preventing type 2 diabetes (Rosenberg & Lawrence, 2000). Research is yet to show if Australian type 2 diabetes public health campaigns that have been running since the Smith et al survey was conducted have changed the Australian public's perception of diabetes preventability.

A similar questionnaire was conducted in NZ in 1989 as part of the Life in NZ health and nutrition survey (Howarth, et al., 1991). Those surveyed were asked if food was very important in the development of particular diseases. In general, more females than males believed that food played an important role in the development of disease. There were some differences in disease prevention perceptions amongst university and

primary educated individuals (Table 2.11). The perception of disease prevention in NZ has not been studied for some time. Since 1989 disease prevention public health campaigns have focused on the link between smoking, heart disease and lung cancer, and the importance of regular cervical smears to screen for cervical cancer. There has also been an industry campaign to encourage consumption of NZ beef and lamb public and a public health campaign encouraging New Zealanders to consume *5 + a day*. The *5 + a day* campaign has been somewhat successful; the message is well recognised and people understand its meaning (Ashfield-Watt, 2006).

Table 2.10: Beliefs about preventability of chronic diseases (B. Smith, et al., 1999)

Health Condition	All or mostly preventable (%)	Sometimes preventable (%)	Rarely or never preventable (%)	Don't know (%)
Skin cancer	61.7	25.6	6.0	6.7
Lung cancer	29.8	33.7	13.2	13.3
High blood pressure	32.1	39.1	14.0	14.8
Heart attacks	23.4	44.2	18.0	14.3
Diabetes	16.7	30.3	24.6	27.0

Candidate's rationale for inclusion of study in literature review: a CHALICE module 3 question is based on this question. It shows that beliefs about disease preventability are not always aligned with current public health campaigns.

Table 2.11: Percentage of participants that responded food is "very important" in the development of specific diseases (Howarth, et al., 1991)

Education	Obesity	Diabetes	Heart disease	Bowel cancer	Osteoporosis
All Males	79%	53%	69%	42%	20%
University educated males	82%	46%	68%	52%	25%
Primary educated males	86%	66%	77%	38%	19%
All Females	87%	66%	73%	52%	34%
University educated females	89%	57%	70%	54%	42%
Primary educated females	81%	68%	72%	59%	26%

Candidate's rationale for inclusion of study in literature review: one of the CHALICE module 7 questions is based on this question and it shows that education does not have a large impact on beliefs about disease.

The effectiveness of the NZ *5 + a day* fruit and vegetable campaign to change consumers' perception of fruit and vegetables was evaluated in 1999 and 2000 (Ashfield-Watt, 2006). The *5 + a day* logo was well recognised by 71% of respondents. Attitudes to fruit and vegetable consumption were assessed by statements linking fruit and vegetables with health. Females had a more positive attitude than males towards eating fruit and vegetables, as did NZ Europeans compared with other ethnic groups. People with tertiary education, compared with secondary or less education, had a more positive attitude towards fruit and vegetables. Those groups with more positive attitudes towards fruit and vegetables also consumed more fruit and vegetables; this association is probably mediated by variables other than just their attitudes. From the results of this study it cannot be ascertained if these differences are the result of the *5 + a day* campaign not reaching the less educated, unskilled or unemployed people, or if it is the result of lack of education, culture or other barriers that may influence fruit and vegetable consumption.

2.2.6 Likelihood of undertaking recommended preventative health action

The HBM is a means of explaining how social and cognitive variables can influence behaviour. The likelihood of engaging in dietary health preventative behaviours has been shown to be influenced by many factors including level of education, nutritional knowledge, a belief in the role of nutrition to prevent disease and higher levels of health motivation (Petrovici, et al., 2006). The factors influence one's perceived threat of disease which in turn along with perceived benefits of, minus perceived barriers to, preventative action influence the likelihood of undertaking recommended preventative health actions.

As discussed in this section of the literature review, one's attitudes and beliefs about health can influence whether or not particular health prevention behaviours are incorporated into one's daily life. These attitudes and beliefs include perceptions about susceptibility to disease, beliefs about the benefits of preventative health behaviours and attitudes towards potential barriers to positive health behaviours. Attitudes and beliefs can be influenced by environmental (Kearney & McElhone, 1999; Petrovici, et al., 2006; B. Smith, et al., 1999), social (Beydoun & Wang, 2008; Petrovici, et al., 2006) and cognitive factors (Contento & Murphy, 1990; Wang, et al., 2009) and strategies and cues to action that acknowledge these factors, and work to influence such factors may

change one’s attitudes and beliefs towards preventative health behaviours, including consumption of a healthier diet (Abood, et al., 2003; Beverly, et al., 2008; E. L. Gibson, et al., 1998).

2.3 Conclusion

The research presented suggests that people who are less educated and of lower SES, consume a less healthy diet. Preventative health behaviours are influenced by social and psychological factors. Understanding how these can influence dietary choices, and ultimately the risk of developing chronic disease, is very important for health professionals, marketers and policy makers who want to improve the health of all New Zealanders.

The aim of this thesis is in line with the overall CHALICE aim of investigating the determinants of physical and mental wellbeing and protective factors against the development of disease.

This thesis uses preliminary data to investigate (using elements from HBM, CBT and SCT) the associations between (1) consumption of a heart healthier diet and pyscho-social variables, (2) consumption of a heart healthier diet and disease beliefs, and (3) how dietary intake compares with a heart healthy diet.

While it is outside the scope of this Master's thesis to investigate correlations within the data, a pilot study such as this one will allow for the development and initial investigation of hypotheses, which may be tested in the future using a larger CHALICE sample.

To date international research indicates that attitudes, beliefs and barriers may differ culturally and geographically. It is not known how the beliefs and barriers of NZ adults compare with their peers in other countries. New Zealanders' knowledge and understanding of some of the heart healthy eating patterns may be a barrier to consuming heart healthy food (Ashfield-Watt, 2006; Gilbey & Fifield, 2006). Addressing social factors, attitudes, beliefs and barriers, as well as knowledge and understanding, may be an effective means to initiate change, and hence improve CVD risk factors. This pilot study will indicate whether New Zealanders beliefs and barriers are similar to those in other countries and if they are linked to nutrient consumption and knowledge of food composition. It will also further clarify how social factors in middle age affect dietary intake.

3.0 Hypotheses

In an initial sample of 50 year olds within the Canterbury District Health Board area it is hypothesised:

- That the dietary intake of fifty year old men and women in Canterbury does not meet heart healthy dietary guidelines

- That positive attitudes and beliefs around a link between food intake and risk of disease are associated with consumption of a heart healthier diet

- That a higher *barriers to eating healthily* score is associated with consumption of a less heart healthy diet

- That greater education, household income and standard of living (measured using the Economic Living Standard Index Short Form ($ELSI_{SF}$))are associated with a heart healthier diet

- That a greater knowledge of food composition (sugar, fat, salt and fibre content) is associated with a heart healthier diet

4.0 Methods

4.1 Study Design

CHALICE is an observational study of a random selection of people aged 50 years currently living in the CDHB area. The data used in this thesis is preliminary data collected from the first 81 CHALICE study participants. Data were collected from self-completed questionnaires, a face to face interview of 4-6 hours duration, lifestyle diaries and diagnostic tests. Longitudinal follow-up is planned for each participant every 5 years as well as brief annual questionnaires. Ethical approval was obtained from the Upper South A Regional Ethics Committee (Appendix A).

4.1.2 Study procedures

4.1.2.1 Sample selection

The Electoral Roll Centre provides an up to date list (health research extract) of people within a defined geographical electorate that may be used to recruit participants into research studies. Such a health research extract was provided in June 2010. The extract contained people with a date of birth between the 19th of June 1959 and the 18th of June 1960 (currently 50 years old) who were registered in the following territorial authorities that align with the CDHB area: Kaikoura District, Hurunui District, Waimakariri District, Christchurch City, Selwyn District, and Ashburton District. There were 6,328 people registered on the electoral roll who were aged 50 years and who were not of Maori descent and 413 who identified as of Maori descent. Each list was randomly ordered and 300 people were chosen, in a ratio of 4:1 non Maori to Maori. The 300 people selected were then randomly assigned to four interviewers who contacted those selected in the order in which they were assigned to them. A new health research extract of 50 year olds will be requested annually for five years to achieve the full CHALICE sample of 2500.

4.1.2.2 Participant contact

Interviewers sent participants a letter of invitation to the address recorded in the electoral roll. If they did not respond to the letter interviewers tried to make contact

with the individuals by telephoning them, up to four times. Phone numbers were sourced from the White Pages and the internet. If there was still no response a second letter was sent six weeks later. If participants had not responded after two letters and/or eight phone calls, or if a home number was not available, interviewers visited participants at home to invite them to partake in the study. If, after these steps, participants were still able to be contacted they were considered to have declined participation.

4.1.2.3 Participant interviews

Participants attended a 4-6 hour assessment and underwent multiple interviews and procedures as part of the wider CHALICE study. For the majority of participants the assessment was completed on one day but in some cases it was completed over two days, for example one participant was blind so all answer options needed to be read aloud, others could not attend for the whole day and did the blood tests and echocardiogram (ECG) on another day. The following modules were completed on the interview day(s):

Module 1 – physical assessment and blood tests
Module 2 – personal health history questionnaire
Module 3 – well-being questionnaire
Module 4 – heart health – ECG
Module 5 – psychological health questionnaire
Module 6 – cognitive health questionnaire
Module 7 – lifestyle questionnaire

4.1.2.4 Participant follow-up

A follow-up phone call was made by the interviewers two weeks after the initial interview to remind participants to complete and send back the food and beverage diary and questionnaires. When food and beverage diaries and questionnaires were returned they were checked for completeness by the candidate (the study dietitian). If the candidate required further information interviewers would contact the participants by telephone or email to ask them relevant questions or for further clarification. The candidate did not contact participants directly to ensure continuity of contact between the interviewers and the participants. Further clarification was sought when quantities of food eaten were not reported clearly, for example when the participant had one

homemade muffin and they had provided a recipe but had not mentioned how many muffins they had made using the recipe, or when the candidate was not familiar with a recorded product/food item, for example a tofu bun.

4.1.2.5 Feedback of results to participants

Participants received a feedback letter detailing any abnormal results from the wider CHALICE study. The letter included results of concern such as high BMI, abnormal blood test results, elevated blood pressure, impaired cognitive function, psychological health issues and markers of eye disease. Feedback on nutritional intake was not given due to the time needed to return, check, enter and analyse the food and beverage diaries. Feedback letters were usually sent before the diaries had been analysed.

4.1.2.6 Raw data handling

Each participant was allocated a study number upon entry to the study. This study number was used on all questionnaires and data collected relevant to that participant. Only study interviewers were aware of the names of participants. Others involved in participant feedback, data entry or checking of food and beverage diaries used the study number to identify participants. Raw data were kept in locked cabinets within the University of Otago CHALICE office.

4.1.3 Questionnaire design

For the purposes of this thesis, only the modules relevant to the research questions will be described.

Module 1 – physical health
Module 2 – personal health history questionnaire – only demographics section
Module 3 – well-being questionnaire – only selected questions
Module 7 – lifestyle questionnaire – only the food and nutrition related sections

4.1.3.1 Module 1 – physical health

The physical health assessment (Appendix B) was completed by a trained nurse. It included assessment of height, weight, waist circumference, body fat composition by

bioimpedance. Details of how the assessment was completed are outlined in section 4.1.4.1.

4.1.3.2 Module 2 – demographics section

The demographics section (Appendix C) included questions on gender, date of birth, ethnicity, education, income and standard of living. Most of the questions in this module were taken from the 2006/2007 NZ Health Survey apart from question 1.10 on education, which was adapted from the 2005 British Social Attitudes Survey (National Centre for Social Research, 2005).

Participants could choose multiple ethnicities. The highest level of education achieved was recorded as: no qualification, secondary school qualification, post-secondary certificate or diploma or trade diploma, university degree or other. If other was chosen the qualification was compared with a similar NZ qualification. Due to the age of the participants, many professional qualifications that are currently delivered by universities were delivered by polytechnics or other institutions (for example, nursing by district health boards). These qualifications were entered as post-secondary school rather than university level education. For participants who had completed higher education outside NZ, their education was coded according to the most relevant course/institution in NZ at that time.

Individual and household incomes were recorded. Household income was used for data analysis because it is more likely to impact on food expenditure and standard of living than individual income. Standard of living was measured using the $ESLI_{SF}$ (Jensen, et al., 2005) which takes into account home ownership, social participation, economising, self-rated standard of living, satisfaction with standard of living and adequacy of income. The $ELSI_{SF}$ has been used as a measure of standard of living in similar studies conducted in NZ (Ministry of Health, 2010a).

4.1.3.3 Module 3 – well-being

The questions selected from Module 3 (Appendix D) related to beliefs about disease preventability (question 5), medical scepticism (question 6) and fatalism (question 20). All of the questions included have been used in previous studies in populations of a similar age to the CHALICE population (Fiscella, Franks, & Clancy, 1998; B. Smith, et

al., 1999; Straughan & Seow, 2000). All questionnaires have been shown to have good face and/or construct validity. (Fiscella, et al., 1998; B. Smith, et al., 1999; Straughan & Seow, 2000). Prior to being used CHALICE, the questions were pre-tested with NZ participants from the study demographic to ensure that face validity was acceptable for use in this population. As all questionnaires are comprised by compiling complete constructs (sections) from other questionnaires there is no reason to believe that this will affect the construct validity of each section.

The *beliefs about disease preventability* question was adapted from a questionnaire used in an Australian study (B. Smith, et al., 1999) which assessed study participants' beliefs regarding the preventability of certain diseases. Some of health conditions in the original question were removed and replaced with those that were more relevant to the CHALICE study population. For example, child drowning, burns and scalds, serious road injury and tooth decay were removed and depression, dementia, bowel cancer and stroke were added.

The medical scepticism question was taken directly from a United States study (Fiscella, et al., 1998) that found that scepticism was associated with a lower uptake of preventative/healthy behaviours. The fatalism question was taken directly from a Singaporean study (Straughan & Seow, 2000) on attitudes towards breast screening.

4.1.3.4 Module 7 – lifestyle

For the purposes of this pilot study, only data from two of the four food-related sections of Module 7 were used: specifically the *Four day food and beverage diary* (Appendix E) and *Your opinion about food* (Appendix F) sections.

The food and beverage diary was a four day estimated food and beverage record. A four day record was used as it allows sufficient time to gather data to estimate usual intake without the high respondent burden of a seven day record (R. S. Gibson, 2005). Collection of weighed food records would be infeasible in this study due to high respondent burden and could adversely affect response rates. Using an estimated four day diary has been shown to provide robust data, suitable for use in large studies and is the method chosen for many large longitudinal cohort studies, such as the UK National

Survey of Health and development (G. D. Mishra, Silva, McNaughton, Stephen, & Kuh, 2011). The food diary was pretested in a group interview with a convenience sample of eight men aged 50 years and older. A group of men was used because they were less likely to know about food preparation and might therefore provide more feedback and suggestions on how to collect this information. The group discussed the food and beverage diary layout and the content of the diary instructions. Their feedback was incorporated into a revised food and beverage diary and the associated instructions for completion.

The *Your opinion about food* questionnaire was also discussed in the group interview. Based on their feedback the wording of some questions was changed to make them clearer and to obtain more information. Two dietitians with experience in survey design also reviewed all nutrition related material. Informal feedback was also obtained from ten New Zealand women aged 50 years and older who were known to the investigators. Feedback from these women was also incorporated into the questionnaire. Men and women aged 50 years and older were used because it is envisaged that these questionnaires will be used in the CHALICE longitudinal study, as participants grow older.

The *Your opinion about food* questionnaire comprised questions relating to estimated fruit and vegetable intake (question 1 and 2), perceived need to make dietary changes (question 3), knowledge of food composition (Table 4.1) (questions 5, 6, 7, 8), barriers to eating healthily (Table 4.2) (question 12) and knowledge of national food and nutrition guidelines (question 13). The estimation of *fruit and vegetable intake* question was adapted from the 2006/07 NZ Health Survey (Ministry of Health, 2007). The *perceived need to make dietary changes* question, "I do not need to make changes to the food I eat as it is already healthy enough", was a validated question taken from a Pan European survey (Lappalainen, Kearney, & Gibney, 1998). The *knowledge of food composition* questions were based on questions used as part of the United Kingdom "The Family Diet Study" (E. L. Gibson, et al., 1998). The foods used in these knowledge questions were altered so that they were compatible with the NZ diet. For example, whole bread/chapatti/roti was changed to bread, and sunflower margarine was changed to polyunsaturated margarine and low fat spread. The *barriers to eating healthily* questions were validated questions taken from a variety of studies: a large

multi country European study (Kearney & McElhone, 1999), a Spanish study (Lopez-Azpiazu, Martinez-Gonzalez, Kearney, Gibney, & Martinez, 1999), the SPARC Obstacles for action study (Sullivan, Oakden, Young, Butcher, & Lawson, 2003) and the 1997 NNS (Russell, et al., 1999). Participants chose an answer from the Likert scale where 1 = strongly disagree to 5 = strongly agree. Barrier statements were adapted as needed to suit the New Zealand population based on feedback from the pre-test group and the focus group. The *knowledge of the NZ national food and nutrition guidelines* question was a validated question used in the "The Family Diet Study" (E. L. Gibson, et al., 1998). Participants were asked to state the number of servings that nutritionists recommend we should eat per day, a "don't know" option was added to the question for people who did not know or could not guess the number of servings recommended.

Table 4.1: Food composition knowledge questions

Questions	Answer options		
Do you think these foods are high or low in fat?			
a. Pasta (without sauce)	High	Low	Don't know
b. Low fat spread	High	Low	Don't know
c. Luncheon meat	High	Low	Don't know
d. Pizza	High	Low	Don't know
e. Bread	High	Low	Don't know
f. Polyunsaturated margarine	High	Low	Don't know
Do you think these foods are high or low in sugar?			
a. Bananas	High	Low	Don't know
b. Rice bubbles	High	Low	Don't know
c. Ice cream	High	Low	Don't know
d. Cordial/fruit juice concentrate	High	Low	Don't know
e. Tomato sauce	High	Low	Don't know
f. Canned fruit in natural juice	High	Low	Don't know
Do you think these foods are high or low in salt?			
a. Sausages	High	Low	Don't know
b. Pasta	High	Low	Don't know
c. Tinned sardines	High	Low	Don't know
d. Red meat	High	Low	Don't know
e. Frozen vegetables	High	Low	Don't know
f. Cheddar cheese	High	Low	Don't know
Do you think these foods are high or low in fibre?			
a. Eggs	High	Low	Don't know
b. Red meat	High	Low	Don't know
c. Broccoli	High	Low	Don't know
d. Baked potatoes with skin	High	Low	Don't know
e. Chicken	High	Low	Don't know
f. Baked beans	High	Low	Don't know

Table 4.2: Barriers to eating healthily questions

The following is a list of possible things that keep people from eating healthily. For each one please indicate if you agree that these make eating healthily difficult for you.					
1 = Strongly agree, 3 = Neither agree nor disagree, 5 = Strongly agree					
a. I have irregular working hours	1	2	3	4	5
b. I have a busy lifestyle	1	2	3	4	5
c. I would have to give up foods I like	1	2	3	4	5
d. I don't have the willpower	1	2	3	4	5
e. I don't want to change my eating habits	1	2	3	4	5
f. It would be too great a change from my diet now	1	2	3	4	5
g. I don't have cooking skills	1	2	3	4	5
h. Healthy food doesn't keep fresh as long	1	2	3	4	5
i. Healthy food takes too long to prepare	1	2	3	4	5
j. I don't have storage facilities for the food	1	2	3	4	5
k. I have limited cooking skills	1	2	3	4	5
l. Healthy foods are too expensive	1	2	3	4	5
m. Healthy food is unappealing	1	2	3	4	5
n. I don't like strange or unusual foods	1	2	3	4	5
o. I feel like people are looking at me when I eat healthy foods	1	2	3	4	5
p. My friends/family don't like the taste	1	2	3	4	5
q. I don't know enough about eating healthily	1	2	3	4	5
r. Experts keep changing their mind	1	2	3	4	5
s. There is limited choice when I eat out	1	2	3	4	5
t. Healthy options are not available at home	1	2	3	4	5
u. Healthy options are not available at work	1	2	3	4	5
v. Healthy options are not available at the shop	1	2	3	4	5
w. Healthy food is more awkward to carry home from the shop	1	2	3	4	5
x. Healthy food doesn't fill me up	1	2	3	4	5

4.1.4 Data collection at interview

4.1.4.1 Module 1

A research nurse conducted Module 1 with the participant. Weight and body composition were measured on the Tanita Body Composition Analyser TBF-300 (Tanita Corporation of America Inc. www.tanita.com) with 0.0 kg entered for clothes and standard male or female setting chosen. Height was measured against a wall using a permanently attached tape measure. Participants were asked to remove their shoes, stand up straight against the wall and look straight ahead before the headpiece was lowered to firmly touch the crown of the head to measure height. Waist circumference was measured against the skin. A tape measure was placed at the mid-point between the lowest rib and the top of the iliac crest. Waist circumference was measured once to the nearest 0.5cm.

4.1.4.2 Modules 2 and 3

Module 2 and 3 questionnaires were asked by the interviewer and participants chose an answer from a list shown on the relevant show card.

4.1.4.3 Module 7

Module 7 consisted of four sections, one of which was sent to participants by mail to complete prior to the interview. The participants received an explanation of how to complete the other three sections at home at the end of the interview. Interviewers explained to the participants how to complete a home food inventory, a short questionnaire (neither of which were used in this thesis) and how to accurately complete an estimated four day food and beverage diary. Participants were asked to complete the food diary on one weekend day and three weekdays, and on alternate days. They were asked to write down all food and drinks consumed during those days, noting the time and location of consumption, the type of the food or beverages (including brand names or point of purchase), the amount consumed in common household measures or standard servings (for example one Griffins Gingernut) and how a food or beverage was prepared, listing all of the ingredients accurately. Participants were taught how to read food labels (to read portion size information, particularly for bread and muesli bars), shown portion estimating pictures (for spreads, jams, marmite and peanut butter) and a

sample diary was shown and explained to help participants accurately complete the diary. Participants were also given written information on how to complete a diary which detailed the information verbally explained.

4.1.5 Larger sample and longitudinal study

Data collection in its current format will continue until the full cohort is achieved. It is planned to follow-up participants annually and conduct an indepth interview every five years.

4.2 Data analysis

4.2.1 Data entry

Raw data (except for the food and beverage diary) were entered by the candidate into a study wide custom built database Progeny 7 (Progeny Software, LLC. www.progenygenetics.com). Data entry accuracy was checked by the study database technician by checking the data entered against the questionnaire answers. The Progeny database calculated the $ELSI_{SF}$ score from the raw data entered into the database. All other scores (for example, the *barriers to eating healthily* score) were calculated in Excel for Windows version 2010, (Microsoft, 2010) from data extracted from the Progeny database. There was no missing data for the 63 participants that returned a complete food and beverage diary.

Prior to entering the estimated food and beverage diaries into the food and nutrient analysis programme a set of data entry guidelines and assumptions were developed to use with all diaries. When recipes were provided the amount of each ingredient in one serve of the recipe was calculated and these ingredients were entered into the analysis programme. If no recipe was provided then a similar item was chosen from the analysis programme library and the portion size was estimated based on the participant's description of the item, for example a blueberry muffin from New World supermarket. Participants were required to provide information on the type of spread they use including the brand name so that an appropriate match could be chosen from the analysis programme. Fruit portion sizes were assumed to be the analysis programme default unless otherwise specified by the participant, for example one kiwifruit is 100 g.

Vegetable portion sizes were also entered using the same assumptions for all participants, for example two potato halves was assumed to be the same as one medium potato which is 114 g.

The food and beverage diary data was converted to nutrients by the candidate, by entering the foods and beverages consumed the data into Diet Cruncher for Windows, version 1.6.0 (Way Down South Software. www.waydownsouthsoftware.com). Only complete diaries were entered. Diary data entry and fruit and vegetable portion assumptions were checked by trained nutritionists with experience of this data entry method (including a thesis supervisor), and all suggested revisions were incorporated into the data files by the candidate. Advice was also obtained from 2008/09 NZ NNS investigators and/or staff where appropriate. Of the nutrient data calculated by the Diet Cruncher programme total energy, total fat, saturated fat and dietary fibre were used in further analyses. Total fat and saturated fat as a percentage of total energy consumed was calculated for each participants by multiplying the grams per day consumed by 37 kJ and dividing by the total energy consumed multiplied by 100. For example,

((50 g of saturated fat x 37 kJ)/8,500 kJ) x 100 = 21.8% TE.

Under-reporting was assessed by in each participant by comparing their estimated energy intake with their estimated energy requirements: basal metabolic rate (measured using Tanita Body Composition Analyser TBF-300) x 1.06 (R. S. Gibson, 2005). Under-reporters were classified as those with an energy intake less than their estimated energy requirements. To ensure that participants were not incorrectly classified as under-reporters, and to help ensure accurate food and beverage consumption data, participants with low energy intakes were asked if there were any other foods or drinks that they consumed and had forgotten to record.

4.2.2 Variable coding procedures

4.2.2.1 Economic living standards index short form

The $ELSI_{SF}$ score is a continuous score from 0 to 31 which is usually broken into seven categories ranging from severe hardship to very good standard of living. For data analysis $ELSI_{SF}$ scores were separated into the three groups as used in the 2006/07 NZ Health Survey: “hardship” (0-16), “comfortable” (17-24), “good/very good” (25-31).

4.2.2.2 Income

Raw household income data ranged from 1 (less than $5,000 per annum) to 15 ($150,000 or more per annum). Annual income was analysed as a continuous variable but participants that answered 'don't know' for household income were excluded from data analyses where income was a variable.

4.2.2.3 Fruit and vegetable portions

Usual fruit and vegetable consumption was calculated by counting the number of standard portions (according to the NZ Food and Nutrition Guidelines (Ministry of Health, 2003)) consumed each day averaged over the four days. For the purposes of this study vegetable portions excluded potato and kumara because they are carbohydrate dense and therefore should replace other carbohydrate dense foods in the diet rather than less energy dense vegetables (New Zealand Guidelines Group, 2009). Fruit and vegetable consumption was reported as the number of serves per day.

4.2.2.4 Knowledge of food composition

Food composition knowledge raw data was coded as 1 for correct answers and 0 for incorrect answers. The correct answers were designated by the candidate and confirmed with a supervisor. A total food composition knowledge score was calculated by adding the number of correct answers across the entire 24 questions; therefore a higher score translated to a greater knowledge of the nutrient composition of food. The minimum score was zero and the maximum score was 24.

4.2.2.5 Barriers to healthy eating

A *barriers to eating healthily* score was calculated by adding participant answers for each of the 24 barriers questions. A higher *barriers to eating healthily* score meant that the participant more strongly agreed that the barriers listed are barriers to eating healthily for them. The minimum score was zero and the maximum score was 48.

4.2.2.6 Knowledge of National food and nutrition guidelines

Knowledge of national food and nutrition guidelines raw data were coded as 1 for correct answers and 0 for incorrect answers or 'don't know' response. The correct answers were taken from the Food and Nutrition guidelines for Healthy Adults (Ministry of Health, 2003). Knowledge of the national food and nutrition guidelines score was calculated by adding the number of correct answers across the five questions. The minimum score was zero and the maximum score was five.

Table 4.3: Knowledge of national food and nutrition guidelines questions

What is the minimum number of servings of the foods below that nutritionists recommend we should eat per day?	
a. Fruit	
b. Vegetables	
c. Breads and cereals (eg. breads, grains, rice and pasta)	
d. Milk and milk products (eg. Milk, cheese, yoghurt, ice cream	
e. Lean meat, poultry, chicken, seafood, eggs, nuts and seeds and legumes	

4.2.2.7 Heart healthy diet definition

For the purposes of discussing whether or not Canterbury 50 year olds consumed a heart healthy diet, a heart healthy diet was defined as a diet in which total fat contributes less than 35% TE, saturated fat contributes less than 10% TE, dietary fibre intake is greater than 25 g per day, fruit intake is more than 2 servings per day and vegetables intake is more than 3 servings per day. This definition is based on the literature presented in the literature review section.

4.2.3 Sample size calculation

As this is a pilot study and CHALICE data collection is an on-going process, a cut-off point of 70 participants was initially decided upon. No formal sample size calculations were undertaken due to the exploratory nature of the data analysis. Seventy participants was the estimated number of people who would have been interviewed after 21 weeks of interviewing (from the end of August till the start of February 2011). Due to two major earthquakes which delayed participant recruitment and return of food diaries, data collection for this thesis was stopped at 63 participants.

4.3 Statistical methods

Data manipulation was conducted in Excel for Windows version 2010 (Microsoft, 2010) and statistical analyses were conducted using R Development Core Team (2010). Initially, predictor variables were assessed independently using simple linear regression and ANOVA. Predictor variables were household income, education, standard of living, knowledge of food composition and *barriers to eating healthily* score. Post hoc t-tests, adjusted for unequal variances if necessary, were used to test differences in mean body composition and nutrient intakes by gender and post hoc Tukey's ‘Honest Significant Difference’ method was used to test differences in household income and BMI by standard of living group. Statistical significance was assumed at $p < 0.05$. Multiple exploratory data analysis and graphical methods were used to investigate associations between variables.

The assumptions of linear regression (independence of errors, equal variance of errors and normality of errors) were checked for all significant linear regression models. The

Durbin-Watson test was used to check for independence of errors, the Scale-location graph was used to check for constant variance and the normality of residuals was checked with Q-Q plots and the Shapiro-Wilk test. The response variables were % TE from total and saturated fat and dietary fibre, fruit portions and vegetable portions consumed per day. Multiple linear regression was used to assess the association between multiple predictors and dietary intake or knowledge of food composition. Backward stepwise selection was used to select the most appropriate models. Where models did not meet the assumptions of linear regression, in the case of dietary fibre intake models, the response variable was transformed by taking the log of the response variable. There is potential for multiple correlations as a result of using multiple response variables to explain dietary intake. This was somewhat addressed by using principal component analysis (PCA) to explore the relationship between dietary intake and predictor variables.

PCA was conducted using five dietary components of a heart healthy diet: total fat intake as a % TE, saturated fat intake as a % TE, dietary fibre intake, fruit intake and vegetable intake. Data was z-scored before it was entered and rotated. The first and second principal components were used based on the elbow in the Scree plot and the interpretability of the first and second components. Multiple linear regression was applied to the first and second principal components with all predictor variables (household income, education, standard of living, knowledge of food composition, *barriers to eating healthily* score and BMI). Non-significant variables that did not contribute to the fit of the model were removed.

5.0 Results

Results are shown for the first 63 participants of the CHALICE project.

5.1 Response rate

Figure 5.1.1 shows an overview of participant recruitment. No interviews were conducted the week after the September 2010 Canterbury earthquake or for three weeks over the Christmas and New Year period. After 22 weeks 226 invitation letters had been sent and 146 people had responded to a letter, phone call or physical call. Of those that had responded 82 had completed an interview and prior to the data collection cut-off point 64 (78% of those completing an interview) had completed a food diary. Data collection and entry were curtailed due to the February 2011 Christchurch earthquake. Therefore only those food diaries that were completed prior to the 22nd of February and were received, checked and any necessary follow –up completed before the 11th of March 2011 were included in this thesis. Data from one food diary was not used because the food diary was not detailed enough and the participant could not provide sufficient additional information when contacted for follow up.

5.2 Sample characteristics

Table 5.1 contains details of the CHALICE sample characteristics. Data from 63 participants (33 females and 30 males) were collated. Average age was 50.85 years. The sample was mostly NZ European with 13% identifying as Maori (total response data). Three participants identified as both Maori and NZ European. Seventy percent of participants were currently married and 62% had post-secondary school qualifications. Most were in paid employment. Household income was distributed relatively evenly across the four income brackets. Mean (± SD) household income was $64,733 ± $12,390. Those in the lower household income bracket were receiving a government benefit, for example sickness, disability or unemployment benefit or were living on only one income. Standard of living was comparable with national data (Ministry of Health, 2010a).

Figure 5.1.1: Participant response rate

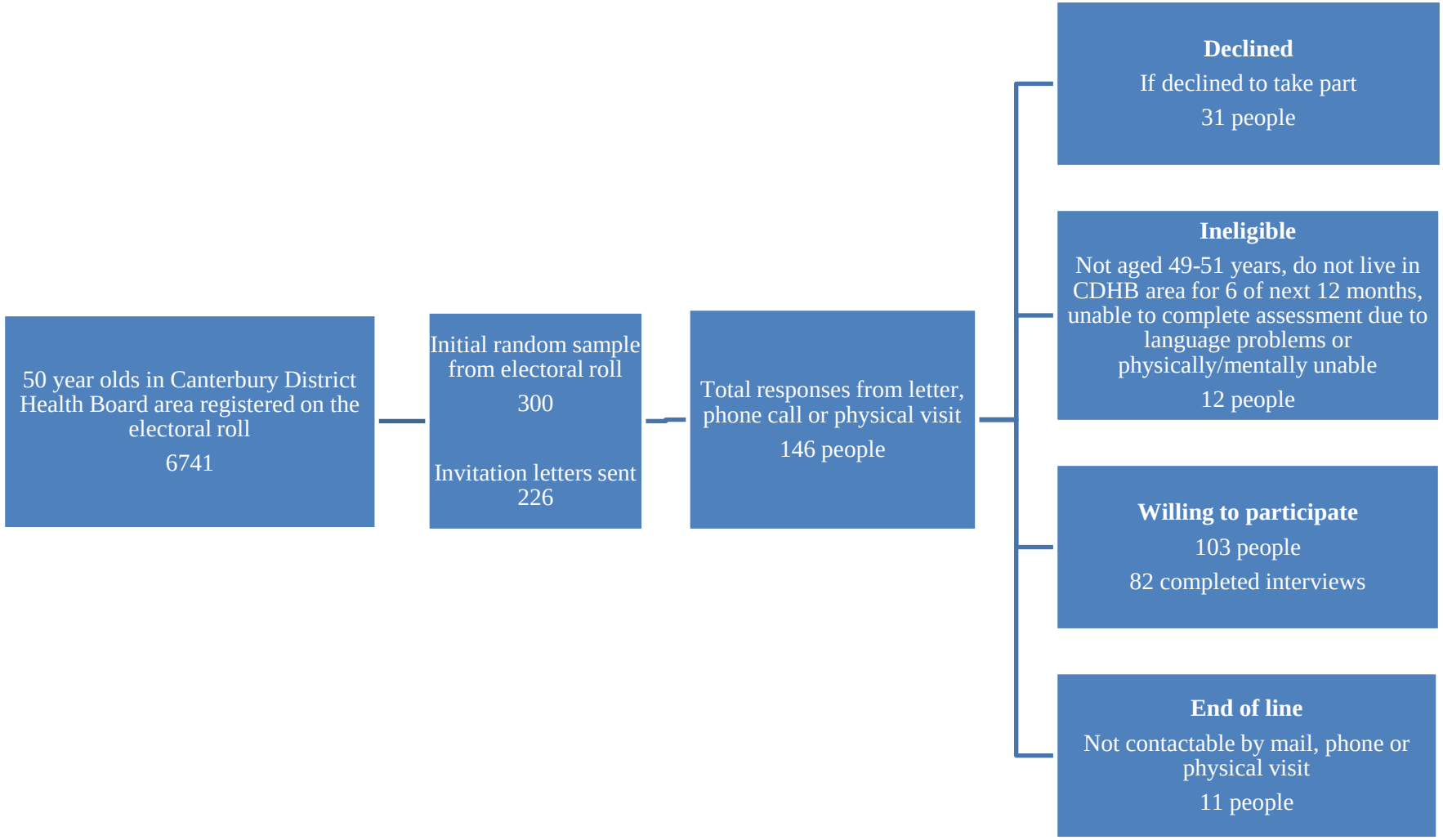


Table 5.1: CHALICE sample demographics

Demographics	Category	Number of participants (% of participants)
Number of participants		63
Gender	Male	30 (48)
	Female	33 (52)
Ethnicity *	NZ European	52 (83)
	Maori	8 (13)
	Other	6 (10)
Marital status (current)	Married	44 (70)
	Separated	4 (6)
	Divorced	6 (10)
	Widowed	4 (6)
	Never married	5 (8)
Education	No qualification	10 (16)
	Secondary school qualifications	12 (19)
	Post-secondary school qualification	28 (44)
	University degree	13 (21)
Employment (current)	In paid employment	56 (89)
	Not in paid work	7 (11)
Household income	< $40,000	12 (19)
	$40,000-70,000	14 (22)
	$70,000-120,000	19 (30)
	> $120,000	15 (24)
	Don't know	3 (5)
Standard of living ($ELSI_{SF}$)	Hardship	7 (11)
	Comfortable	19 (30)
	Good and very good	37 (59)

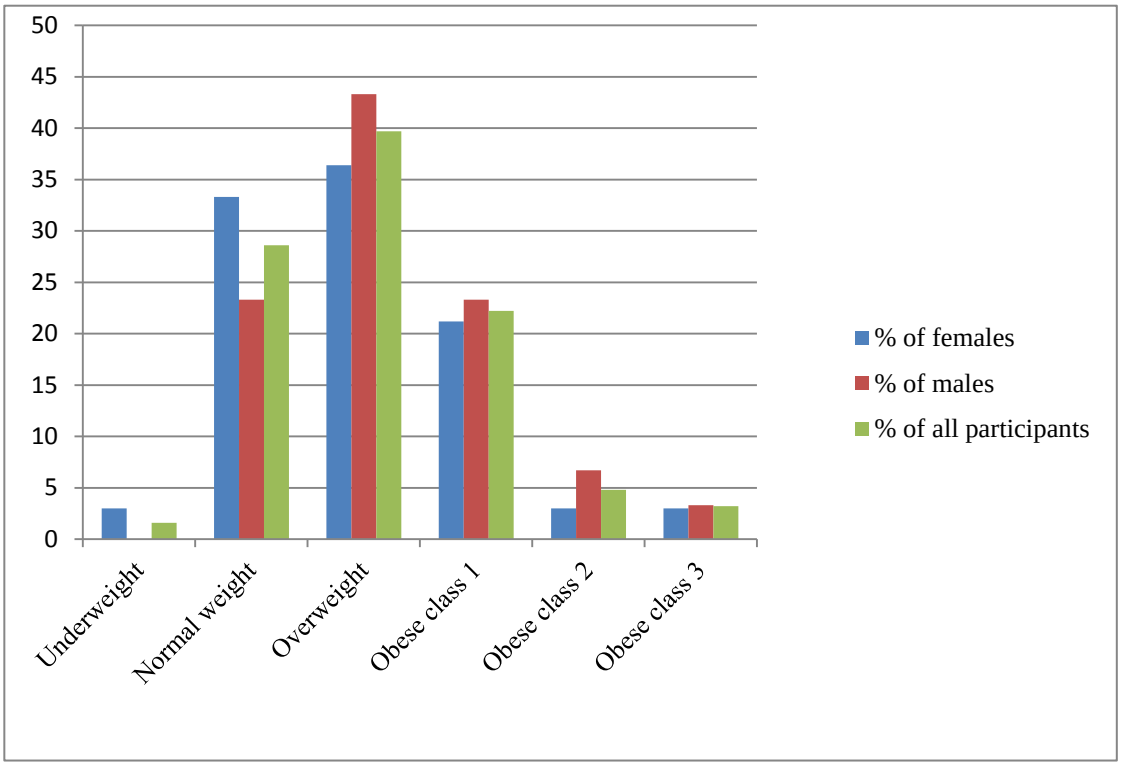
Note: Ethnicity data do not add up to 63 participants because 3 participants identified as of both Maori and NZ European ethnicity. That is, total response ethnicity is recorded.

5.2.1 Body composition

Figure 5.2.1 shows the BMI distribution of males and females; BMI did not differ significantly between the sexes ($t(60.35) = -0.68$, $p = 0.496$). Mean BMI was in the middle of the overweight category and body fat percentage was also higher than recommended (Table 5.2). The proportion of obese participants, classified as a BMI > 30 kg/m^2, was 30% which mirrors the NZ Health Survey 2006/07 results (Table 5.3).

Waist circumference measurements (Table 5.4) were distributed evenly across the three categories with approximately one third of participants above the cut off of 88 cm for females and 102 cm for males. Thirty-three percent of males had a waist circumference of greater than 102cm and 36.4% of females had a waist circumference greater than 88 cm.

Figure 5.2.1: Body mass index distribution of CHALICE participants



Note: BMI cut-offs are: (World Health Organisation, 2003)

Underweight: < 18.5 kg/m^2

Normal weight: 18.5 – 24.9 kg/m^2

Overweight: 25.0 – 29.9 kg/m^2

Obese class 1: 30.0 - 34.9 kg/m^2

Obese class 2: 35.0 – 39.9 kg/m^2

Obese class 3: > 40.0 kg/m^2

Table 5.2: Body composition of CHALICE participants

Composition measures	Females Mean ± SD	Males Mean ± SD	All participants Mean ± SD
Weight (kg)	74.7 ± 18.4	89.5 ± 17.1	81.8 ± 19.2
Height (cm)	165.1 ± 6.9	177.4 ± 6.5	171.0 ± 9.1
BMI (kg/m^2)	27.4 ± 6.5	28.5 ± 5.4	27.9 ± 6.0
Body fat (%)	37.8 ± 6.5	26.5 ± 7.6	32.4 ± 9.1
Waist circumference (cm)	87.0 ± 15.6	100.0 ± 13.4	94.0 ± 15.9

Note: The recommended percentage body fat for 50 year old males is 11-22% and 23-34% for females (Gallagher et al., 2000). These ranges are based on the average fatness of 50 year olds within the normal BMI range of 18.5-24.9 kg/m^2.

Table 5.3: Comparison of CHALICE sample with national data for a similar age group

Percentage with BMI >30 kg/m^2	Females (%)	Males (%)
2010 – CHALICE 50 year olds	27.2	33.3
2006/07 – NZ * 45-54 year olds	30.2	30.8
2002/03 – NZ** 45-54 year olds	24.5	26.0
1999 – NZ *** 45-64 year olds	26.5	23.0

* Source: 2006/07 NZ Health Survey (Ministry of Health, 2007)

** Source: 2002/03 NZ Health Survey (Ministry of Health, 2004)

*** Source: 1997 NZ National Nutrition Survey (Russell, et al., 1999)

Note: Waist circumference national data is not available. The 1997 NZ NNS reports waist to hip ratio not waist circumference data. Waist circumference was not measured in the NZ Health Surveys.

Table 5.4: Waist circumference distribution of CHALICE participants

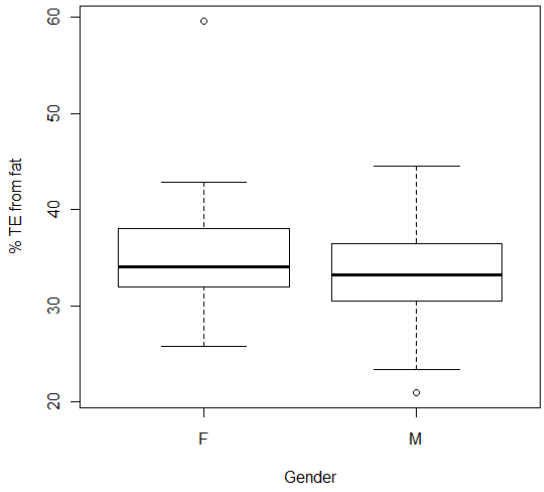
Waist circumference cut offs	Females (%)	Males (%)
Recommended Females < 80 cm, males < 94 cm	36.4	36.7
At increased risk Females 80-88 cm, males 94-102 cm	27.3	30.0
At substantially increased risk Females > 88 cm, males > 102 cm	36.4	33.3

Note: Cut-off source: (World Health Organisation, 2003). A waist circumference of more than 88 cm for females and 102 cm for males is associated with substantially increased risk of CVD as well as type 2 diabetes, hypertension and dyslipidaemia (National Institutes of Health, 1998).

5.3 How dietary intake compares with a heart healthy diet

Figures 5.3.1 – 5.3.5 illustrate the average dietary intake of total fat and saturated fat as a % TE and intakes of dietary fibre, fruit and vegetables from the four day food records. There were no significant differences between males' and females' intakes of total and saturated fat as a percentage of total energy intake or fruit and vegetables portions. Intake of dietary fibre differed significantly between males and females ($t(60.0) = -2.42$, $p = 0.019$). However when energy intake was taken into account dietary fibre intake did not differ significantly between males and females ($t(49.11) = 1.40$, $p = 0.019$). Mean (± SD) fibre intakes per 1000 kJ were 2.7 ± 0.5 g/1000kJ for females and 2.5 ± 0.7 g/1000kJ for males. The main sources of total fat, saturated fat and dietary fibre are shown alongside Figures 5.3.1 – 5.3.5. Recipes contributed at least 12% to total and saturated fat intakes. The food group 'recipes' is comprised of products that are entered into the nutritional analysis programme as a ready-made products such as cheese-cake rather than as the individual ingredients of a product. The recipes food group contains foods such as pan-fried whitebait fritters, quiche, meat pies, cheese cake and carrot cake.

Figure 5.3.1: Average total fat intake (% TE)



Mean intake ± SD

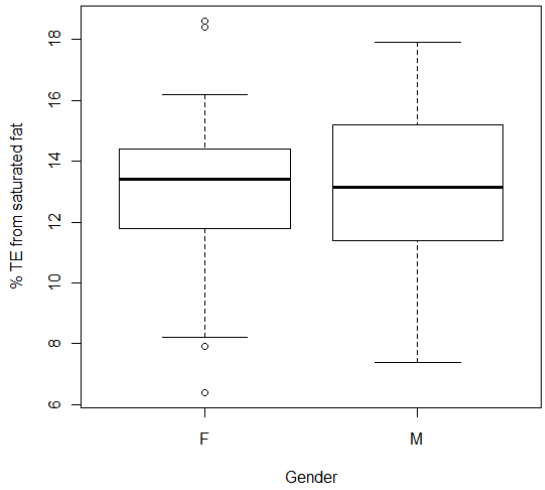
Female intake: 35.2 ± 6.0% TE

Male intake: 33.3 ± 5.2% TE

All participants: 34.3 ± 5.7% TE

Sources of total fat in descending order: Dairy products, Meat, Recipes, Fast Foods, Fat and Oils

Figure 5.3.2: Average saturated fat intake (% TE)



Mean intake ± SD

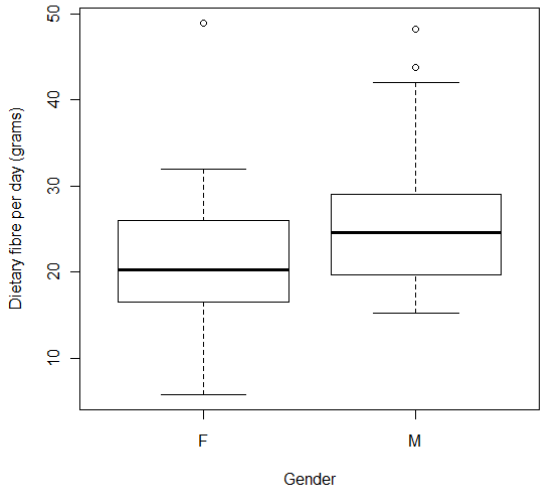
Female intake: 13.0 ± 2.8% TE

Male intake: 13.2 ± 2.6% TE

All participants: 13.1 ± 2.7% TE

Sources of saturated fat in descending order: Dairy products, Meat, Fast Foods, Recipes

Figure 5.3.3: Average dietary fibre intake (g/day)



Mean intake ± SD

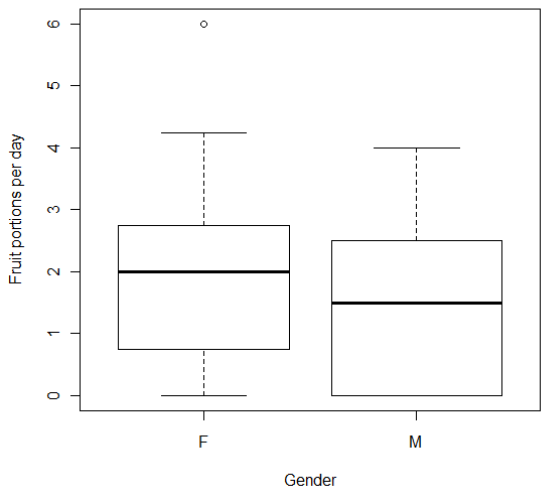
Female intake: 21.2 ± 7.9 g/day

Male intake: 26.1 ± 8.2 g/day

All participants: 23.6 ± 8.3 g/day

Sources of dietary fibre in descending order: Breads, Cereals and Baked Goods, Vegetables, Fruit, Fast Foods

Figure 5.3.4: Average fruit intake (portions/day)



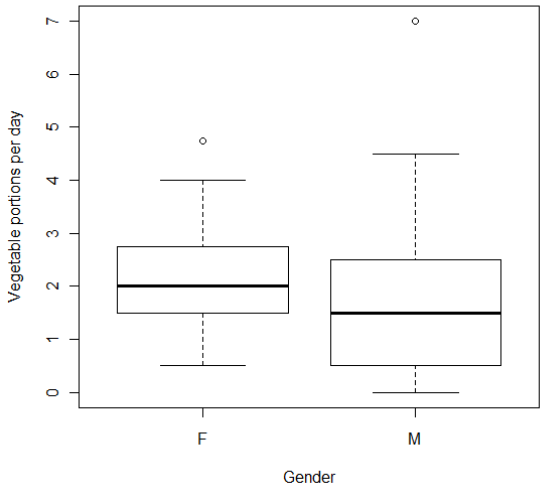
Mean intake ± SD

Female intake: 1.9 ± 1.4 portions per day

Male intake: 1.5 ± 1.3 portions per day

All participants: 1.7 ± 1.4 portions per day

Figure 5.3.5: Average vegetable intake (portions/day)



Mean intake ± SD

Female intake: 2.3 ± 1.1 portions per day

Male intake: 1.9 ± 1.5 portions per day

All participants: 2.1 ± 1.3 portions per day

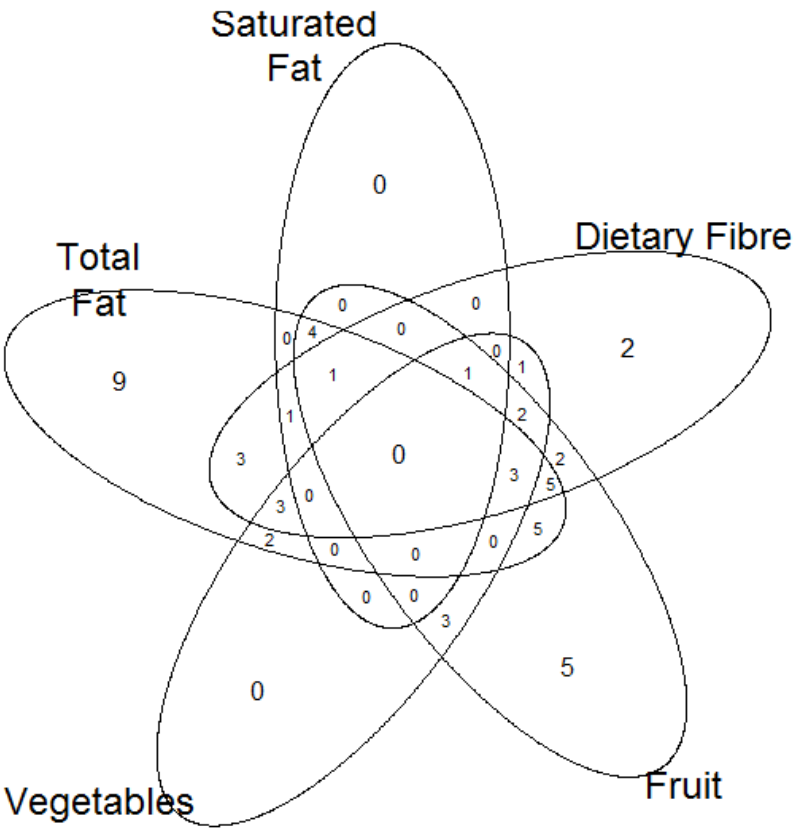
Fruit and vegetable intake was assessed using two methods: four day estimated food and beverage diary and the estimation of *fruit and vegetable intake* question. Only 36% of participants estimated that they consumed at least 2 serving of fruit per day and only 35% estimated that they consumed at least 3 servings of vegetables per day (excluding potato and kumara). Participants' estimation of their fruit intake was on average within 0.05 portions of their fruit intake from the food and beverage diaries. Vegetable intake was on average 0.43 portions more the vegetable intake recorded in the food and beverage diaries.

The only heart healthy dietary recommendation met by at least half of participants was percent energy from total fat (34.3% TE). Mean intakes of saturated fat, dietary fibre, fruit and vegetables did not meet the recommendations. Figure 5.3.6 shows the distribution of participants that met the various heart healthy dietary recommendations. No participant met all five of the heart healthy dietary guidelines (Figure 5.3.7). Approximately 50% of participants obtained less than 35% TE from fat and ate at least two servings of fruit per day. Only 11.5% obtained less than 10% TE from saturated fat and approximately one third of participants consumed more than 25 g per day of dietary fibre and ate at least three servings of vegetables (excluding potatoes and kumara) per day (Figure 5.3.8).

The participants who obtained less than 10% TE from saturated fat tended to consume no red meat or only small portions (no more than 100 g per day) of lean red meat, poultry or pork. They usually consumed only ½ cup of low fat dairy per day or used soya or rice milk in place of cow's milk. If they did eat cheese it was usually no more than 30 g a day of Edam cheese and they did not consume it every day.

Under-reporting occurred in 11% of the participants based on an energy intake less than 1.06 times their basal metabolic rate as measured using Tanita Body Composition Analyser TBF-300. The mean difference between estimated energy requirement (basal metabolic rate times 1.06) and estimated energy intake was 105 kJ.

Figure 5.3.6: Number of participants that met heart healthy dietary recommendations



Note: Recommendations: total fat <35% TE, saturated fat <10% TE, dietary fibre >25 g/day, fruit > 2 servings/day, vegetables >3 servings/day

Figure 5.3.7: Percentage of participants who achieved from 0 to 5 of the heart healthy dietary recommendations

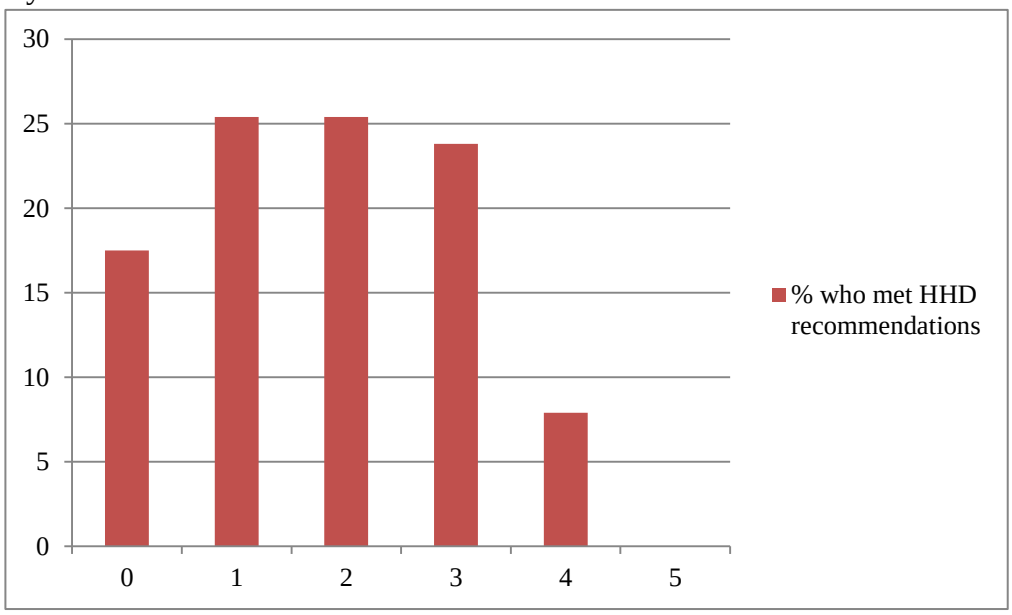
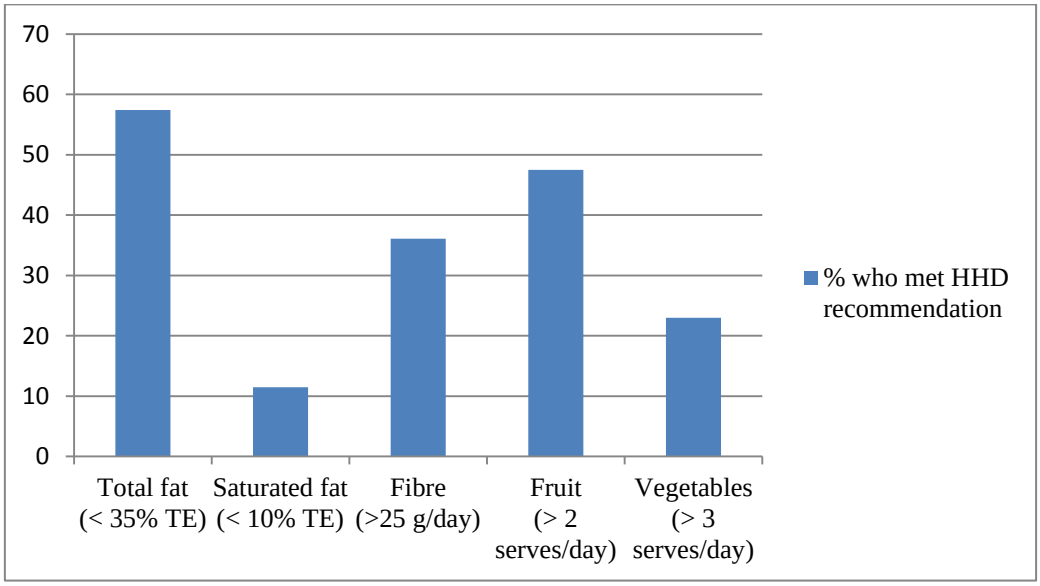


Figure 5.3.8: Percentage of CHALICE participants who achieved the heart healthy dietary recommendations for each item



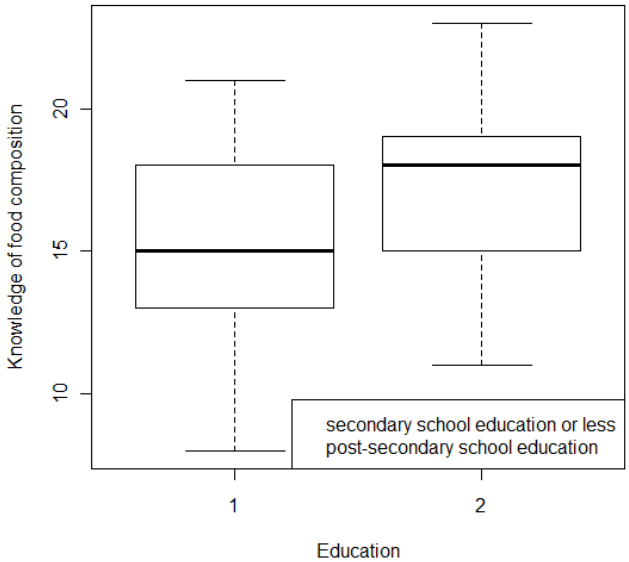
5.4 Psychosocial barriers and facilitators to healthy eating

5.4.1 Knowledge of food composition

Knowledge of food composition was measured on a scale of 0 to 24. On average, participants identified the correct answer to 70% of the questions, and the mean (± SD) knowledge score was 17.0 ± 3.3. There was no significant difference in food composition knowledge between males and females ($t(60.12) = 1.57$, $p = 0.122$). There were six out of 24 knowledge of food composition questions (Table 5.5) for which less than 51% of participants correctly identified whether a food was low or high in fat, sugar or salt. More than 50% of participants correctly answered all of the dietary fibre questions. Approximately 85% of participants thought that low fat spread was low in fat, whereas low fat spread is approximately 50% fat.

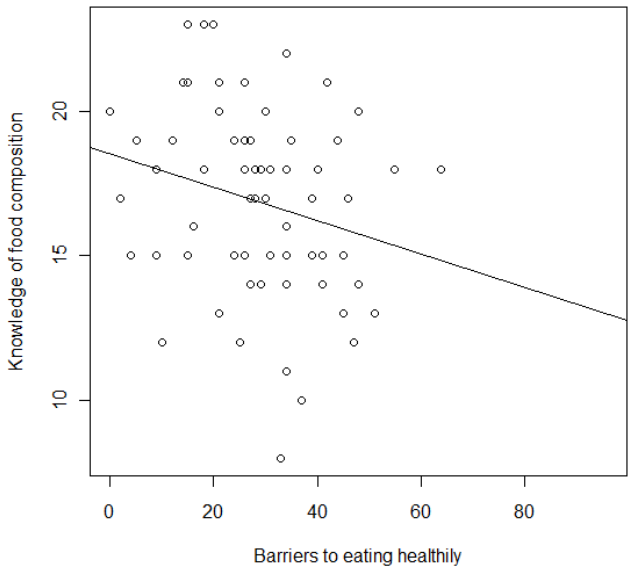
Knowledge of food composition was not associated with standard of living, income or BMI. However, post-secondary school education compared with secondary school education or less was associated with a greater knowledge of food composition score. Those with post-secondary school education were estimated to score (β=2.06, 95% CI: [0.39, 3.73], Adj $R^2 = 0.08$, $p = 0.016$) more than those with secondary school education or less (Figure 5.4.1). There was a close to significant negative association between knowledge of food composition and *barriers to eating healthily* ($\beta = -0.06$, 95% CI: [-0.12, 0.00], Adj $R^2 = 0.04$, $p = 0.056$); as *barriers to eating healthily* increased, knowledge of food composition score decreased (Figure 5.4.2).

Figure 5.4.1: Association between level of education and knowledge of food composition (regression of categorical predictors)



Note: difference between secondary school education or less and post-secondary school (β=2.06, 95% CI: [0.39, 3.73], Adj R^2 = 0.08, p = 0.016)

Figure 5.4.2: Association between *barriers to eating healthily* and knowledge of food composition (linear regression)



Note: as *barriers to eating healthily* increased knowledge of food composition score decreased (β = -0.06, 95% CI: [-0.12, 0.00], Adj R^2 = 0.04, p = 0.056)

5.4.2 Knowledge of national food and nutrition guidelines

Overall knowledge of the national food and nutrition guidelines was poor. Only one participant out of 63 correctly knew four of the five national guidelines. No participants knew that the recommended number of servings of breads and cereals per day is six servings. Thirty percent of participants knew that New Zealanders are recommended to eat two servings of milk or milk products and two servings of fruit per day. Thirty-eight percent and 44% of participants knew that they should eat three servings of vegetables and one serving of meat, poultry or alternatives per day, respectively. Twenty-seven percent of participants thought that the recommended servings per day for fruit and for vegetables was five servings of each. Table 5.6 describes the national guidelines and the percentage of participants that knew each guideline.

Table 5.5: Knowledge of food composition questions that less than 50% of participants answered correctly

Nutrient	Knowledge of food composition questions	Correct answer	Participants who answered correctly (%)
Fat	Low fat spread	High	17
	Polyunsaturated margarine	High	51
Sugar	Bananas	High	44
	Rice bubbles	Low	46
	Canned fruit in natural juice	High	41
Salt	Tinned sardines	High	44

Table 5.6: Knowledge of national food and nutrition guidelines

Food group	Food and nutrition guideline (serves/day)	Participants who answered correctly (%)
Fruit	2	30
Vegetables	3	38
Breads and cereals	6	0
Milk and milk products	2	30
Lean meat, poultry, chicken, seafood, eggs, nuts and seeds and legumes	1	44

5.4.3 Barriers to eating healthily

A score of zero on the *barriers to eating healthily* scale corresponded to strongly disagreeing that the specified barriers make eating healthily difficult; that is, a participant does not have any *barriers to eating healthily*. In contrast a score of 96 corresponds to strongly agreeing that the specified barriers make eating healthily difficult. The mean (± SD) barrier score was 29.06 ± 13.74 which means that on average participants agreed that the barriers listed made eating healthily somewhat difficult. Participants who neither agreed nor disagreed that the specified barriers made eating healthily difficult scored 48. There was no significant difference between barrier scores of males and females ($t(59.90) = -1.12$, $p = 0.266$).

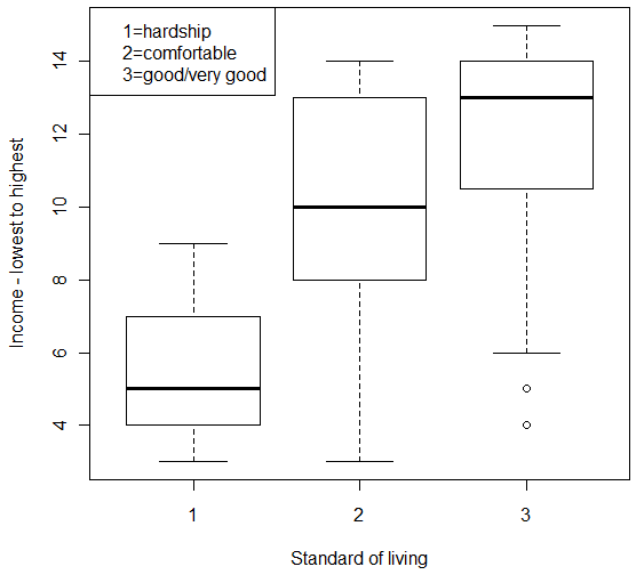
The most common barrier to eating healthily was "I would have to give up foods I like". Forty-one percent of participants agreed or strongly agreed that this made eating healthily difficult for them. Thirty percent of participants reported that "I have irregular working hours", "I have a busy lifestyle" and "Healthy foods are too expensive" made eating healthily difficult for them. On the other hand 90% of participants disagreed or strongly disagreed that "Healthy food is more awkward to carry home from the shop" made eating healthily difficult. At least 80% of participants disagreed or strongly disagreed that "I don't have storage facilities for the food", "I have limited cooking facilities" and "Healthy options are not available at home" were barriers to eating healthily.

5.4.4 Standard of living

The majority of participants (59%) had a "good or very good" standard of living ($ELSI_{SF}$ score of 25-31) and 11% experienced at least some "hardship" ($ELSI_{SF}$ score of 0 - 16). Standard of living was associated with household income ($F(2,57) = 15.71$, $MSe = 126.82$, $p < 0.001$), as household income increased so did standard of living. Mean household income of the "hardship" standard of living group was $22,885 which was significantly lower than those with a "comfortable" standard of living whose mean household income was $61,670 (Tukey's 'Honest Significant Difference' method $p = 0.002$) and significantly lower than the those with a "good/very good" standard of living whole mean household income was $81,160 (Tukey's 'Honest Significant Difference' method, $p < 0.001$). Those in the "comfortable" standard of living group did not have a

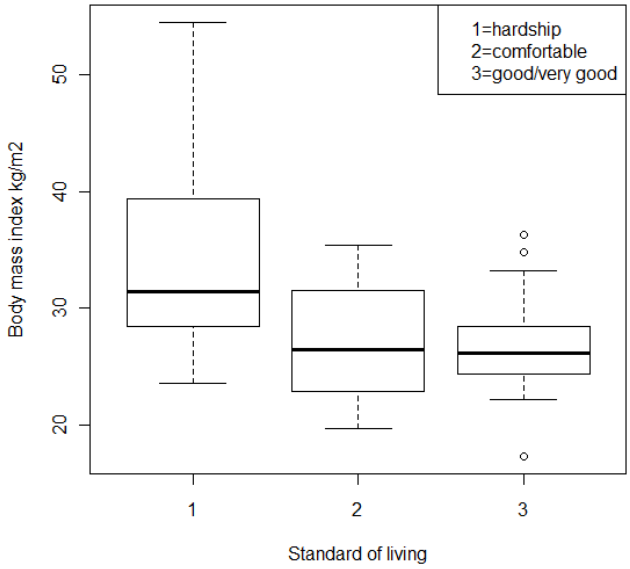
significantly lower household income than those with a “good/very good” standard of living (Tukey's ‘Honest Significant Difference’ method, $p = 0.065$). An analysis of variance including all three standard of living categories showed an inverse association with BMI ($F(2,60) = 6.58$, $MSe = 199.12$, $p < 0.003$). Tukey's ‘Honest Significant Difference’ method was to see where the differences existed; there were only significant differences in BMI between those with a “hardship” standard of living and those with a “comfortable” ($p = 0.006$) or “good/very good” standard of living ($p = 0.002$) and no difference between the “comfortable” and “good/very good” standard of living groups ($p = 0.983$), none of the mean BMI values for each standard of living category were significantly different from each other. Standard of living was not associated with level of education or *barriers to eating healthily*. Figures 5.4.3 and 5.4.4 show the relationship between standard of living and household income and BMI.

Figure 5.4.3: Standard of living against household income (ANOVA)



Note: As household income increased so did standard of living ($F(2,57) = 15.71$, $MSe = 126.82$, $p < 0.001$), There were significant differences between the "hardship" category and the other two categories (Tukey's 'Honest Significant Difference' method, $p < 0.002$) but not between the "comfortable" and "good/very good" category ($p = 0.065$). Income data excludes 3 participants who did not know their usual annual household income.

Figure 5.4.4: Standard of living against body mass index (kg/m^2) (ANOVA)

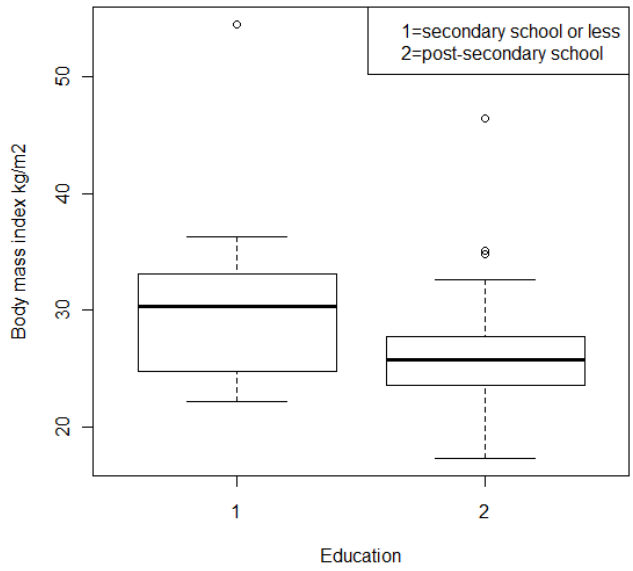


Note: inverse association with BMI ($F(2,60) = 6.58$, $MSe = 199.12$, $p < 0.003$). There were significant differences between the "hardship" category and the other two categories (Tukey's 'Honest Significant Difference' method, $p < 0.006$) but not between the "comfortable" and "good/very good" category ($p = 0.983$). The lowest standard of living category included participants with BMIs of 46.1 kg/m^2 and 59.6 kg/m^2

5.4.5 Level of education

Level of education was divided into two groups for the purposes of analysis. Level of education 1 comprised participants with secondary school education or no qualifications. Level of education 2 comprised those with post-secondary school education including university degrees. Level of education was associated with BMI ($F(1,61)=5.746$, $MSe = 190.617$, $p < 0.020$); mean BMI of those with secondary school education or less was 30.3 kg/m^2 which was significantly higher ($t(32.64) = 2.165$, $p = 0.038$) than the mean BMI of those with post-secondary school education which was 26.7 kg/m^2 (Figure 5.4.5). Level of education was not associated with household income or *barriers to eating healthily* score.

Figure 5.4.5: Level of education against body mass index (kg/m^2) (ANOVA)



Note: inverse association with BMI ($F(1,61)=5.746$, $MSe = 190.617$, $p < 0.020$). Mean BMI of those with secondary school education or less was significantly ($t(32.64) = 2.165$, $p = 0.038$) lower than those with post-secondary school education.

5.4.6 Attitudes and beliefs about disease

Beliefs about disease preventability, specifically preventability of heart attacks and high blood pressure, were not associated with level of education or standard of living. Ninety percent of participants believed that heart attacks, high blood pressure and type 2 diabetes were totally or sometimes preventable. Approximately 95% of participants agreed or strongly agreed that good health and prevention of disease is mostly controlled by their own actions and self-care. Due to the limited data variability and the small sample size participant answers to questions on beliefs about disease preventability, attitudes towards preventative programmes and attitudes towards self-help disease management were not included in models with dietary intake (see full descriptive results in Tables 5.7 - 5.9).

Table 5.7: Disease preventability beliefs of participants (percentage of participants)

Opinion	Skin Cancer	Lung Cancer	Bowel Cancer	High blood pressure	Heart attacks	Type 1 diabetes	Type 2 diabetes	Stroke	Dementia	Depression
Totally preventable	35	49	11	27	14	11	37	8	2	19
Sometimes preventable	62	43	67	67	76	38	54	57	11	59
Rarely preventable	2	3	13	2	8	27	5	19	42	14
Not preventable	2	5	3	5	2	17	0	14	40	3
Don't know	0	0	6	0	0	6	5	2	6	5

Note: percentages may not add to 100% due to rounding

Table 5.8: Attitudes towards self-help management of illness (percentage of participants)

Opinion	I can overcome most illness without help from a medically trained professional	Home remedies are often better than drugs prescribed by a doctor	If I get sick, it is my own behaviour that determines how soon I get well again	I understand my health better than most doctors do
Strongly agree	3	3	17	5
Inclined to agree	24	14	43	30
Neither	30	25	24	24
Inclined to disagree	32	41	13	33
Strongly disagree	0	0	0	0
Don't know	11	17	3	8

Table 5.9: Attitudes towards preventative programmes (percentage of participants)

Scale from 1 to 7	Life and death are all predestined: there is nothing we can do to change our destiny	Serious diseases like cancer are all fated; we cannot prevent them from happening	If you are fated to get cancer, you will get cancer; there is nothing you can do to change fate	If you don't die from this, you'll die from that. So there's no point taking screening test	If we feel well, we should not go looking for trouble by having medical screening tests	Many types of disease can be prevented; it's up to us to do something about it	Whether I enjoy good health or not depends a lot on how well I take care of myself
Strongly disagree	14	13	16	49	30	0	0
↓	27	32	33	30	30	0	0
	16	17	11	11	22	3	0
	5	22	17	5	8	3	5
	14	6	14	0	2	19	16
	16	3	5	3	5	46	49
Strongly agree	8	6	3	2	3	29	30

5.5 Associations with dietary intake

To assess for associations with dietary intake exploratory analysis was conducted using multiple linear regression with the following predictors: household income, level of education, standard of living, knowledge of food composition and *barriers to eating healthily*.

5.5.1 Total fat

One participant consumed a high proportion of energy as fat (59.6% TE) as a result of choosing to eat a low starch diet to control a health condition. This result was removed from total fat modelling because it was an outlier and the linear modelling was not designed to make predictions around such a high level of intake. Level of education, knowledge of food composition and *barriers to eating healthily* were not associated with the % TE obtained from total fat, however standard of living was inversely associated with the % TE obtained from total fat. Standard of living explained 13.1% of the variation in the % TE obtained from fat ($F(2,59) = 5.609$, $p = 0.006$). Those with a "comfortable" standard of living obtained 6.5% TE (95% CI: [-10.4, -2.6], $p = 0.001$) less from total fat than those with a "hardship" standard of living. Similarly those with a "good/very good" standard of living obtained 4.8% TE (95% CI: [-8.4, -1.2], $p = 0.01$) less from total fat than those with a "hardship" of standard of living.

5.5.2 Saturated fat

Level of education explained 13.2% of the variation in the % TE obtained from saturated fat ($F(1,61) = 10.38$, $p = 0.002$). Participants who had post-secondary school education were estimated to obtain 2.1% TE (95% CI: [-3.4, -0.8]) less from saturated fat than those with only secondary school education or less. Knowledge of food composition, *barriers to eating healthily* and standard of living were not associated with saturated fat intake.

5.5.3 Dietary fibre

Level of education was the only psychosocial variable associated with dietary fibre intake. Level of education explained 6.6% of the variation of fibre intake ($F(1,61) = 5.39$, $p=0.023$). Post-secondary school education was associated with an estimated increase in dietary fibre intake of 1.2 g/day (95% CI: [1.0, 1.5]) compared with secondary school education or less.

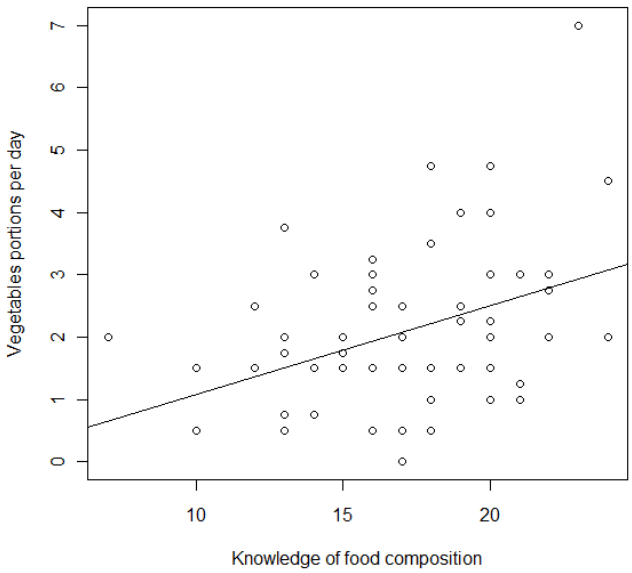
5.5.4 Fruit

None of the psychosocial variables were associated with fruit intake.

5.5.5 Vegetables

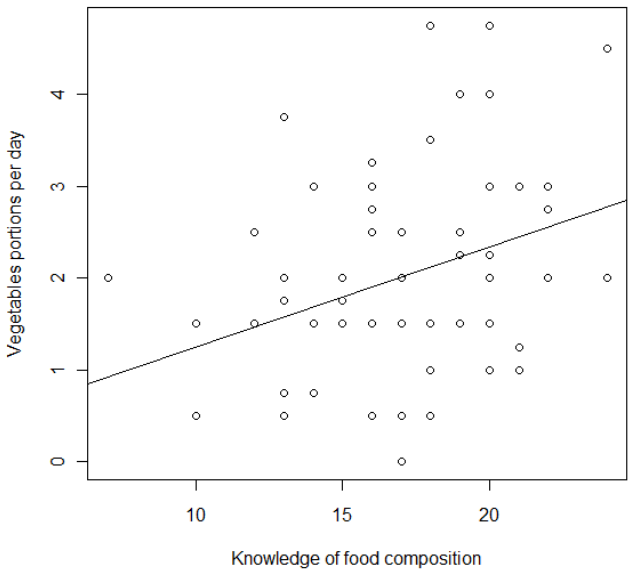
One participant ate a large number of vegetable portions per day (seven servings of vegetables per day). Linear modelling was carried out both including (Figure 5.5.1) and excluding this value (Figure 5.5.2). Of the psychosocial variables only knowledge of food composition was associated with vegetable intake. With all data included vegetable consumption increased by 0.15 (95% CI: [0.06, 0.25], Adj $R^2 = 0.13$) portions per day as knowledge of food composition increased by one point ($F(1,61) = 10.47$, $p = 0.002$). Excluding the participant that consumed an average of seven portions per day vegetable consumption increased by 0.12 (95% CI: [0.03, 0.19], Adj $R^2 = 0.10$) portions/day as knowledge of food composition increased by one point ($F(1,60) = 7.49$, $p = 0.008$).

Figure 5.5.1: Association between knowledge of food composition and vegetable intake including all data (linear regression)



Note: as knowledge of food composition increased intake of vegetables increased (0.15 (95% CI: [0.06, 0.25], Adj R^2 = 0.13))

Figure 5.5.2: Association between knowledge of food composition and vegetable intake excluding outlier (linear regression)



Note: as knowledge of food composition increased intake of vegetables increased (0.12 (95% CI: [0.03, 0.19], Adj R^2 = 0.10))

5.6 Heart healthy diet consumption

Principal component analysis was performed on the dietary intake data for total and saturated fat as a % TE, dietary fibre, fruit and vegetables portions, to generate dietary patterns and to investigate if the dietary patterns produced were associated with a particular combination of psychosocial variables. PCA produced three patterns. Over 50% of the dietary intake variation was explained by the first and second patterns (Table 5.10). The third pattern did not significantly add to the overall dietary intake variation.

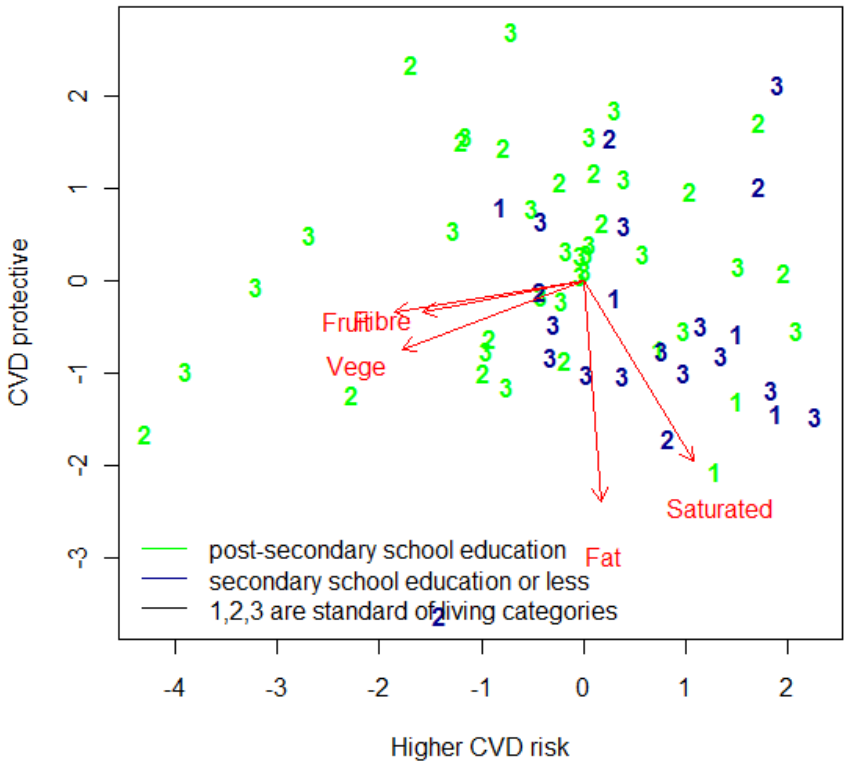
The first principal component pattern ("higher CVD risk") reflects a high saturated fat, moderate total fat and low fruit and vegetable and dietary fibre diet. A more positive score for this pattern corresponds to high saturated fat intake and a lower fruit, vegetable and fibre intake. This dietary pattern is more likely to increase CVD risk. The second principal component pattern ("CVD protective") was affected more by total and saturated fat intake. A more positive pattern score for this pattern corresponds to a lower total and saturated fat intake and a higher fruit, vegetable and fibre intake. This dietary pattern can be described as CVD protective.

Figure 5.6.1 illustrates the relationship between the "higher CVD risk" and the "CVD protective" patterns and the distribution of participants within the different standard of living categories and levels of education. Participants with post-secondary school education tended to lie in the upper half of the figure which corresponds to a dietary pattern higher in dietary fibre, fruit and vegetables than those with secondary school education or less. Also those with secondary school education or less and those with a "hardship" of standard of living are clustered towards the bottom right hand area which indicates that they tend to have a dietary pattern with higher amounts of total and saturated fat as % TE.

Table 5.10: Principal component analysis loadings and importance

	Component 1	Component 2	Component 3	Component 4	Component 5
Total fat	0.051	-0.743	0.249	0.119	0.607
Saturated fat	0.334	-0.610	-0.328	-0.237	-0.593
Dietary fibre	-0.491	-0.105	-0.820	0.172	0.216
Fruit	-0.579	-0.107	0.194	-0.785	-0.009
Vegetables	-0.556	-0.230	0.348	0.533	-0.482
Standard deviation	1.385	1.193	0.851	0.714	0.652
Proportion of variance	0.383	0.285	0.145	0.102	0.085
Cumulative proportion	0.383	0.668	0.813	0.915	1.000

Figure 5.6.1: Distribution of participant intake and their level of education and category of standard of living (principal component analysis)

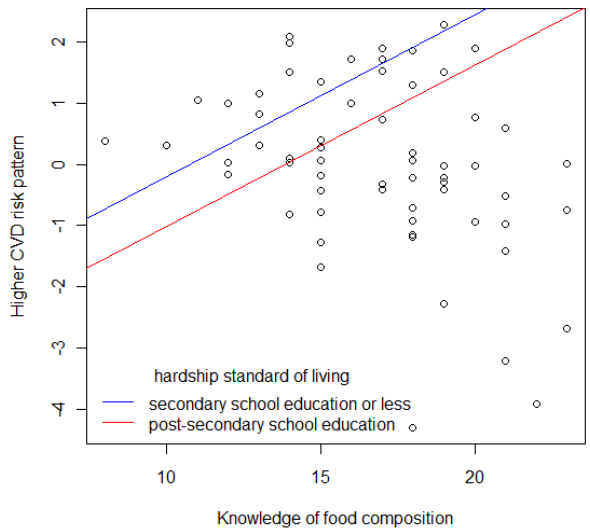


Note: the red arrows show the direction of the pattern

5.6.1 Cardiovascular disease risk pattern

The “higher CVD risk” pattern explains 38% of the overall dietary variation. Exploratory multiple linear regression was conducted to investigate associations between psychosocial variables and the dietary pattern. The psychosocial variables that were associated with this dietary pattern were standard of living, level of education and knowledge of food composition. The best linear model included all three of these variables plus an interaction between standard of living and knowledge of food composition. This model explained 24.9% of the variation within the dietary pattern ($p = 0.001$). Figures 5.6.2 – 5.6.5 explain how level of education and standard of living are associated with the “higher CVD risk” pattern.

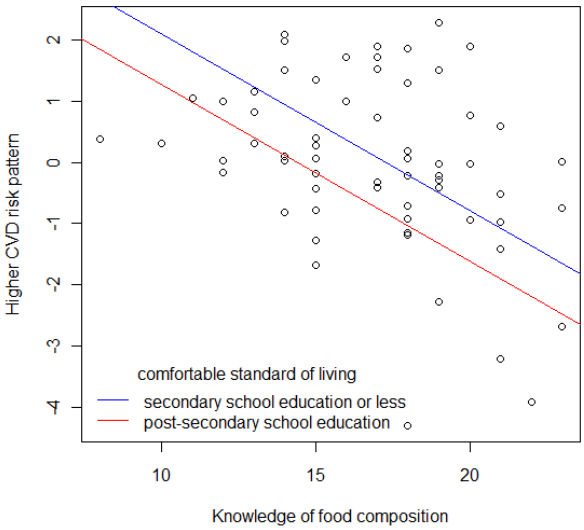
Figure 5.6.2: Association between knowledge of food composition, "hardship" standard of living and level of education with a "higher CVD risk" dietary pattern (multiple linear regression, Adj R^2 = 0.25)



Interpretation of figure 5.6.2

All of the data included in the multiple linear regression analysis are plotted in the figure; however the regression lines are only relevant for the seven participants with a "hardship" standard of living. As knowledge of food composition increases, participants with a "hardship" standard of living tend to consume a dietary pattern higher in saturated fat and lower in fruit, vegetables and dietary fibre. This association did not reach statistical significance. There was a statistically significant difference in pattern score between those with secondary school education or less and those with post-secondary school education (β = -0.82, 95% CI: [-1.52, -0.13], Adj R^2 = 0.25, p = 0.021). As knowledge of food composition increased those with secondary school education or less had higher scores for the "higher CVD risk" dietary pattern than those with post-secondary school education.

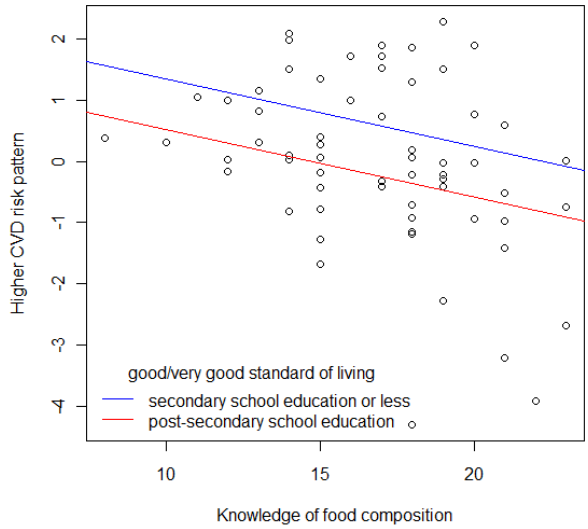
Figure 5.6.3: Association between knowledge of food composition, "comfortable" standard of living and level of education with a "higher CVD risk" dietary pattern (multiple linear regression, Adj R^2 = 0.25)



Interpretation of figure 5.6.3

All of the data included in the multiple linear regression analysis are plotted in the figure; however the regression lines are only relevant for those participants with a "comfortable" standard of living. There was a significant association between "comfortable" standard of living and a "higher CVD risk" pattern score and knowledge of food composition (β = 7.79, 95% CI: [1.46, 14.13], Adj R^2 = 0.25, p = 0.017). As knowledge of food composition score increased, participants with a "comfortable" standard of living tended to consume a dietary pattern of more fruit, vegetables and dietary fibre and less saturated fat. Those with post-secondary school education consumed a healthier dietary pattern (β = -0.82, 95% CI: [-1.52, -0.13], Adj R^2 = 0.25, p = 0.021) than those with secondary school education or less.

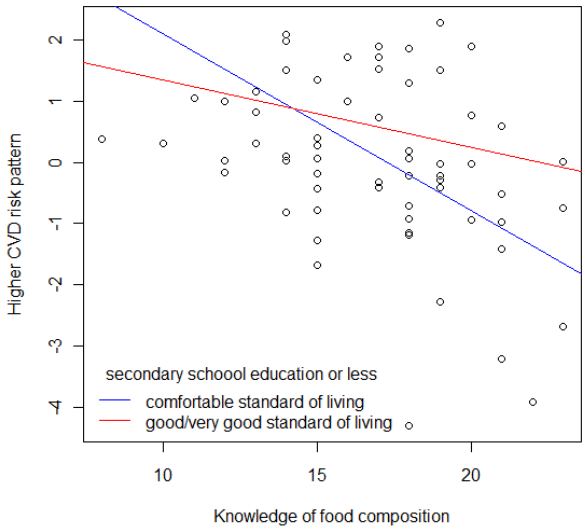
Figure 5.6.4: Association between knowledge of food composition, "good/very good" standard of living and level of education with a "higher CVD risk" dietary pattern (multiple linear regression, Adj R^2 = 0.25)



Interpretation of figure 5.6.4

All of the data included in the multiple linear regression analysis are plotted in the figure; however the regression lines are only relevant for those with a "good/very good" standard of living. The same trend was seen in participants with a "good/very good" standard of living, as with those with a "comfortable" standard of living, but the relationship was not as strong. As knowledge of food composition increased, participants consumed a dietary pattern that was slightly higher in fruit, vegetables and dietary fibre and lower in saturated fat (β = 5.25, 95% CI: [-0.22, 10.73], Adj R^2 = 0.25, p = 0.060). Overall those with post-secondary school education consumed a healthier dietary pattern than those with secondary school education or less (β = -0.82, 95% CI: [-1.52, -0.13], Adj R^2 = 0.25, p = 0.021).

Figure 5.6.5: Association between knowledge of food composition and standard of living interaction with a "higher CVD risk" dietary pattern (multiple linear regression, Adj R^2 = 0.25)



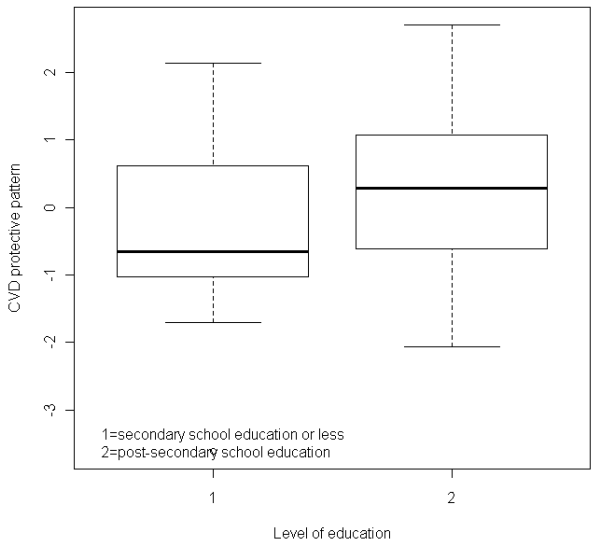
Interpretation of figure 5.6.5

All of the data included in the multiple linear regression are plotted in the figure; however the regression lines are only relevant for those participants with secondary school education or less. For participants with a "comfortable" or "good/very good" standard of living, as knowledge of food composition increased participants consumed a dietary pattern lower in fat and higher in fruit, vegetable and dietary fibre. This trend was more pronounced for participants with a "comfortable" standard of living (β = -0.55, 95% CI: [-0.94, -0.16], Adj R^2 = 0.25, p = 0.007), than a "good/very good" standard of living (β = -0.37, 95% CI: [-0.71, -0.03], Adj R^2 = 0.25, p = 0.033). Graphically this trend is shown for participants with secondary school education or less, but the trend for participants with post-secondary school education parallels that of participants with secondary school education or less (as seen in the previous figures).

5.6.2 Cardiovascular disease protective pattern

Modelling with the "CVD protective" pattern is less clear than with a "higher CVD risk" pattern because it explained only 28% of the variation of the overall diet. Level of education was the only psychosocial variable significantly associated with the pattern score explaining 6.1% of the pattern variation. Post-secondary school education was associated with a higher score ($\beta = 0.69$, 95% CI: [0.08, 1.29], Adj $R^2 = 0.06$, $p = 0.028$). A more positive score corresponded to a dietary pattern that is lower in total and saturated fat and higher in fruit, vegetables and dietary fibre. There was no significant association with standard of living which may be due to lack of power.

Figure 5.6.6: Association between level of education and a "CVD protective" dietary pattern (regression of categorical predictors)



Note: post-secondary school education associated with higher pattern score ($\beta = 0.69$, 95% CI: [0.08, 1.29], Adj $R^2 = 0.06$, $p = 0.028$).

6.0 Discussion

This discussion is divided into three sections. The first discusses sample characteristics and how dietary intake compares with a heart healthy diet. The second section discusses the psychosocial variables and how they impact on 50 year olds' consumption of a heart healthy diet and will be discussed under the construct of the health belief model presented in the literature review. The final section discusses the limitations, strengths of the research and the implications and possible future direction of research, based on the hypotheses presented in this thesis. Section 6.1 below summarises the main findings of the study before the discussion divides into three.

6.1 Summary of main findings

The main findings of the thesis were that 50 year old men and women in Canterbury do not eat a heart healthy diet, defined as a moderate fat, low saturated fat, high fibre, fruit and vegetable diet. Participants' knowledge of the national food and nutrition guidelines and basic knowledge of the sugar, fat, fibre and salt content of common foods is poor. Ninety percent of participants believed that heart attacks, high blood pressure and type 2 DM are totally or sometimes preventable. Consumption of total fat, saturated fat, dietary fibre or vegetables was predicted by level of education, standard of living and/or knowledge of food composition. Poor knowledge of food composition, a lower level of education in those with a "comfortable" or "good/very good" standard of living was associated with consumption of a "higher CVD risk" dietary pattern; and only the level of education predicted consumption of a "CVD protective" dietary pattern.

6.2 Sample characteristics

The random participant sample was comprised of relatively equal number of males (30) and females (33) with an average age of 50.85 years. Maori were purposely over selected as part of the randomisation process, 12.7% of CHALICE participants identified as of Maori ethnicity compared with approximately 7.3% of the Canterbury population (Statistics New Zealand, 2006).

The usual level of education of NZ 50 year olds is not readily available, national statistics tend to report the level of education of recent school leavers or the uptake of training opportunities, rather than the education status of older age groups. The 1988-1990 NZ Workforce Survey (Metcalf, et al., 2006a) found that 49% of the then 40-78 year old New Zealanders had secondary school education or less and 8% had university education. However the NZ Workforce Survey sample was quite different to the Canterbury sample due to the high number of Pacific Island (11.7%) people surveyed. The 2006 Census reported that 61.5% of Cantabrians aged 15 years and older had secondary school education or less. In comparison the education level of the CHALICE sample was quite high, only 35% had only secondary school education or less and 21% had a university degree.

The Canterbury unemployment rate was 3.9% in 2006 (Statistics New Zealand, 2006), age specific unemployment rates are not available. Eighty-eight percent of CHALICE participants were in the labour force. Most of those that were not currently working were receiving a government benefit such as the sickness or ACC benefit rather than being unemployed.

The NZ mean household income (including all types of households) is estimated to be $77,168 in June 2010 (Statistics New Zealand, 2006). This is slightly higher than the CHALICE mean income of $64,733, and may be due to a number of reasons. These include: the small sample size but also three participants were excluded from the income analysis because they didn't know their usual household income. Common reasons for not knowing household income were that their partner looked after the household finances therefore the participant did not know the household financial situation, often self-employed participants did not know their income, or did not want to declare it to study interviewers. National household income data includes all types of households, some of which will earn more because there are two people working full time who contribute to the household income, whereas some CHALICE participants

still have dependent children at home, therefore both adults may not be working full time. There were also some single person households.

In the 2006/2007 NZ Health Survey the $ELSI_{SF}$ was used for the first time to measure standard of living in conjunction with the NZDep96. The CHALICE sample standard of living distribution is comparable to that of 45-54 year olds in the NZ Health Survey (Table 6.1). Analysis of the standard of living data as a predictor of food intake was limited due to the small number of participants (7) that are classified as having a "hardship" standard of living.

Table 6.1: Comparison of standard of living between NZ population and CHALICE participants

Standard of living category	NZ health survey 2006/07	CHALICE 2010/11
Hardship	9%	11.1%
Comfortable	28%	30.2%
Good/very good	63%	58.7%

Body composition was also comparable between the CHALICE males and females and the 2006/2007 NZ Health Survey sample. Approximately 30% of participants were classified as obese (BMI > 30.0 kg/m^2). As expected, rates of obesity were higher in the CHALICE population than in the 1997 NNS. In the last decade NZ obesity rates have been increasing in all age groups including 50 year olds (Ministry of Health, 2010a). Approximately 30% of the participants were still within the healthy BMI range (BMI 18.5-24.9 kg/m^2). In 1997 approximately 33% of the NZ 45-64 year olds were within the healthy weight range (Russell, et al., 1999).

Waist circumference is a more sensitive predictor of future health risk than BMI as it measures central adiposity which is associated with higher rates of dyslipidaemia,

hypertension and type 2 diabetes, all of which increase the risk of CVD (National Institutes of Health, 1998). One third of CHALICE participants had a waist circumference that put them at substantially increased risk of these conditions. As rates of overweight, obesity and central adiposity increase, treatment rates for hypertension and hypercholesterolemia increase as well (Ministry of Health, 2007; Walls et al., 2011). Previously, waist to hip ratio was used to quantify central adiposity, with waist circumference not being widely reported; therefore there are limited NZ data on the usual waist circumference of the NZ population. Seeing as the average weight of New Zealanders has been increasing, it is logical to conclude that average waist circumference has also been increasing. A recent publication from the US National Health and Nutrition Examination Studies (NHANES) (Walls, et al., 2011) presented waist circumference data from 1988-1994 compared with 2005-2006 data. Mean waist circumference had increased over that decade. In male and female 50-59 year olds, it had increased from a mean of 97.8 cm (95% CI: [97.1-98.5]) to 100.6 cm (95% CI: [99.0-102.2]) (results were not separated in mean male and female waist circumference). Mean waist circumference of the US population is much higher than CHALICE participants (93.5 ± 15.9 cm). Recent NZ waist circumference data from a convenience sample of 816 South Island Europeans (Taylor et al., 2010) with an average age of 47 years found that average waist circumference for men was 99.3 ± 13.0 cm which is comparable with CHALICE males (100.3 ± 13.4 cm). Average waist circumference for females was 97.8 ± 15.2 cm which is much higher than the average CHALICE female waist circumference of 87.2 ± 15.6 cm. Although the average CHALICE female waist circumference is lower than the other South Island population the mean waist circumference of both CHALICE males and females still puts them at increased risk of dyslipidaemia, hypertension, type 2 DM and CVD (National Institutes of Health, 1998).

Under-reporting of dietary intake was low in this population; 11% of participants had an energy intake less than 1.06 times their basal metabolic rate. Under-reporting is difficult to assess in a population because estimates of basal metabolic rates in overweight and obese people are not well documented. The current method of estimating under-reporting of a group may not be accurate if many of the participants weigh more than 84kg (R. S. Gibson, 2005). Seeing as 35% of participants in this study

weighed more than 84kg, estimates of basal metabolic rate and therefore estimates of under-reporting may not be accurate. Also some of those participants deemed as under-reporters may actually have been under-eaters or dieting during data collection rather than under-reporting. However, participants with low energy intakes were asked if there were any other foods or drinks that they consumed and had forgotten to record, all emphatically denied consuming anything other than what they had recorded. Reporting the incidence of under-reporting is not common place in recent research. Under-reporting data was not published for the 1997 NNS because 25% of the population weighed more than 84kg (Russell, et al., 1999). Under-reporting was reported for the NHANES III that used a one day 24 hour recall to assess dietary intake. Individuals were classified as under-reporters if energy intake was less than BMR x 0.9. This method classified 28% of females and 18% of males as under-reporters (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997). These numbers are significantly higher than the potential under-reporting in this study.

6.3 How dietary intake compares with a heart healthy diet

Hypothesis discussed in this section:

- That the dietary intake of 50 year old males and females in Canterbury does not meet heart healthy dietary guidelines.

The likelihood of being diagnosed with risk factors associated with heart disease (hypercholesterolemia, hypertension, obesity) that are influenced by dietary intake increases from age 50 (Ministry of Health, 2007). Consumption of a CVD protective dietary pattern may help improve risk factors and reduce incidence of CVD. As discussed in the literature review section, the nutrients most strongly associated with CVD are high saturated fat and low dietary fibre intakes.

6.3.1 Total fat

The total fat recommendation was the most likely of the five CVD protective nutrient recommendations to be met by CHALICE participants. Cohort studies have shown that total fat intake as a % TE is not as strongly associated with CHD outcomes as saturated fat intake as a % TE (Skeaff & Miller, 2009). However, a lower total fat intake, as a % TE, may assist with achieving a lower saturated fat intake through the use of low fat dairy products and lean meats and poultry. Mean total fat intake was 34.32% TE, which is comparable with the 1997 NNS sample average fat intake of 35% TE. Historically, New Zealanders have consumed a diet high in total fat (up to 40% TE) but dietary fat intake has been decreasing since the first NNS in 1977. The results of this study imply that average total fat intakes may now be steadily contributing around 35% TE.

6.3.2 Saturated fat

Fifty-six (88.5%) participants consumed more saturated fat than is recommended, with only 11.5% consuming less than the recommended 10% TE from saturated fat. A diet in which saturated fat contributes less than 10% TE results in lower total and LDL cholesterol concentrations (Obarzanek, et al., 2001) which are associated with a lower risk of CVD (Mann & Truswell, 2002). These results are similar to other NZ nutrition

studies. In the 1997 NNS saturated fat intake at the 10th percentile was 9% TE in 45-64 year olds. The main sources of saturated fat of CHALICE participants in descending order were dairy products, meat and fast foods. Many participants used standard milk, rather than trim milk, in coffee and at breakfast time. Most participants used a margarine or low fat spread on bread, but some still used butter. Cheese was frequently eaten either in sandwiches, with crackers or at social occasions. Most people did not remove the fat from chicken or red meat prior to cooking it. Common fast foods that contributed to saturated fat intake were hot chips, burgers, ethnic curries and fried chicken. This study indicates that dairy product fat is still a significant source of saturated fat; a study of New Zealand's fat consumption from 1961-1995 showed that New Zealander's consumption of dairy fat has been decreasing over time but their consumption of meat and poultry fat has been increasing (Laugesen & Swinburn, 2000). The 1997 NZ NNS reported the main food sources of fat, but it was not broken into sources of saturated fat and other fatty acids. The sources of total fat for 45-64 year olds were similar to that of CHALICE participants. Butter and margarine contributed 18% to total fat intake, followed by meat, chicken and other meat products and then dairy products. Fast foods were not mentioned as a separate food group; therefore it is difficult to say if they contributed significantly to total fat intake. Butter and margarine tended to contribute more fat to people's diets as they aged. This may be a generational trend.

Of the seven participants for whom saturated fat contributed less than 10% TE all consumed limited amounts of dairy products (approximately ½ cup of low fat milk per day) or used soya or rice milk instead of cow's milk. Approximately half of these participants did not consume red meat or poultry during the four days of diet recording and if participants did consume red meat or poultry it was in small portions (less than 100 g per day). These participants also tended to eat limited amounts of low fat cheese. A healthy diet with less than 10% TE from saturated fat does not need to be a semi vegetarian low dairy product diet as indicated by the CHALICE participants that did meet the saturated fat recommendation. A healthy, low saturated fat diet that is advocated by the national food and nutrition guidelines includes low fat or lean versions of foods that are traditionally high in saturated fat, for example 2-3 servings of low fat dairy products per day, lean red meat and lean poultry or other white meats. Limiting

consumption of high saturated fat snack and takeaway foods is also necessary. The DASH trial used a low saturated fat (and high fruit, vegetable and dietary fibre) diet to reduce total and LDL cholesterol concentrations (Obarzanek, et al., 2001). A saturated fat intake of 7% TE was achieved by using low fat dairy products and small portions of red meat. Also snack foods and sweets, which can be high in saturated fat, were replaced with fruit based and whole grain foods.

Traditionally the NZ diet has been a high saturated fat diet (Birkbeck, 1979) but saturated fat intakes have been slowly decreasing over the last 20 years (Russell, et al., 1999), probably due to increasing public awareness of the role large amounts of animal fats play in the development of heart disease. The results of this small sample of 50 year olds from Canterbury indicate that saturated fat intakes may have decreased since the last published NNS in 1997. The results of the next NNS are due in 2011.

6.3.3 Dietary fibre

Adequate dietary fibre helps reduce CVD risk and lowers total and LDL cholesterol concentrations (Anderson, et al., 2000; Lairon, et al., 2005; Liu, et al., 2002; Obarzanek, et al., 2001; Wolk, et al., 1999). The latest Australian and NZ CVD prevention guidelines suggest that to improve cholesterol profiles females should consume at least 28 g per day and males at least 38 g per day of dietary fibre (NHMRC, 2006). The current national guidelines recommend that men and women should consume at least 25 g of dietary fibre per day (Ministry of Health, 2003). Dietary fibre intakes of CHALICE participants were less than 25 g per day for 65% of participants. CHALICE participants did consume slightly more dietary fibre than the 45-64 year olds surveyed in the 1997 NNS. On average CHALICE females consumed 21 g of fibre per day, whereas females in the NNS consumed only 19 g of fibre per day. Dietary fibre consumption of males was also higher in the CHALICE sample than the 1997 NNS sample, 26 g per day compared with 24 g per day, respectively. Participants' main sources of dietary fibre were breads and cereals and other baked goods, then vegetables (including potato and kumara), fruit and fast foods. Fast foods probably contributed to dietary fibre intake due to participants eating food prepared outside of the home more

frequently. Females had significantly higher dietary fibre intakes than males per 1000 kJ despite there being no significant difference in total fruit and vegetable consumption between males and females. The most likely reason that females consumed more dietary fibre per 1000 kJ is that females tended to consume less energy than males yet consumed the same amount of fruit and vegetables portions per day. Females may also be more inclined to choose higher fibre breads and cereals and snacks than men. Breads and cereals typically contribute about 45% of total dietary fibre of New Zealanders diets (Russell, et al., 1999).

6.3.4 Fruit and vegetables

More frequent consumption of fruit and vegetables is associated with lower LDL cholesterol concentrations (Djousse, et al., 2004; Obarzanek, et al., 2001) and lower relative risk of CVD (Bazzano et al., 2002; Dauchet, et al., 2006; Hung, et al., 2004; Liu, et al., 2000). The evidence for this relationship is not as strong as that for total dietary fibre intake (Lairon et al., 2005; Pereira et al., 2004).

Fruit and vegetable consumption in this population was lower than the national food and nutrition guidelines recommend. Only 47% of participants ate at least two servings of fruit per day and only 23% of participants ate at least three servings of vegetables per day (excluding potatoes and kumara). Internationally, average fruit and vegetable consumption is often lower than most national guidelines (Bazzano, et al., 2002; Djousse, et al., 2004; Giskes, Turrell, Patterson, & Newman, 2002; Wardle, et al., 2000). Fruit and vegetables are a significant source of dietary fibre, so lower fruit and vegetable consumption contributes to lower than recommended dietary fibre intakes. There are no recent national data on actual fruit and vegetable consumption patterns of adult New Zealanders. The NZ Health Survey asks how many servings of fruit and vegetables New Zealanders consume each day (estimated intake). Of the 45-54 year old population surveyed, 60% reported that they ate two or more servings of fruit each day and 67% reported that they ate three or more servings of vegetables per day. These proportions are much higher than the estimated fruit and vegetable intake and the actual fruit and vegetable consumption of the CHALICE population and higher than the 1997

NNS results which asked a similar question. Reported vegetable consumption in the NZ Health Survey is probably higher than the CHALICE participants' intake because it includes potato and kumara as a vegetable, whereas the CHALICE results do not include potato or kumara as a vegetable. Potato was excluded as a vegetable because it is commonly consumed as a fried product which is not a healthy way to meet daily vegetable recommendations. Also potato is a good source of carbohydrate and is thought of, by dietitians and nutritionists, more as a substitute for pasta, rice or noodles in a balanced meal, rather than as part of the vegetable portion of a meal.

6.3.5 Conclusion

Hypothesis - on average 50 year old males and females do not meet the heart healthy dietary guidelines.

As hypothesised it appears that 50 year old males and females in Canterbury do not eat a heart healthy diet. Consumption of a heart healthy diet is associated with lower total and LDL cholesterol concentrations and lower risk of CVD. These findings are not surprising and are consistent with data from the 1997 NNS; however the dietary profiles of CHALICE participants do appear to be closer to the national guidelines than the dietary profiles of New Zealanders in the 1997 NNS.

6.4 Psychosocial factors

The HBM takes into account elements that influence the likelihood of taking recommended preventative health actions. The preventative health action of interest is eating a more heart healthy diet with a view to reducing risk of hypertension, hyperlipidaemia, obesity and ultimately CVD. The influence of psychosocial factors on the consumption of a heart healthy diet is discussed in the following sections under the constructs of the HBM: demographic and social variables, perceived susceptibility to disease, perceived threat of disease, perceived benefits and barriers of preventative action and cues to action.

Hypotheses discussed in this section:

- That greater education, household income and standard of living (measured using the Economic Living Standard Index Short Form ($ELSI_{SF}$))are associated with a heart healthier diet

- That a greater knowledge of food composition (sugar, fat, salt and fibre content) is associated with a heart healthier diet

- That positive attitudes and beliefs around a link between food intake and risk of disease are associated with consumption of a heart healthier diet

- That a higher *barriers to eating healthily* score is associated with consumption of a less heart healthy diet

6.4.1 Demographic and social variables

Demographic and social variables have differing influences on dietary intake. This section is broken into the two main social variables (level of education and standard of living) and their impact on dietary intake and associations with predictors of dietary intake.

6.4.1.1 Education

Level of education has been associated with food consumption patterns. Higher education has been associated with the consumption of a greater variety of food and more "new age" foods, whereas those that are less educated tend to consume more "traditional" foods (Worsley, Blasche, Ball, & Crawford, 2004) which are often lower in dietary fibre and higher in total and saturated fat. This thesis did not address the consumption of specific foods but assessed food group consumption. Results showed that a higher level of education was associated with a lower saturated fat intake as a % TE and higher dietary fibre intake. Those with post-secondary school education consumed 2.1% TE less saturated fat per day, and 1.2g per day more dietary fibre, than those with only secondary school education or less. The level of education was also an important factor in dietary pattern modelling. Post-secondary school education was associated with consumption of a more "CVD protective" dietary pattern (higher fruit, vegetable and dietary fibre diet). Post-secondary school education as well as standard of living was also associated with consumption of a less "high CVD risk" dietary pattern (high saturated fat diet). This link between higher education and higher consumption of fruit and vegetables has been found in other studies (Ashfield-Watt, 2006; E. L. Gibson, et al., 1998; McNaughton, Mishra, Stephen, & Wadsworth, 2007; Metcalf, Scragg, & Davis, 2006b).

The level of education of a population not only influences dietary intake, but is independently associated with nutritional knowledge (Howarth, et al., 1991; Wardle, et al., 2000). Knowledge of food composition or nutrition is often assessed using different methods/questionnaires therefore it is difficult to make comparisons across cohorts. The results of this thesis research indicate that a higher level of education was associated with a greater knowledge of food composition. The 1989 Life in NZ survey found that those with secondary school education or less had a good awareness of which food groups were good and not good for health, but that post-secondary school educated people could better identify which individual foods within a food group were better or not as good for health.

Level of education appears to be associated with dietary intake of CVD protective food groups but was also associated with a non-dietary risk factor: BMI. Those with secondary education or less had a significantly higher BMI than those with post-secondary school education. This trend has also been seen in other studies (Metcalf, Scragg, & Davis, 2007). Level of education also appears to be associated with other CVD risk factors. A study of NZ (Metcalf, et al., 2007) adults over 40 years of age reported a greater odds ratio for CVD risk factors as level of education decreased. This trend was seen for blood pressure, diabetes, BMI and 5 year CVD risk.

It seems that one's level of education plays a role in determining dietary intake and risk factors for CVD that are influenced by dietary intake. It may be that the level of education obtained influences other social variables, such as income and standard of living, which also impact on people's health status. However, in this study, education still appears to have an effect independent of these variables.

6.4.1.2 Standard of living

Standard of living is a measure of a household's use of goods and services required to lead a healthy life. Using income as a measure of socioeconomic status assumes that a certain level of income enables a healthy living situation. As seen in this study, standard of living is often correlated with household income. As standard of living, measured using the $ELSI_{SF,}$ is a relatively new standard of living assessment tool there are no published dietary studies that use the $ELSI_{SF}$ as a measure of standard of living or socioeconomic status.

Higher rates of obesity have been seen in more deprived communities (Ministry of Health, 2007) and lower standard of living groups (Ministry of Health, 2010a). In the NZ Health Survey 2006/07 (Ministry of Health, 2010a) those in the lowest of the three "hardship" categories of standard of living were 25% more likely to be obese than those with a "good/very good" standard of living. In this study, standard of living was weakly associated with BMI. Participants with a "hardship" standard of living tended to have higher BMIs than those with a "comfortable" or "good/very good" standard of living.

However, when the means of the standard of living categories were investigated further (with t-tests) there was not a significant difference between the categories. The decreasing trend in BMI with increasing standard of living is most probably due to two factors: two participants in the "hardship" category that had very high BMIs (46.1 and 59.6 kg/m^2) and there were only 7 out of 63 participants with a "hardship" standard of living at this early stage of recruitment into the CHALICE study. With a larger sample size there may be a stronger association between standard of living and BMI in this population.

Some barriers to eating healthily can be income dependent and, thus, associated with standard of living. In this population the overall *barriers to eating healthily* score increased (participants more strongly agreed that the potential barriers listed made it difficult for them to eat healthily) as standard of living decreased. There were not enough participants in this study to assess which barriers were more common in lower standard of living groups compared to higher standard of living groups. However, a large Pan EU study of 14,331 people from 15 EU states (Kearney & McElhone, 1999) aged 15 years and older found that price was more commonly a barrier for those who were unemployed compared to those in employment. Another study, which did not assess price as barrier but assessed how social factors can act as barriers to eating healthily, found that lower social status groups found it more difficult to avoid high fat foods due to their social environment (B. Smith, et al., 1999).

Standard of living takes into account the affordability of necessities such as fresh fruit and vegetables, clothing, heating, visits to doctors, medication and social interaction. In this population there was an association between fat intake (as a % TE) and standard of living. As standard of living increased, fat contributed less energy to the diet. This may be due to the perceived affordability of healthier, lower fat foods that are still filling. It could also be due to other factors such as transport and accessibility of healthy food for people with a "hardship" standard of living. A similar trend of higher fat intakes in lower socioeconomic groups has been seen in other studies (Metcalf, et al., 2006b; Russell, et al., 1999; B. Smith, et al., 1999), as has lower dietary fibre, fruit and vegetable intakes (Giskes, et al., 2002; G. Mishra, Ball, Arbuckle, & Crawford, 2002) in

lower socioeconomic groups. Population based surveys have also shown that dietary profiles are less healthy in lower socioeconomic (Ministry of Health, 2007) or deprived sectors of the community (Russell, et al., 1999).

Dietary modelling with total fat, saturated fat, dietary fibre, fruit and vegetable intakes found that standard of living, as well as knowledge of food composition and level of education, were significantly associated with a "higher CVD risk" dietary pattern. For those with a "comfortable" and "good/very good" standard of living, there was a significant trend towards consumption of a less "higher CVD risk" eating pattern as knowledge of food composition increased. This trend was more prominent in those with a "comfortable" standard of living. The reason for this association was not tested, but it may be worth investigating in the future if those with a "good/very good" standard of living spend more money on eating out and therefore their diets are not as healthy as those who have less money to spend and tend to eat at home more. It was more difficult to interpret the dietary trend for those with a "hardship" standard of living, as there was a non-significant trend towards increasing consumption of saturated fat (as a % TE), and lower consumption of fruit, vegetables and dietary fibre as knowledge of food composition increased. One would expect that their dietary intake would become healthier as knowledge increased. A British study of 1,040 people found that nutrition knowledge partially mediated the relationship between socioeconomic status and nutrition intake (Wardle, et al., 2000). The lack of an association between a "hardship" standard of living, nutritional knowledge and a "higher CVD risk" dietary pattern may be due to the small "hardship" standard of living sample size of this present study.

Standard of living was not associated with a "CVD protective" dietary pattern, but level of education was. This may be due to lack of power because standard of living comprises three categories, whereas education is split into two. Also this dietary pattern explained only 28% of the total variation, again with a larger sample there may be an association between standard of living and a CVD protective dietary pattern.

6.6.1.3 Conclusion

Hypothesis - that greater education, household income and standard of living is associated with a heart healthier diet.

Overall it appears that the level of education achieved and standard of living have a significant impact on the dietary intake of 50 year olds in Canterbury. Participants with post-secondary school education and a "comfortable" or "good/very good" standard of living tended to consume a healthier diet. Those with secondary education or less and a "hardship" standard of living consumed a less healthy diet.

6.4.2 Perceived susceptibility to disease

Perceived susceptibility to disease may be influenced by many variables, for example family history, beliefs about control and preventability of disease and perceived impact of personal actions. Disease prevention beliefs were assessed as part of the CHALICE project.

Believing that a disease is preventable may give people a greater sense of control over their health. Beliefs around disease preventability did not vary greatly within this population. A study of risk perceptions and disease beliefs (Wang, et al., 2009) showed that people who perceived they were at a lower risk of developing diseases felt they had a greater sense of control over developing that disease. In the Wang et al study the US adults, mean age of 50, felt they had more control over developing heart disease than colon, breast or ovarian cancers and their perceived risk of developing cancer was greater than that of developing heart disease. The public's idea of having more control over preventable diseases is further confirmed by most CHALICE participants agreeing with the statements that "many types of disease can be prevented; it's up to us to do something about it" and "whether I enjoy good health or not depends a lot on how well I take care of myself".

Disease preventability beliefs may have changed as a result of more marketing, media attention and/or government initiatives. Of the disease beliefs related to CVD 90% of

study participants believed that heart attacks, high blood pressure and type 2 DM were totally or sometimes preventable and 78% of participants believed that colon cancer was totally or sometimes preventable. Whereas, an Australian study conducted in 1995 (B. Smith, et al., 1999) found relatively low proportion of people rated heart attacks and high blood pressure as mostly or sometimes preventable. Only 68% and 71% of adults surveyed felt that heart attacks and high blood pressure respectively were preventable. Interestingly, about 15% of respondents did not know if heart attacks and high blood pressure were preventable or not.

There is evidence that disease prevention beliefs and believing in a link between dietary intake and risk of disease affect dietary intake (Petrovici, et al., 2006; A. Smith & Owen, 1992; Wang, et al., 2009). This was not assessed in this study due to the small sample size and lack of variability in participant beliefs but will be investigated with a larger sample of this cohort.

6.4.2.1 Conclusion

Hypothesis - that positive attitudes and beliefs around a link between food intake and risk of disease are associated with consumption of a heart healthier diet.

Due to a small sample size and a lack of variability in participant answers about disease preventability and fatalism, this hypothesis could not be thoroughly assessed. Based on the results of other studies there is some evidence that the public is becoming more aware of preventable diseases and there may be a link between disease beliefs and dietary intake.

6.4.3 Perceived benefits and barriers of preventative action

The HBM works on the principle that if perceived benefits outweigh perceived barriers then one is more likely to adopt the preventative action.

6.4.3.1 Perceived benefits

Knowledge of food composition and understanding the national food and nutrition guidelines may be seen as a perceived benefit or barrier, depending on the level of nutritional knowledge one has. A greater awareness of the role of food and nutrition in the prevention of disease may be related to dietary habits. It is difficult to eat a heart healthy diet if one is not aware of what constitutes healthy eating and why it is important. For example, a good knowledge of which foods are high in fat may increase the chances of choosing lower fat foods if lower fat foods are perceived to be better for health.

CHALICE participants were unaware of the national food and nutrition guidelines. Fruit and vegetable guidelines are the most widely publicised of the guidelines. The role of mass media and the research that has looked at the effectiveness of mass media campaigns will be discussed under the "Cues for action" section. Only 30-40% of participants knew that New Zealanders should eat at least two servings of fruit and three servings of vegetables. Many people must believe that *5 + a day* means you should eat five servings of fruit and five servings of vegetables each day, as many people answered five servings per day for both fruit and vegetables. Knowledge of the bread and cereals nutrition guidelines was very poor. Breads and cereals are our main source of dietary fibre but no participants knew that we should eat six servings of breads and cereals each day. Is this because the public perceive that eating too much bread makes one fat, or do they not understand the concept of a serving size and think that one should eat breads and cereals twice day at breakfast and lunch and forget that foods such as pasta and rice belong to the breads and cereals category? This study did not assess the reasons behind participants' knowledge or understanding of all the national food and nutrition guidelines and no research was found that assessed this either. This could be a target for further research.

Knowledge of food composition was fair; on average participants identified the correct answer to 70% of the questions. Participants answered the dietary fibre questions most accurately, whereas the sugar content of food was answered most poorly. This may be because high fibre foods are easier to identify, for example grainy breads and cereals,

fruit and vegetables with their skins. Whereas there are many different types of sugar, for example sugar in processed foods, natural sugar and fruit sugar. Participants could be confused between what constitutes a high sugar food and what is perceived as a healthy food. This is exemplified by the observation that only 41% of participants knew that canned fruit in natural juice was still high in sugar even though it is in fruit juice rather than syrup. Also, only 44% of participants knew that bananas are high in sugar; other participants may have thought that because it is a fruit and therefore "good" for you, that it should not be high in sugar, because high sugar foods are "bad" for you. Again this study did not assess the reasons behind participant answers. The fat content of spreads and margarines was another food group that confused participants. Half of the participants knew that margarine was high in fat but only 17% knew that a low fat spread was still high in fat. Most low fat spreads are 45-55% fat, much higher in fat than low fat 'lite' cream cheese for example which is only 16% fat or edam cheese which is 25% fat (Diabetes New Zealand). New Zealanders and Australians have been found to not have a good understanding of the meaning of 'lite' products (Mhurchu & Gorton, 2007), it appears that CHALICE participants do not either. Knowledge of food composition and/or nutrition was also fair in other studies (Petrovici, et al., 2006; Wardle, et al., 2000).

A better level of nutrition knowledge has observed in those who consume a more healthy diet (Noureddine & Stein, 2009). In the CHALICE sample knowledge of food composition was inversely associated with a "higher CVD risk" dietary pattern for participants with a "comfortable" or "good/very good" standard of living, and was positively associated with vegetable intake, but not with total fat, saturated fat, dietary fibre or fruit intake. One participant had a high average vegetable intake: seven portions per day excluding potatoes. Linear modelling was completed with and without this participant; either way, as knowledge of food composition increased so did vegetable consumption. The effect was greater when the outlier was included in the analysis but excluding the outlier probably gives a more realistic picture of the relationship between knowledge of food composition and vegetable consumption. Other research that assesses the impact of nutrition knowledge on nutrition intake has had variable results. An American study of people aged over 51 years in South Carolina, USA (Ryan & Gates, 1988) saw a strong positive relationship between the

nutritional composition of a 24 hour dietary recall and nutrition knowledge score (p = 0.03). The nutrition knowledge score was calculated from a 23 question true/false questionnaire. Nutrition knowledge was assessed by questions such as: "processed meats like sausage and bologna are high in saturated fat", and understanding of how nutrition affects health was assessed by questions including: "hardening of the arteries is caused by fat in the diet". A large US study of adults aged 20-65 years old (Beydoun & Wang, 2008) also used a nutrition knowledge belief score (less comprehensive than the previous study) and found that a high knowledge belief score and higher education were associated with a healthier nutritional intake. On the other hand, there is some evidence to show that there is not a strong link between dietary intake and nutrition knowledge (Noureddine & Stein, 2009). However, in the Noureddine et al study, half of the participants already consumed a healthy American diet and the nutrition knowledge score used was quite different, therefore not comparable to the previously mentioned studies. The nutrition knowledge scale most similar to the one used in the CHALICE project was used to assess mothers' knowledge (E. L. Gibson, et al., 1998) and how their level of knowledge impacted on the dietary intakes of their children. Mothers' nutritional knowledge was only significantly associated with their children's fruit intake but not with vegetable intake or macronutrient profile of children's diets.

Knowledge of food composition was a significant predictor, in conjunction with level of education and standard of living, of the CVD risk dietary pattern which explained 38% of the overall dietary variation. No previous research was found that has used dietary modelling to assess how knowledge of food composition is associated with a dietary intake.

6.4.3.2 Conclusion

Hypothesis – that a greater knowledge of food composition is associated with a heart healthier diet

The findings of this study support the hypothesis that a greater knowledge of food composition is associated with a "healthier" diet. A greater knowledge of food composition was positively associated with a higher vegetable intake but was not

associated independently with the other constituents of a heart healthy diet. However, using dietary pattern modelling a greater knowledge of food composition was positively associated with a heart healthier diet for some sub groups of the sample.

6.4.3.3 Perceived barriers

If knowledge of food composition can act as a perceived benefit, then poor knowledge of food composition is probably a barrier to eating healthily. Although when participants were asked which, of a list of potential barriers made it difficult for them to eat healthily, they did not identify "I don't know enough about eating healthily" as a barrier. In other surveys which have asked a similar question, lack of knowledge was not a major barrier either (Kearney & McElhone, 1999; Petrovici, et al., 2006; A. Smith & Owen, 1992). However 60% of CHALICE participants felt they needed to make changes to the food they eat as it was not already healthy enough. This perceived need to improve dietary quality was quite different compared with those in a Pan EU study (Kearney & McElhone, 1999). Of the total EU sample only 29% felt they needed to make changes to their diets. This perception varied geographically; only 13% of the Italian sample thought they needed to change their diet whereas more than 40% of those surveyed in Greece and Finland felt they needed to make dietary changes. The authors attributed these low rates to consumers tending to overestimate the healthiness of their diets. The CHALICE sample does not appear to overestimate the healthiness of their diets. This may be more related to age and the traditionally higher saturated fat diet of New Zealanders compared with the much publicised "healthy" Mediterranean style diet of South Europeans. Participants also do not appear to think that lack of nutrition knowledge is a barrier to eating healthily. This may be a barrier to health professionals who are trying to educate this age group on ways to reduce their CVD risk through dietary manipulation.

There were similarities in the perceived barriers between the CHALICE sample and other studies. Of the CHALICE participants 41% felt that "I would have to give up foods I like" and 30% that "irregular working hours", "busy lifestyle" and "healthy foods are too expensive" were barriers to eating healthily. These were also the most

frequently cited barriers for the EU sample as well as “willpower”, which 18% of the EU sample felt was a significant barrier to eating healthily (Kearney & McElhone, 1999). Again barriers to eating healthily varied geographically. The Luxembourg sample of the Pan EU study had the most similar barriers to the NZ sample, where 43%, 40% and 20% felt that “giving up the foods I like”, “irregular working hours” and “a busy lifestyle” respectively made it difficult to eat healthily. In Romania, a relatively poor country, “giving up the foods I like” and “high price of healthy food” were barriers for 78% of those surveyed. “Lack of time” was still a barrier for 34% of the Romanian sample (Petrovici, et al., 2006).

Despite participants identifying that they do have barriers to eating healthily, the overall *barriers to eating healthily* score was not independently associated with dietary intake. Similar results were found in other studies (Petrovici, et al., 2006; A. Smith & Owen, 1992). Due to the small sample size of this study, analysis of the association between specific barriers and dietary intake could not be undertaken. Similar analyses in other studies have found that for those who perceive money as a barrier to eating healthily intake of dietary fat tended to be higher (A. Smith & Owen, 1992), but no other barriers were associated with dietary intake. The *barriers to eating healthily* score did not significantly assist in explaining the dietary variation when included in the heart healthy dietary modelling.

6.4.3.4 Conclusion

Hypothesis – that a higher *barriers to eating healthily* score is associated with consumption of a less heart healthy diet.

The findings of this study do not support the hypothesis that a higher *barriers to eating healthily* score is associated with consumption of a less heart healthy diet. Unawareness of one’s lack of nutrition knowledge and self-rated dietary healthiness may be acting as barriers. Exploring people’s perception of what healthy eating means may help improve the balance between perceived benefits and perceived barriers to eating healthily.

6.4.4 Cues to action

Cues to action are influences from outside of one's immediate environment that cause one to consider how that might impact on their health. For example food package marketing, mass media campaigns, and newspaper, magazine, radio and television articles. The only effect of cues to action assessed in this study was knowledge of the national food and nutrition guidelines.

The most widely promoted national food and nutrition guideline is the fruit and vegetable recommendation. The *5 + a day* fruit and vegetable public health message was launched in NZ in 1994 (5+ A Day Charitable Trust). The *5 + a day* campaign aims to promote the consumption of at least 5 servings of fruit and vegetables each day. A 2008 Colmar Brunton survey (5+ A Day Charitable Trust) reported that 93% of shoppers were aware of the *5 + a day* campaign. However, the results of this study indicate that 50 year olds in Canterbury do not understand the message. Only 30-40% of participants could correctly report that the recommendation is two servings of fruit and three servings of vegetables per day. There may be some confusion about what *5 + a day* means, as 27% of participants thought that the recommendation is five servings of both fruit and vegetables each day. No recent research has assessed understanding of fruit and vegetable nutrition guidelines. A survey of 2000 households in 1999 and 2000 reported that 71% of people were aware that *5 + a day* logo but only 2.5% could identify that one portion of fruit or vegetables is the amount that fits into the palm of your hand (Ashfield-Watt, 2006).

There are currently more magazine articles (eg. The Healthy Food Guide) and real life television programmes that focus on the importance of food and nutrition in the prevention and management of chronic diseases such as CVD and diabetes. These cues to action often emphasize improving basic knowledge of nutrition and food choices and focus on practical ideas to make eating healthily easier. There has not been research conducted on how these cues to action affect the beliefs and actions of their target audiences. The present study was not designed to test this. There is some evidence though that in older adults (age 56-70 years) a greater perception of the importance of healthy behaviours, for example consuming a lower fat diet to improve cholesterol

profile and reduce the risk of CVD, is associated with a lower BMI (Wang, et al., 2009). In 40-55 year olds a greater perception of the importance of health behaviours is associated with a lower consumption of sugar and fat (Wang, et al., 2009).

6.5 Strengths and limitations

This study used the data from the first 63 participants of the CHALICE project. When recruitment started it was calculated that data for 70 participants (taking into account that not all participants would return a completed food diary and that recruitment would cease for three weeks over the Christmas/New Year period) should be available after 20 weeks of data collection. Due to two unforeseen major earthquakes in the Canterbury/Christchurch region the final sample size is slightly lower than originally planned. The small sample size did restrict the power of statistical analysis of small sub groups of the data, for example the "hardship" standard of living category, which contained only seven participants. However this is a pilot study, the purpose of which was to generate hypotheses, to test with a large sample size, therefore the reduction in participant numbers and the small sample size should not impact on hypothesis generation.

The high food and beverage dairy completion rate and use of the electoral roll to select a random sample of Canterbury 50 year olds are strengths of this study. Completing some questionnaires before the interview allowed interviewers to check that participants understood the questions and check if there were any missing answers. Missing data was not an issue in this study.

The demographics of the CHALICE sample were similar to those of the Canterbury 50 year old population. CHALICE participants may be more highly educated than the general Canterbury population but the household income and employment status is probably representative of this age group, based on available local and national population statistics. The ethnic diversity of the sample is also relatively representative of the Canterbury population, with a slight over representation of Maori.

CHALICE project participants are all aged 50 which can make the results of this study less generalisable to other age groups of the population. However, including participants of the same age does reduce the measurement error as a group of 50 year olds is likely to be more homogeneous than a group of adults aged 40 years or older. This is not a significant limitation of the study, and may be a strength, when it comes to analysing a longitudinal data set.

Pre-testing of dietary related questionnaires with a representative sample helped refine the questionnaires and food and beverage diaries. Some of the dietary questions had been developed and used in overseas studies; pre-testing with a representative NZ population ensured that they were culturally acceptable to this population group. Also use of validated tools ($ELSI_{SF}$) and NZ questionnaires improved comparability with national studies.

Participants generally completed and returned their estimated food and beverage diaries in a timely manner, however, some needed more than one reminder phone call to return a completed diary. The food and beverage diary response rate was very good up to the pre-Christmas period (two weeks prior to Christmas) with 89% of participant's interviewed returning a food diary. The food diary return rate dropped to 50% in the last six weeks of participant recruitment mainly due to participants being busy or on holiday over the Christmas/New Year period (only participants that were involved in their usual routines completed a food diary over this period). Also those participants that were interviewed at the start of February had limited time to complete and return their diaries prior to the Christchurch earthquake on the 22nd of February. The overall food and beverage diary response rate was 77% which is still high compared with large nutritional surveys. Nutritional survey response rates usually vary from 50-73%; the response rate for the 1997 NZ NNS was 50.1% (Parnell, Wilson, & Russell, 2001), 61% for the Australian National Nutrition Survey (Miura, Giskes, & Turrell, 2009) and 73% for the NHANES III survey (Briefel, et al., 1997).

The high return rate of food and beverage diaries is probably due to a number of factors. The 50 year old population is likely to be a motivated group because they are becoming more interested in, and maybe concerned, about their current and future health. The CHALICE study is an in depth study which requires participants to complete questionnaires prior to and after the face to face interview. Also, due to the long duration of the interview the interviewers create a rapport with participants and have regular telephone contact with participants before and after the interview. This interviewer/participant relationship may have helped improve the food diary return rate.

Dietary intake was calculated from estimated food and beverage diaries. Weighed food records are considered the 'gold standard' method of assessing nutrient intake (Bingham et al., 1995; R. S. Gibson, 2005), however they are not appropriate for all study situations (R. S. Gibson, 2005). As the CHALICE study is a longitudinal study with an extended recruitment phase and with participants from a range of social and ethnic backgrounds an estimated food record was used. An estimated food record is less burdensome on the respondent than a weighed food record yet can provide a good estimate of usual nutrient intake. Nutrient intakes from estimated records tend to correlate well with that of weighed records (Bingham et al., 1994). Estimated food records rely on participants accurately recording the portion size of food consumed and providing detailed descriptions of foods eaten outside of the home. All participants received verbal and written information on how to accurately complete a food and beverage diary. To reduce inter-data entry variation, completed food diaries were entered by only one person and data was entered using the same set of assumptions for all diaries. The greatest variability in data entry was for food items that were consumed outside of the home and that were not a commercially standardised portion size, for example a slice of cake from a café. If portion size information was vaguely recorded participants were asked for more information, for example dimensions of scones, sweets or baked products. This information was used to select an appropriate food weight and a food item from the nutrient database that was most likely to have a similar total fat, saturated fat and dietary fibre profile. These precautions helped to ensure that the dietary data entered were as accurate as possible.

The HBM model is a relatively simple model to use with a complex behaviour such as eating. In this study it was used as framework (alongside CBT and SCT) under which to discuss how individual perceptions and modifying factors may be associated with the likelihood of people consuming a heart healthy. The HBM would not be appropriate to use in a more in-depth analysis of this relationship.

A general *barriers to eating healthily* question was used in this study. The question included a range of reasons that one may find eating healthily difficult, for example, "I have irregular working hours", "Healthy food doesn't keep as long", "My friends and family don't like the taste". Some of the potential barriers listed may be of more importance for increasing fruit and vegetable intake than choosing lower fat foods or cooking methods. However, participants were asked to consider the list of possible barriers in relation to their own perception of eating healthily. It was assumed that participants considered eating healthily to mean eating lower fat foods and eating more fruit, vegetables and higher fibre foods and that they would answer the question based on what they find most difficult when trying to eat healthily.

Questionnaire data was entered into a study-wide database and data entry was double-checked to reduce likelihood of data entry errors. Statistical analysis was limited due to the use of some categorical variables, which included low number of participants in some groups; this reduced the power of some of the analyses. Continuous data was used where possible to maximise statistical power, however indices for level of education and standard of living were collapsed into 2 or 3 groups to ensure adequate numbers of participants within each group and to make the categories more sensible and comparable with other studies.

The interpretation of the heart healthy dietary modelling was limited due to the small sample size. Dietary modelling is usually applied to large sample sizes where there are many variables to be included in the model. It is often used with food frequency questionnaire data, rather than with the results of dietary analysis of a four day food and beverage record. However, it provides an interesting means of assessing dietary trends

in relation to a heart healthy diet. It also reduces the risk of multiple correlations as a result of using multiple response variables (total fat, saturated fat, dietary fibre, fruit and vegetables) to explain dietary intake.

6.6 Implications

Basic knowledge of food composition appears to be an important psychosocial factor which is modifiable, unlike standard of living or education which is not as easily modified. Public health campaigns and health professionals who provide small group or one to one education, should not assume that the public are aware of which foods are high in fat, sugar or salt. Increasing basic knowledge of food composition and the role food can play in disease prevention could help to improve the healthiness of dietary intake.

Improving standard of living in this population may positively affect their likelihood of consuming a more heart healthy diet. To improve the standard of living of this population would require changes to government funding changes that would affect all New Zealanders. Such changes may include: making healthy foods more affordable through removing the goods and service tax from fresh fruit and vegetables, further subsidising medical care and prescriptions especially for those who need to visit the doctor often, and encourage all New Zealanders to adequately insulate their homes to make them easier and more affordable to heat.

Participants do not appear to be aware of the NZ food and nutrition guidelines, nor understand them. Increasing public awareness of the food and nutrition guidelines and what they mean in practical terms, with an emphasis on achieving the basic nutrition guidelines, could help improve dietary profiles and reduce consumption of less nutritious, high fat, energy dense, convenience foods. There are some public health initiatives already established that aim to increase consumers' nutrition awareness, for example eM*ark* classifies foods based on their energy density (New Zealand Nutrition Foundation) and *Pick the Tick* indicates foods that are low in salt, saturated fat and

energy, or high in fibre or calcium. Another option could be to review the current nutrition guidelines to make them more understandable for the general public.

Although the *barriers to eating healthily* score does not appear to be linked to dietary intake, the barriers score was higher in lower standard of living groups. Identifying the most common barriers to eating healthily for different sectors of the community, and targeting these groups, may help improve the healthiness of food choices in those communities.

6.7 Future Research

CHALICE recruitment is on-going. Testing the hypotheses of this study with a larger sample would allow more robust analysis of the relationship between standard of living, beliefs about disease and *barriers to eating healthily* with dietary intake. With a larger sample size principal component analysis of the heart healthy diet would allow a more in depth analysis of the influence of psychosocial variables on patterns of dietary intake. It would also allow an assessment of how individual barriers to eating healthily may differ between different sectors of the community, for example those with a "hardship" standard of living may have different barriers from those with a "good/very good" standard of living. Understanding more about New Zealanders' barriers to eating well may help design more targeted nutrition programmes for specific sectors of the community.

The CHALICE project is planned to be a longitudinal study. As participants age and become more aware of the implications and risk factors for chronic diseases such as CVD, will allow for the investigation of how knowledge of food composition, dietary intakes and beliefs about disease change over time. Perceived seriousness/severity of disease, one of the elements of the HBM, was not assessed in this study. Family health history data is collected as part of the CHALICE project, and participants are given feedback on their risk of CVD in a results feedback letter, it may be interesting to assess perceived seriousness/severity of disease in subsequent surveys as the population group

ages. Understanding the relationship between all of the elements of the HBM, and appealing to a range of these elements, is probably the best means of improving the uptake of preventative health actions.

7.0 Conclusion

The results of this pilot study indicate that Canterbury 50 year olds do not consume a heart healthy diet that could assist in improving total and LDL cholesterol concentrations and reduce their risk of developing CVD. Psychosocial variables appear to be associated with dietary intake. More educated participants who enjoy a higher standard of living consume healthier diets than less educated participants. As participant knowledge of food composition increases participants tend to consume a less "high CVD risk" dietary pattern – lower in saturated fat and higher in fruit, vegetables and dietary fibre.

8.0 References

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9.0 Appendices

Appendix A: Ethics Approval

14 June 2010

Professor Peter Joyce
Department of Psychological Medicine
Christchurch School of Medicine & Health Sciences
P O Box 4345
Christchurch

Attn: Janet Spittlehousew3

Dear Professor Joyce,

URA/10/03/021 **Canterbury Health, Ageing and Life Course Study**

Investigators **Prof P Joyce, Mr C Lacey, A/Prof V Cameron, Prof S Chambers,**
Dr R Gearry, Dr H Jamieson, Prof M Kennedy

This study was given ethical approval by the Upper South A Regional Ethics Committee on 14 June 2010.

Approved Documents

- Protocol version 2.1 dated 18.05.10
- Information sheet and Consent form version 2.1 dated 12.05.10
- CHALICE Yearly health questionnaire version 1.0 dated 02.06.10

This approval is valid until 31 August 2016, provided that Annual Progress Reports are submitted (see below).

Access to ACC

For the purposes of section 32 of the Accident Compensation Act 2001, the Committee is satisfied that this study is not being conducted principally for the benefit of the manufacturer or distributor of the medicine or item in respect of which the trial is being carried out. Participants injured as a result of treatment received in this trial will therefore be eligible to be considered for compensation in respect of those injuries under the ACC scheme.

Amendments and Protocol Deviations

All significant amendments to this proposal must receive prior approval from the Committee. Significant amendments include (but are not limited to) changes to:

- the researcher responsible for the conduct of the study at a study site
- the addition of an extra study site
- the design or duration of the study
- the method of recruitment
- information sheets and informed consent procedures.

Significant deviations from the approved protocol must be reported to the Committee as soon as possible.

Annual Progress Reports and Final Reports

The first Annual Progress Report for this study is due to the Committee by 30 June 2011. The Annual Report Form that should be used is available at www.ethicscommittees.health.govt.nz. Please note that if you do not provide a progress report by this date, ethical approval may be withdrawn.

A Final Report is also required at the conclusion of the study. The Final Report Form is also available at www.ethicscommittees.health.govt.nz.

Requirements for the Reporting of Serious Adverse Events (SAEs)

For the purposes of the individual reporting of SAEs occurring in this study, the Committee is satisfied that the study's monitoring arrangements are appropriate.

SAEs occurring in this study must be individually reported to the Committee within 7-15 days only where they:

- are *unexpected* because they are not outlined in the investigator's brochure, and
- are not defined study end-points (e.g. death or hospitalisation), and
- occur in patients located in New Zealand, and
- if the study involves blinding, result in a decision to break the study code.

There is no requirement for the individual reporting to ethics committees of SAEs that do not meet all of these criteria. However, if your study is overseen by a data monitoring committee, copies of its letters of recommendation to the Principal Investigator should be forwarded to the Committee as soon as possible.

Please see www.ethicscommittees.health.govt.nz for more information on the reporting of SAEs, and to download the SAE Report Form.

We wish you all the best with your study.

Yours sincerely

Alieke Dierckx
Administrator
Upper South A Regional Ethics Committee
Email: alieke_dierckx@moh.govt.nz

Appendix B: Module 1 Questionnaire

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

CHALICE
Canterbury Health, Ageing and Lifecourse Study

Module 1
Case Report Form

Date of Assessment		Participant Study Number	
Interviewer's Name		Interviewer's Number	

Informed consent given by study participant ☐

Blood samples: Blood taken at: **Time:** ☐☐☐☐ 24 hour clock

Yes, fasting blood sample taken **OR** none fasting blood taken **OR** no blood taken

If not fasting, details and time of food/drinks in the last 12 hours: _____

☐ **Tick if fasting blood has not been taken but the participant has been given a form for a fasting blood appointment.**

Comments: -

_____

_____

Urine sample: Urine taken at **Time:** ☐☐☐☐ 24 hour clock

Comments: -

_____

_____

Body Measurements:

Height: _____ cm Weight: _____ kg

Waist: _____ cm

Bioimpedance Assessment:

BMI: _____ kj BMR: _____ kj

Impedance: _____ Ω

Fat %: _____ Fat Mass: _____ kg

FFM _____ kg TBW: _____ kg

Blood Pressure and Pulse: Time taken:

Time:					24 hour clock

Heart rate: _____ / min Sphygmomanometer: Manual / Automatic

Blood pressure: _____/_____ Arm: L / R

Comments: -

_____

_____

Fundus Photograph:

(a) **What was your eye colour at age 25?**

(i) Blue / grey (light) ☐ (ii) Green / hazel (medium) ☐

(iii) Brown (dark) ☐

(b) **What was your natural hair colour as a teenager?**

(i) Blonde (light) ☐ (ii) Red ☐

(iii) Brown (dark) ☐

(c) **Did you have difficulty seeing close-up (hyperopia) without glasses or contact lenses when you were in your:**

20's? Yes ☐ No ☐

40's? Yes ☐ No ☐

(d) **Did you have difficulty seeing at a distance (myopia) without glasses or contact lenses when you were in your:**

20's? Yes ☐ No ☐

40's? Yes ☐ No ☐

(e) **Has your doctor ever told you that you have any type of eye problem?**

(f) **If yes, what did he/she say it was?** _____

(g) **If yes, how old were you when you were first told this?** _____ (in years)

Front of eye photo taken?

Left ☐ Right ☐ Not done ☐

Comments: _____

Fundus photograph taken?

Left ☐ Right ☐ Not done ☐

Comments: _____

Appendix C: Module 2 Questionnaire

CHALICE
Canterbury Health, Ageing and Lifecourse Study

Module 2 Questionnaire
Personal Health History

Date of Assessment		**Participant Study Number**	
Interviewer's Name		**Interviewer's Number**	

TABLE OF CONTENTS

1. DEMOGRAPHICS

First, I am going to ask you some general questions about you and your household. Then we will go on to talk about your health.

1.01 **You are male/female…? [Circle one]**
1 Male
2 Female

Date of birth

1.02 **Firstly, what is your date of birth? [Record]**
Enter eight digit date (e.g. 4 March 1946 = 04031946).

_____/_____/_____

.R Refused

Ethnicity

[Showcard 1.03a]
1.03a **Which ethnic group or groups do you belong to? Call the number or numbers of the ones that apply to you from Card 1.03a. [record all mentioned]**

1 New Zealand European → **GO TO THE QUESTIONNAIRE FOR MAORI PARTICIPANTS**
2 Māori
3 Samoan
4 Cook Island Māori
5 Tongan
6 Niuean
7 Chinese
8 Indian
9 Other, such as Dutch, Japanese, Tokelauan → **GO TO 1.03b**
.K Don't know

1.03b **What other ethnicity or ethnicities do you belong to? [Record]**

_____

1.04a **Are you descended from Māori? That is did you have a Māori ancestor? [Circle one]**

1 Yes
5 No
.K Don't remember → **GO TO 1.05a**
.R Refused

1.04b **What are your iwi affiliatations? [Record all]**

_____

.K Don't remember
.R Refused

1.05a **Which country were you born in? [Circle one]**

1 New Zealand → **GO TO 1.06**
2 Australia
3 England
4 Scotland
5 China (People's Republic of)
6 South Africa
7 Samoa
8 Cook Islands
9 Other **[specify the present name of the country]** _____
.K Don't know .R Refused

1.05b **In what year did you arrive *to live* in New Zealand? [Record 4 digit year]**

_____
.K Don't remember
.R Refused

1.06 **How long have you *lived* in Canterbury? [Record years and months]**

Years_____ **Months** _____
.K Don't remember
.R Refused

Marital/Relationship Status

[Showcard 1.07a]

1.07a **Looking at Card 1.07a, which one of these statements is true about your CURRENT relationship status?**

1 I am married (or living together for 1 year or more)
2 Separated
3 Divorced
4 Widowed
5 Never married
.K Don't know
.R Refused

1.07b **Are you currently in a relationship? How long (in years) have you been in your current relationship?**

_____

1.08 **How long (in years) is/was the longest intimate relationship you've had in your life?**

_____

Sexuality

[Showcard 1.09]

1.09 **Looking at Card 1.09, which of the following best describes yourself?**

1 Heterosexual ("straight")
2 Gay
3 Lesbian
4 Bisexual
5 Transsexual
6 Can't choose
.K Don't know .R Refused

Education

[Showcard 1.10]

1.10 **What is your highest qualification? Please do not count incomplete qualifications or qualifications that take less than 3 months of full-time study to get. Please tell us your *highest* qualification, shown on Card 1.10. [Record one]**

1 No qualification
2 Secondary school qualifications
3 Post secondary certificate, diploma, or trade diploma
4 University degree
5 Other **[specify]**_____
.K Don't know
.R Refused

Income support and employment

[Showcard 1.11]

1.11 **Looking at Card 1.11, are you *currently* receiving any of these types of income support? [Record all mentioned]**

1 NZ Superannuation
2 Working for Families (Family Support, In Work Payment, Family Tax Credit)
3 Unemployment benefit
4 Domestic purposes benefit
5 Sickness benefit
6 Invalid's benefit
7 Student allowance
8 Disability allowance
9 ACC (as income support, *not* reimbursement for health services)
10 Other government benefits (independent youth benefit, war pension, etc)
11 None of the above
.K Don't know
.R Refused

1.12 **In the past 12 months, have you been out of paid work at any time for more than one month? Please do not include time out of paid work which was from your own choice, such as being a homemaker, caregiver, or full-time student.**

1 Yes
5 No
.K Don't know/unsure
.R Refused

1.13 **What is your trained trade or profession? [Record]**

_____

[Showcard 1.14a]

1.14a **Which of the statements on Card 1.14a best describes your current work situation. Please also say if you are self employed. [Circle one]**

- Self employed are to be coded as 1 (working in paid employment). Please also tick the box "self employed".

- Working in paid employment (1) <u>includes students</u> (full time or part time) if they have <u>any</u> paid employment.

1 Working in paid employment. **[Tick if self employed ☐]**

2 Not in paid work, and looking for a job → **GO TO 1.15**

3 Not in paid work, and not looking for a job (for any reason, such as being retired, a homemaker, caregiver, or full-time student). → **GO TO 1.15**

Specify_____

4 Other **Specify** _____

.K Don't know .R Refused

1.14b **How many hours a week do you <u>usually</u> work? [Record hours]**

_____

.K Don't know

.R Refused

1.14c **What is your current occupation? (What is your job called? What kind of work do you do?) [Record]**

_____

[Showcard 1.15]

1.15 **Looking at Card 1.15, in the last 4 weeks, which of these have you done, *<u>without pay</u>*? [Record all mentioned]**

1 Household work, cooking, repairs, gardening, etc, for my own household
2 Looked after a child who is a member of my household
3 Looked after a member of my household who is ill or has a disability
4 Looked after a child (who does NOT live in my household)
5 Helped someone who is ill or has a disability (who does NOT live in my household)
6 Other voluntary work for or through any organisation, group or marae
7 Studied for 20 hours or more per week at school or any other place
8 Studied for less than 20 hours per week at school or any other place
9 None of these
.K Don't know
.R Refused

Income

[Showcard 1.16]

1.16 **Looking at Card 1.16, what is the total income that *you yourself* got from *all sources*, before tax or anything was taken out of it, in the last 12 months? [Record one]**

1 Less than $5,000
2 $5,001 - $10,000
3 $10,001 - $15,000
4 $15,001 - $20,000
5 $20,001 - $25,000
6 $25,001 - $30,000
7 $30,001 - $40,000
8 $40,001 - $50,000
9 $50,001 - $60,000
10 $60,001 - $70,000
11 $70,001 - $80,000
12 $80,001 - $100,000
13 $100,001 - $120,000
14 $120,001 - $150,000
15 $150,001 or more
.K Don't know .R Refused

Household income

[Showcard 1.16]

1.17 **Still looking at Card 1.16, what is the total income that *your household* got from *all sources*, before tax or anything was taken out of it, in the last 12 months? [Record one]**

1 Less than $5,000
2 $5,001 - $10,000
3 $10,001 - $15,000
4 $15,001 - $20,000
5 $20,001 - $25,000
6 $25,001 - $30,000
7 $30,001 - $40,000
8 $40,001 - $50,000
9 $50,001 - $60,000
10 $60,001 - $70,000
11 $70,001 - $80,000
12 $80,001 - $100,000
13 $100,001 - $120,000
14 $120,001 - $150,000
15 $150,001 or more
.K Don't know
.R Refused

ELSI (Economic Living Standard Index)

[Showcard 1.18]

1.18 **I'm now going to ask you some questions about things you may or may not have access to in your household. Looking at card 1.18 for the answer, do you have……**

If respondent asks: "Does this include a cellphone?": Access to a telephone in the household is the key concept, for example, if there is a cellphone and no landline then 'Yes', but only if cellphone is in the house whenever the respondent is home and they can make a phone call on it.

	1 Yes	2 No (don't want it)	3 No (due to the cost)	4 No (other reason)	Refused (R) Don't know (K)
(a) Telephone (see note above)					
(b) Washing machine					
(c) Heating available in all main rooms					
(d) A good pair of shoes					
(e) A best outfit for special occasions					
(f) Personal computer					
(g) Home contents insurance					
(h) Enough room for family to stay the night					

[Showcard 1.18]

1.19 **Still looking at Card 1.18 for the answer, do you do the following activities?**

	1 Yes	2 No (don't want it)	3 No (due to the cost)	4 No (other reason)	Refused (R) Don't know (K)
(a) Give presents to family and friends on birthdays					
(b) Visit the hairdresser at least once every 3 months					
(c) Have holidays away from home every year					
(d) Have a holiday overseas at least once every 3 years					
(e) Have a night out at least once a fortnight					
(f) Have family or friends over for a meal at least once a month					

[Showcard 1.20]

1.20 **Now I'm going to ask you about some things some people do to help keep costs down. Looking at Card 1.20, <u>in the last 12 months</u>, have you done any of these things not at all, a little, or a lot?**

	1 Not at all	2 A little	3 A lot	Refused (R) Don't know (K)
(a) Gone without fresh fruit and vegetables to keep costs down				
(b) Continued wearing clothing that was worn out because you couldn't afford a replacement				
(c) Put off buying clothes for as long as possible to help keep down costs				
(d) Stayed in bed longer to save on heating costs				
(e) Postponed or put off visits to the doctor to help keep down costs				
(f) NOT picked up a prescription to help keep down costs				
(g) Spent less on hobbies than you would like to help keep down costs				
(h) Gone without or cut back on trips to the shops or other local places to help keep down costs				

The next questions are about your material standard of living – the things that money can buy. Your material standard of living does NOT include your capacity to enjoy life. You should NOT take your health into account for these questions.

[Showcard 1.21]

1.21 **Looking at Card 1.21, generally, how would you rate your material standard of living? Would you say that it is high, fairly high, medium, fairly low or low? [Circle one]**

1 High
2 Fairly high
3 Medium
4 Fairly low
5 Low
.K Don't know
.R Refused

[Showcard 1.22]

1.22 **Looking at Card 1.22, generally, how satisfied are you with your material standard of living? Would you say you were very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied or very dissatisfied? [Circle one]**

1 Very satisfied
2 Satisfied
3 Neither satisfied nor dissatisfied
4 Dissatisfied
5 Very dissatisfied
.K Don't know
.R Refused

[Showcard 1.23]

1.23 **Looking at Card 1.23, how well does your (and your partner's combined) total income meet your everyday needs for such things as accommodation, food, clothing and other necessities? Would you say you have not enough money, just enough money, enough money, or more than enough money? [Circle one]**

By total income we mean all the money respondent has access to for everyday necessities

1 Not enough
2 Just enough
3 Enough
4 More than enough
.K Don't know
.R Refused

Home Ownership

[Showcard 1.24]

1.24 **Who owns your home? [Circle one]**

1 You own or partly own your house or flat (with or without a mortgage)
2 Family members
3 A family trust
4 A private landlord
5 A local authority or city council
6 Housing New Zealand
7 Other **[specify]**_____
.K Don't know .R Refused

Medical Insurance

1.25 **Are you covered by any health or medical insurance scheme? [Circle one]**

1 Yes
5 No
.K Don't know .R Refused

Appendix D: Module 3 Questionnaire

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

CHALICE
Canterbury Health, Ageing and Lifecourse Study

Module 3 Questionnaire
Attitudes and Beliefs

Date of Assessment		**Participant Study Number**	
Interviewer's Name		**Interviewer's Number**	

[Showcard 2.05]
Q5. The next few questions are about your opinions on medical conditions and illness in general. How possible do you think it might be to prevent certain health problems for people living in your area?

	[Tick a box]	1 Totally or mostly preventable	2 Sometimes preventable	3 Rarely ever preventable	4 Not preventable	Refused (R) Don't know (K)
a	Skin Cancer					
b	Lung Cancer					
c	Bowel Cancer					
d	High Blood Pressure					
e	Heart Attacks					
f	Diabetes Type I					
g	Diabetes Type II					
h	Stroke					
i	Dementia					
j	Depression					

[Showcard 2.06]
Q6. How much do you agree or disagree with the following statements?

	[Tick a box]	1 Strongly agree	2 Inclined to agree	3 Neither agree or disagree	4 Inclined to disagree	5 Strongly disagree	Refused (R) Don't know (K)
a	I can overcome most illness without help from a medically trained professional.						
b	Home remedies are often better than drugs prescribed by a doctor.						
c	If I get sick, it is my own behaviour that determines how soon I get well again.						
d	I understand my health better than most doctors do.						

[Showcard 2.20]
Q20. How much do you agree or disagree with the following statements?

	[Tick a box]	Strongly Disagree ←						→ Strongly Agree	Refused (R) Don't know (K)
		1	2	3	4	5	6	7	
a	Life and death are all predestined; there is nothing we can do to change our destiny.								
b	Serious diseases like cancer are all fated; we cannot prevent them from happening.								
c	If you are fated to get cancer, you will get cancer; there is nothing you can do to change fate.								
d	If you don't die from this, you'll die from that. So there's no point taking screening tests.								
e	If we feel well, we should not go looking for trouble by having medical screening tests.								
f	Many types of disease can be prevented; it's up to us to do something about it.								
g	Whether I enjoy good health or not depends a lot on how well I take care of myself.								

Appendix E: Module 7 Food and Beverage Diary

Participant ID: **Interviewer ID:**

CHALICE

Food and beverage diary

If you have any questions about this diary please contact the CHALICE team.

Part 3: Food Diary

How to fill in your diary

Below is a step-by-step guide on how to fill in your food diary. It is very important that you do not change what you normally eat or drink just because you are keeping a diary so that we get a true picture of what you eat and drink. Try to fill in the diary each time you have something to eat or drink rather than leave it until the end of the day so that you don't forget anything.

Step 1: When

Write down the exact time you ate or drank something. So, for example, if you had breakfast at 7.30am, write in "7.30am".

Step 2: Where

Please record where you were when you ate something. The next column along in the food diary is for you to write in where you were when you ate or drank something. This could be:

At home – e.g. in the kitchen, in bed
Away – e.g. in the street, in the car/on a bus, at a friend's or relative's house,
In a café/ restaurant (please specify McDonalds, Pizza Hut, etc.),
At work – e.g. in canteen, in lunchroom, at your desk.

Step 3: Who with

In the next column in the food diary, please write down who you were with when you ate or drank something. For example, you might have been alone, with family or with friends. Experts have shown that by thinking who you were with during the day can help you to remember what you have eaten. We do not use this data in our research, it is just there to aid your memory.

Step 4: Food and drink

The next step in the food diary is to describe what you ate or drank. The more details you are able to give about the food and drink you have consumed, the better we will be able to estimate your nutrient intake. Include any extras like sugar and milk in your tea or cereal, butter or other spreads on your bread and sauces such as tomato sauce and mayonnaise. Do not forget to include drinking water.

Step 5: Brand and details

It would also help us if you can write down the brand name of any foods or drinks if you know it (e.g Watties, Pams, Arnotts). If convenient, staple the wrapper to the back page of this book.

For breakfast cereals, as well as the brand name, please write down the name of the cereal (e.g. coco pops, corn flakes, Sanitarium toasted museli: golden oats and fruit).

For sandwiches, please describe the type of bread used, how many slices of bread were used and give details of the filling.

For salad or mixed vegetables, please describe what is in it (eg. 1 lettuce leaf, half a tomato,6 slices of cucumber).

For pizza, please describe the topping (e.g. cheese and tomato, ham and pineapple).

Step 6: Preparation and cooking

If you know the cooking method used (e.g. roast, baked, boiled, fried) please write it down in this section.

Step 7: Quantity

In the next column, please write in the size of the portion of food or drink you had. For drinks, you can specify glass, cup, or mug or bottle/can size. Other descriptions include: packet (e.g. for crisps), number (e.g. for biscuits), slice (e.g. for cake, pizza), teaspoon (e.g. for sugar), tablespoon (e.g. for tomato sauce, peas), cupful (e.g. for cooked pasta or rice), handful (e.g. for nuts, grapes, berries), package weights (e.g. 150g Fresh and Fruity yoghurt). On the next page you will find some more information on how to describe the food and drink that you consume.

If you have **kitchen scales** it is helpful to weigh foods and record these amounts.

For **mixed food dishes and recipes** it may be easier to list the total ingredients, then describe the proportion of this recipe that you consumed.

e.g. 1/3 of recipe 1

Recipe example Creamy tuna pasta (recipe 1)

250g	Diamond spiral pasta
½ cup	Oxo chicken stock, pre-mixed with water
¼ cup	Chopped parsley
2 cups	Sliced button mushrooms
220g	John West tuna canned in oil, liquid drained
1 cup	Carnation evaporated skim milk
1 tablespoon	Parmesan cheese, dried
¼ teaspoon	Freshly ground black pepper

I had one third of this recipe

If you make your food from separate ingredients then you can write the recipes down in the recipe list at the back of this diary.

Please write down all the ingredients for each recipe (including Brand names, amounts and preparation or cooking details). Indicate the proportion of the recipe you consumed.

Don't forget about any drinks that you have between meals e.g. tea, coffee, wine, beer, orange juice.

How to describe your food and drink using household measures

Below are some suggestions are given on how to describe certain food and drink items together with their household measures.

Food	Description of food or drink and brand	Household measure
Bacon	Shoulder or streaky; fried or grilled rashers, smoked or unsmoked	Number
Bread	Type of bread, eg. white, brown, wholemeal, granary, French stick, ciabatta, currant. Description of slice eg sandwich, toast	Number of slices
Canned drinks	Type, brand name For example: 335ml can Diet Coca Cola	Number or full or half can
Crisps	Type, brand name e.g. 30g Rashuns	Packet weight
Fruit	Type and size of fruit eg large granny smith apple For tinned fruit; slices/ halves etc in juice or syrup	Number of pieces or tablespoons
Jams	Type, brand name e.g. Pam's strawberry jam	Teaspoons, heaped or flat
Milk	Type; full cream, trim, semi-trim	Pints, glasses or cups
Oil	Type eg canola oil, sunflower oil, corn oil, olive oil Brand name e.g. Pam's olive oil	Tablespoons
Prepacked foods eg beefburgers, pies, biscuits, confectionery	Full name of product including brand name. For example: Bird's Eye fish fingers. Keep the package.	Number
Sandwiches	Describe fully if homemade or if bought; Full name, place of purchase and price, describe bread as above and note loaf size.	Number of slices of bread or number of rolls
Spreads on bread or toast	Type e.g. butter, low fat spread, rice bran oil spread, canola spread, reduced fat canola spread, weightwatchers spread. Full description, and brand name Keep the package	Number of teaspoons or thinly, average or thickly spread
Sugar	Type e.g. caster, rich brown, white	Teaspoons, heaped or flat
Sweets, chocolate and snack bars	Name, size (weight) and price (if known) For example: king size Mars bar 99c Keep the wrapper	Weight of bar or number of sweets
Takeaways	Describe in full, give name of restaurant For example: One scoop chips, T High Street chip shop. Standard chicken chow mein, Kwang Chow	Portion size and price
Vegetables	Type; fresh, frozen, tinned or dried Brand name	Tablespoons, full or heaped

Adapted from NUGENOB study (www.nugenob.com)

Sample record sheet

Please record all food and drink consumed during the whole day, including snacks and water.
Remember to report any additions to each food and drink, such as milk, sugar, salt, sauce or spreads.

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity
8 am	In bed	alone	Gourmet muffin	New World – double chocolate	None	1
			Coffee	Nescafe instant Sugar Green top milk	Hot water added	1 heaped teaspoon in a mug 1 heaped teaspoon 1/8th of a mug
10 am	Kitchen	Family	Tea	Twinings Peppermint	Hot water added	1 mug, no milk or sugar
			Biscuits	Tim Tam Double Chocolate	None	2
12pm			Creamy tuna pasta	Homemade recipe 1	Pasta boiled in water	1/3 recipe
			French bread stick	Bought–New World		6cm long
			Margarine	Pams–Canola low salt		1 level tsp
			Chicken breast	Skin and bone removed	Fried in olive oil	1 medium chicken breast
			Olive oil	Luppi	fried	½ tbsp
			Cherry tomatoes		raw	2
			Orange juice	McCoy, unsweetened		200ml
5.30pm	Mc Donalds	Son	Burger Fries Diet Coke	Mc Donalds Big Mac (no pickles)		1 Large Large
6.30pm	Home	Friends	Beer	Monteiths Radler		2 bottles
			Toast	Vogels Rice and Rye	Toasted	2 slices
			Margarine	Pams–Canola low salt		1 level tsp

Please record **brand names** e.g. McCoy
Please use **household measures** to describe amounts of food such as margarine, butter and milk e.g. teaspoons (tsp), tablespoons (tbsp), cups

Day 1 Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 1 continued

Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 2 Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 2 continued

Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 3 Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 3 continued

Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 4 Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Day 4 continued

Date_____

When	Where	Who with	Food or Drink	Brand and details	Preparation/ Cooking	Quantity

Recipes

Please write down the ingredients of your recipes in this section.

Recipe Number	Food or Drink	Brand and details	Quantity

Are there any special reasons why this week may differ from 'normal' in terms of household food (for example a child's birthday party or other family celebration)?

Please circle either Yes or No

If yes please state reason_____

_____

Please check that you have answered all the questions in part 1 and 2 please make sure that you have filled in your diary for all four days.

Don't forget to include any:

- **Drinks e.g. tea, coffee, wine, beer, orange juice, soft drinks, water**
- **Snacks between meals e.g. biscuits, crisps, peanuts, slices, muffins**
- **Lollies or sweets**

THANK YOU!

Appendix F: Module 7 “Your opinion about food”

Participant ID:

Interviewer ID:

Your opinion about food

Please answer the questions as honestly and accurately as you can

How to answer this questionnaire

Use a **blue** or **black** pen (that does not soak through the paper), or a **dark** pencil. Put an tick inside the box provided.

☐ 1 ☑ 2 ☐ 3 ☐ 4 ☐ 5

If you change your mind or make a mistake:
Fill in the whole box and mark the correct one as shown.

☐ 1 ■ 2 ☑ 3 ☐ 4 ☐ 5

1 How many servings of fruit, of any sort, do you eat on a typical day? Do not include fruit juice or dried fruit. ☐

(A serving=1 medium piece **or** 2 small pieces of fruit **or** ½ cup of stewed fruit,

e.g. 1 apple + 2 small apricots=2 servings)

2 How many servings of vegetables, **not counting potatoes or vegetable juices**, do you eat on a typical day? ☐

(A serving=1/2 cup cooked vegetables **or** 1 cup of salad vegetables,

e.g. 1 cup of salad vegetables + ½ cup of peas + ½ cup of carrots =3 servings)

Participant ID:

Interviewer ID:

3 Please indicate how much you personally agree or disagree with this statement.

	Strongly disagree		Neither agree nor disagree		Strongly agree
I do not need to make changes to the food I eat as it is already healthy enough	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

4 Please indicate how much you personally agree or disagree with each statement. (Mark one box for each statement).

By eating more fruit and vegetables I think that people can reduce their chance of getting;	Strongly disagree		Neither agree nor disagree		Strongly agree
a Heart disease	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Cancer	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Digestive problems	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Overweight	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e Tooth decay	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f Acne	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

5 Do you think these foods are high or low in **fat?** (Mark one box for each food).

	High	Low	Don't know
a Pasta (without sauce)	☐ 1	☐ 2	☐ 3
b Low fat spread	☐ 1	☐ 2	☐ 3
c Luncheon meat	☐ 1	☐ 2	☐ 3
d Pizza	☐ 1	☐ 2	☐ 3
e Bread	☐ 1	☐ 2	☐ 3
f Polyunsaturated margarine	☐ 1	☐ 2	☐ 3

Participant ID:

Interviewer ID:

6 Do you think these foods are high or low in **sugar?**
(Mark one box for each food).

	High	Low	Don't know
a Bananas	☐ 1	☐ 2	☐ 3
b Rice bubbles	☐ 1	☐ 2	☐ 3
c Ice cream	☐ 1	☐ 2	☐ 3
d Cordial/fruit juice concentrate	☐ 1	☐ 2	☐ 3
e Tomato sauce	☐ 1	☐ 2	☐ 3
f Canned fruit in natural juice	☐ 1	☐ 2	☐ 3

7 Do you think these foods are high or low in **salt?**
(Mark one box for each food).

	High	Low	Don't know
a Sausages	☐ 1	☐ 2	☐ 3
b Pasta	☐ 1	☐ 2	☐ 3
c Tinned sardines	☐ 1	☐ 2	☐ 3
d Red meat	☐ 1	☐ 2	☐ 3
e Frozen vegetables	☐ 1	☐ 2	☐ 3
f Cheddar cheese	☐ 1	☐ 2	☐ 3

8 Do you think these foods are high or low in **fibre?**
(Mark one box for each food).

	High	Low	Don't know
a Eggs	☐ 1	☐ 2	☐ 3
b Red meat	☐ 1	☐ 2	☐ 3
c Broccoli	☐ 1	☐ 2	☐ 3
d Baked potatoes with skin	☐ 1	☐ 2	☐ 3
e Chicken	☐ 1	☐ 2	☐ 3
f Baked beans	☐ 1	☐ 2	☐ 3

Participant ID:

Interviewer ID:

12

The following is a list of possible things that keep people from eating healthily. For each one please indicate if you agree that these make eating healthily difficult **for you**

	Strongly disagree		Neither agree nor disagree		Strongly agree
a I have irregular working hours	1	2	3	4	5
b I have a busy lifestyle	1	2	3	4	5
c I would have to give up foods I like	1	2	3	4	5
d I don't have the willpower	1	2	3	4	5
e I don't want to change my eating habits	1	2	3	4	5
f It would be too great a change from my diet now	1	2	3	4	5
g I don't have cooking skills	1	2	3	4	5
h Healthy food doesn't keep fresh as long	1	2	3	4	5
i Healthy food takes too long to prepare	1	2	3	4	5
j I don't have storage facilities for the food	1	2	3	4	5
k I have limited cooking facilities	1	2	3	4	5
l Healthy foods are too expensive	1	2	3	4	5
m Healthy food is unappealing	1	2	3	4	5
m I don't like strange or unusual foods	1	2	3	4	5
o I feel like people are looking at me when I eat healthy foods	1	2	3	4	5
p My friends/family don't like the taste	1	2	3	4	5
q I don't know enough about eating healthily	1	2	3	4	5
r Experts keep changing their mind	1	2	3	4	5
s There is a limited choice when I eat out	1	2	3	4	5
t Healthy options are not available at home	1	2	3	4	5
u Healthy options are not available at work	1	2	3	4	5
v Healthy options are not available at the shop	1	2	3	4	5
w Healthy food is more awkward to carry home from the shop	1	2	3	4	5
x Healthy food doesn't fill me up	1	2	3	4	5

Participant ID:	Interviewer ID:

13 What is the minimum number of servings of the foods below that nutritionists recommend we should eat per day?

a Fruits	
b Vegetables	
c Breads and cereals (e.g breads, grains, rice and pasta)	
d Milk and milk products (e.g. milk, cheese, yoghurt, ice cream)	
e Lean meat, poultry, chicken, seafood, eggs, nuts and seeds and legumes	

Please check that you have answered all the questions.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.