

Growing up on Shaky Ground: An Investigation into the Emotional and Behavioural Wellbeing of Four-Year-Olds in Canterbury's Post-Disaster Environment

A Thesis by Kara Seers

Acknowledgements

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Abstract

A series of major earthquakes began in Canterbury, New Zealand, in September 2010 which continued for approximately the next three years. The Canterbury earthquakes have left healthcare providers, teachers and parents concerned for the mental wellbeing of children growing up in Canterbury.

Previous research has indicated that exposure to a large natural disaster during childhood can lead to emotional and behavioural disturbances in children which could potentially have long lasting effects on personal and population health. There are, however, serious methodological limitations in many of the available studies on this topic.

The B4 school check, which has been in use in NZ since 2008, is a nation-wide health screening tool for four-year-olds which includes the Strengths and Difficulties Questionnaire (SDQ), a measure of behavioural and emotional problems in children. The current study aimed to investigate the impact of earthquakes on the emotional and behavioural wellbeing of four-year-olds in Canterbury by analysing data from the B4 School Check.

Temporal and geographical trends in various measures of wellbeing were analysed using logistic regression to ascertain whether the trends in Canterbury may have been impacted by the earthquakes. Mean population SDQ scores and the proportion of abnormal SDQ scores in the population over time both decreased on all measures over the study period. Analyses indicated that, when compared to a control population, an overall population-level negative impact on SDQ scores due to the earthquakes was not present in the considered data.

This finding is surprising given the extent of community disruption and distress following the Canterbury earthquakes and is not consistent with other most similar research findings. Various explanations can be given for why the current results were found. Firstly, the study findings may be a true result. This could be because of positive factors such as resilience, the age of participants being a possible protective factor, or a general failure for exposure levels to meet a threshold level. Alternatively, a possible true result could be explained by the effect of the earthquakes being on non-studied measures only. Secondly, other explanations such as chance, bias, confounding or error could explain why the current results were found.

Any practical implications must be made with caution due to limitations of the study and the narrow generalizability of the findings. Further work is needed to explore the health needs specific to the children in Canterbury.

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Acronyms and Abbreviations

ADHD – attention deficit hyperactivity disorder

CBCL – Child Behaviour Check List

CBD – central business district

CDHB – Canterbury District Health Board

CHQ – Child Health Questionnaire

DHB – district health board

ECE – early childhood education centre

EQC – Earthquake Commission

MoE – Ministry of Education

MoH – Ministry of Health

ODD – oppositional defiant disorder

OR – odds ratio

PEDS – Parental Evaluation of Developmental Status

PHO – primary health organisation

PTG – post-traumatic growth

PTS – post-traumatic stress

PTSD – post-traumatic stress disorder

RR – relative risk

SES – socioeconomic status

SDQ – Strengths and Difficulties Questionnaire

SDQP – Strengths and Difficulties Questionnaire, parent version

SDQT – Strengths and Difficulties Questionnaire, teacher version

WHO – World Health Organisation

1 Executive Summary

1.1 Introduction

On September 4, 2010, the first of what was to be a long series of earthquakes and aftershocks struck the Canterbury region of New Zealand. The following 3 years of earthquakes sequelae would change not only the physical environment but also the social and emotional landscape of the people of Canterbury forever.

1.1.1 Disasters and population health

Disasters, natural or otherwise, are not uncommon life experiences. In fact, it has been posited that the lifetime incidence of disaster exposure is increasing and set to continue to increase due to climate change and industrialisation (Mutch, 2014). The risks posed by disasters are universal, therefore, understanding the multitude of ways in which populations can be affected by disasters is of paramount importance in developing evidence-based knowledge about how best to support people after their inevitable occurrence.

Population-level traumas such as natural disasters affect population health in a myriad of ways (Johnson & Galea, 2009). Complex and self-perpetuating networks of strengths and vulnerabilities at the individual, community and societal levels all interact to shape population health and wellbeing, including the ability to cope with and recover from disaster-related stresses (Thornley, Ball, Signal, Lawson-Te Aho, & Rawson, 2015). The focus on recovery, thus, must not rest only in the recovery of individuals, but in the recovery of the contexts in which they live. It is in this way that overcoming population-level traumatic events requires a population health approach (Mooney et al., 2011).

Health is conceptualised by the World Health Organization (WHO) as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (World Health Organization, 1946). Mental health is an important resource which enables us to live effective, meaningful lives. At a population level, mental health facilitates the growth and maintenance of a successful community and thus is an important resource to protect and promote.

1.1.2 Child population health

If a society wishes to have a healthy population, the mental health needs of the youngest members cannot be ignored, for they both influence community wellbeing now and will largely determine that of the future (Shonkoff et al., 2012). Indeed, improving child wellbeing generally has a positive effect on the wider population as it builds a sustainable community of resourceful, capable and constructive members (Miles, Espiritu, Horen, Sebian, & Waetzig, 2010).

In order to enhance wellbeing over the lifespan, early recognition and treatment of mental health problems in children is a public health priority. However, child mental health problems are often

overlooked or mis-perceived due in part to the common assumption by caregivers, education providers and health professionals that childhood represents a stage of uncomplicated and blissful development (Carter, Briggs-Gowan, & Davis, 2004). Child problems may be overlooked, but if left unchecked they may persist and can potentially escalate (Galante & Foa, 1986; Stone, Otten, Engels, Vermulst, & Janssens, 2010).

Emotional and behavioural wellbeing are especially salient mental health processes in children. This is because childhood represents a time at which capacities to experience, regulate and express mental wellbeing are developing, thus laying the path for future mental health. Positive biological development is strengthened by positive early life experiences, while health promoting environments support healthy emotional and behavioural development (Shonkoff et al., 2012). Conversely, mental health problems in children can impair their development (Carter et al., 2004).

1.1.3 Natural Disasters and Child Mental Health

Evidence from a range of studies indicates that children may develop mental health problems as a result of exposure to natural disasters (Rubonis & Bickman, 1991; Wang, Chan, & Ho, 2013). The nature of the relationship between exposure and outcome is, as of yet, unclear.

1.1.4 Gaps in the Collective Knowledge

The challenges typically inherent to public health research are amplified in the disaster context. As a result, there are serious methodological flaws to the evidence base currently available from which inferences are drawn. The most salient difficulty is that of obtaining a quality control sample to which the disaster-affected sample can be compared. Due to the unpredictable nature of natural disasters, procuring pre-disaster or concurrent measures of the wellbeing of a sample is usually impossible.

1.1.5 The Canterbury Opportunity

Databases capturing child emotional and behavioural problems for all New Zealand 4-year-olds (rated by both parents and teachers) were available both before, during, and after the Canterbury earthquakes. An examination of these databases provided the opportunity to assess the longitudinal impact of the Canterbury earthquakes on child mental health and make comparisons with national trends over this time.

1.1.6 The Current study

This research seeks to examine the social and emotional impact on one of the most vulnerable populations: pre-schoolers at age 4 years. By analysing data from the B4 School Check, this study focuses on emotional and behavioural wellbeing as the mental health outcomes of children in disasters.

1.2 Methods

1.2.1 Design

The current study followed a repeated cross-sectional design. Continuous near-complete regional cohorts of 4-year-old children made up each cross-section. Trends in the population-level wellbeing of four-year-olds were the outcome of interest. Using this design, it was possible to compare pre-earthquake 4-year-olds with children who were 4 years old at increasingly distant peri- and post-earthquake periods.

1.2.2 Study Sample

A database managed by the Ministry of Health (MoH) contains all historical B4 School Check findings. Access was granted to this database for the purposes of conducting the current study. This database contains data pertaining to measures of well-being for most children who have been 4 years old at any point between 2008 and the present (2015) in New Zealand. For the current study, a whole of source population sample approach was taken, that is, data from every eligible B4 School Check case was included in the sample.

1.2.3 The Research Tools

Exposure to the Canterbury earthquakes was the independent variable of this study. This was measured dichotomously by proxy using data regarding the district health board (DHB) in which each child had their check completed. Any child who had a B4 School Check done in the Canterbury District Health Board (CDHB) at any time after August 2010 was considered to have been exposed. The scores derived from the Strengths and Difficulties Questionnaire (SDQ) tool were the main dependent variables of interest in the current study. The SDQ is a multi-dimensional measurement of child wellbeing that has been previously used in other studies of children in a disaster context, making the findings relatable to the existent literature. Due to the many ways in which the SDQ can be used, a range of SDQ-based outcomes of interest were employed to cover as many potential earthquake impacts on child population health as possible.

1.2.4 Analyses

Stata IC 13 was used to perform statistical manipulation and multivariable logistic regression analyses. The data were first cleaned to manage outlying, missing and excluded values. Secondly, descriptive statistics and then analytical statistics were produced and examined.

1.2.5 Ethics

Full ethical approval was granted by the Human Research Ethics Committee of the University of Otago through the Category A departmental approval system. The Ethics Committee reference number assigned to this project is HD14/40. Research was conducted in accordance with the University of Otago's Responsible Practice in Research- Code of Conduct.

1.3 Results

1.3.1 Sample Description

Over the course of the study period, less than 5% of data were excluded due to not meeting inclusion criterion. Ethnicities were predominantly New Zealand European, socioeconomic statuses generally skewed towards the less deprived end of the scale, and sex roughly equally distributed. Children in the exposed group were more likely to have a B4 School Check at a younger age than those in the control group. The number of B4 School Checks completed in each region increased over time and this appears to reflect an increase in the coverage of the eligible population.

1.3.2 Main Results

Overall, no evidence of a negative earthquake effect on child SDQ scores was found. Mean population scores and the proportion of abnormal scores in the population over time both decreased on all measures over the study period. This indicates that since September 2009 the prevalence of emotional and behavioural problems in 4-year-olds in Canterbury has decreased.

In order to investigate whether changes over time were specific to this region, or were in fact representative of a general downwards trend in emotional and behavioural problem prevalence more generally, Canterbury trends were compared with those of a control group. Five of the eight outcome variable trends were not statistically significantly different compared to control group trends, indicating that this decrease in morbidity is not specific to the Canterbury context. For the three outcomes where a significant difference was found, it did not appear that the occurrence of the earthquakes had caused a negative impact on trends compared with the control group.

1.4 Discussion

1.4.1 Possible explanations for main results

Various explanations can be given for why the current results were found. Firstly, the study findings may be a true result. This could be because of positive factors such as resilience, the age of participants being a possible protective factor, or a general failure for exposure levels to meet a threshold level. Alternatively, a possible true result could be explained by the effect of the earthquakes being on non-studied measures only. Secondly, other explanations such as chance, bias, confounding or error could explain why the current results were found.

1.4.2 Comparisons with the Existing Literature

The current finding of no negative earthquake effect on child mental wellbeing does not support the majority of the existing literature. However, a number of differences between previous studies and the current one may explain why this discrepancy exists. The current study, however, is not entirely alone in the nature of its findings; some previous studies do provide evidence that is congruent with the current findings.

1.4.3 Implications

Four theoretical implications of the current findings are discussed. Exposed children may generally have had sufficient protective factors and/or insufficient risk factors to develop negative responses to the exposure; the particular exposure may not be causal for emotional and behavioural problems; chance, error, confounding and bias may explain the results found in contradicting previous research, or lastly; the tool used may not be fit for the purposes of the current study. Any practical implications must be taken with caution due to limitations of the study and the narrow generalizability of the findings. Further study is required.

2 Introduction

2.1 *The Canterbury Earthquakes*

2.1.1 Technical details

At 4:35am on September 4, 2010, a 7.1 magnitude earthquake struck 40km West of the city of Christchurch, New Zealand. Although no deaths were directly attributed to the earthquake, significant damage was done to the physical environment throughout the Canterbury region. Water, sewerage and electricity infrastructures were all damaged and a state of emergency was declared in Christchurch. What began as a single terrifying event would ultimately become only the beginning of an ongoing saga for the people of Canterbury (Canterbury Earthquakes Royal Commission New Zealand, 2012). Typically, an earthquake is followed by a series of aftershocks of diminishing magnitude over the following months or years. In Christchurch, however, four more major earthquakes would follow in the next 15 months (December 2010, February, 2011, June 2011 and December 2011), as well as tens of thousands of smaller aftershocks which have continued to date in 2015. The most destructive of the earthquakes occurred on February 22, 2011. While smaller in magnitude than the September earthquake, the shallow epicentre near the Christchurch central business district (CBD) and extremely high peak ground acceleration of the February earthquake would result in substantially greater loss and damage (Thornley et al., 2015). 185 people died that day due to the earthquake- the majority due to two catastrophic building collapses. Thousands more were severely injured and the CBD was essentially demolished. In the wake of this disaster, residents were constantly re-traumatised with over 440 aftershocks occurring in just the following 24 hours alone (Ardagh et al., 2012).

Liquefaction (a process in which the ground essentially turns to liquid), rock falls, lateral and vertical spreading and landslides all contributed to the damage done by the various earthquakes (McColl & Burkle, 2012). Infrastructure and essential services were repeatedly compromised, including hundreds of kilometres of water systems and thousands of kilometres of roading, as well as homes and businesses being damaged to varying degrees. Flooding in certain parts of the city became commonplace in winter due to changes in land formation and drainage facilities (McColl & Burkle, 2012). With no obvious endpoint in sight, decisions regarding actions to repair and rebuild were delayed under the logic that there was little point in doing this until the shaking had settled (Mutch, 2014).

With the absence of any major earthquakes in the last few years, Christchurch is now recovering- although progress is slow (Thornley et al., 2015) and the impact of this disaster has indelibly changed the psychosocial landscape of the local community. As time passes, however, a new 'normal' emerges. Five-year-olds today have never known a pre-earthquake Christchurch. The resident population now includes many people who never experienced Christchurch's shakiest times. Memories of the earthquakes are now settling into the collective history of the region.

2.1.2 Damage

In New Zealand, those who take up insurance pay a levy to the Earthquake Commission (EQC) to provide cover in the case of natural disasters. With about 540, 000 residents in the entire Canterbury region, EQC has received over 500, 000 claims due to the Canterbury earthquakes (EQC, 2015). It has been estimated that the economic cost of recovery for Canterbury sits around NZ\$40 billion, which is greater than the cost of any previous natural disaster in New Zealand's history (McColl & Burkle, 2012; Mutch, 2014). Conservative estimates predict that the rebuild of the city will take around 15 years.

2.1.2.1 Infrastructure

In the immediate aftermath of earthquakes people would often experience difficulties in accessing cell phone coverage due to overloading and damage to communication towers which, for many people, was a stressful and frustrating circumstance (McColl & Burkle, 2012). Loss of electricity was also experienced in most areas, further complicating the situation. Eighty percent of the city's sewerage and water system was damaged causing loss of function and concerns about the safety of drinking water. Reticulated water supplies were compromised causing loss of service to most areas for varying lengths of time; while some people had running water within hours of the earthquakes, others would wait up to two months, relying on emergency rain water and deliveries from tankers (McColl & Burkle, 2012). Portable and chemical toilets were brought in to the city by the thousands, to serve many neighbourhoods until normal sewerage systems could be repaired: again, in some regions, this would take months (McColl & Burkle, 2012).

2.1.2.2 Housing

Following the earthquakes, substantial portions of the land in the region was found to no longer be suitable for what it had previously been used for. All land was categorized into zones defined by its suitability for use. Whole neighbourhoods disappeared as they were "red-zoned", leaving what was left to be demolished (McColl & Burkle, 2012). With approximately 7, 800 homes being deemed uninhabitable and roughly 100, 000 being damaged, the reduction in the supply of housing combined with the influx of rebuild workers to the city increasing demand, sufficient and affordable housing has become increasingly difficult to come by (Thornley et al., 2015). New areas are being developed for housing in the long term but in the short-term, living conditions for many, particularly the most vulnerable members of society, are less than suitable.

2.1.3 Uniqueness of Canterbury experience

The Canterbury earthquakes were unique in a number of ways. Firstly, the events themselves were atypical geophysically with the causative fault line having been previously unknown, the peak ground acceleration being the highest ever recorded, and the various epicentres being either within or very close to the centre of a medium-sized city. Secondly, the chronicity and severity of the aftershocks in this case went beyond the normally expected pattern (Thornley et al., 2015). An implication of these

circumstances was that notions of what to expect based on evidence from past earthquakes in other regions was less than convincing and thus was of little help in relieving anxiety about what the future might hold. With so much unpredictability, residents were left disempowered.

However, compared with similarly sized earthquakes in urban centres around the world, Canterbury's death toll was remarkably low (Ardagh et al., 2012) (McColl & Burkle, 2012). New Zealand has strict building codes which likely was a major protective factor. Furthermore, the emergency responses were particularly effective, with good access to high quality health care available to those who needed it. The occurrence of the first earthquake, which struck while most people were sleeping, acted as a preparatory exercise for the following earthquakes. Civil Defence educated people on how best to prepare for, and survive during further earthquakes, and it is likely that this increased preparedness helped in mitigating the effects of the subsequent seismic events.

2.1.4 Migration

In response to the earthquakes, migration patterns in Christchurch are believed to have changed compared with pre-earthquake patterns. A study of postal redirection of Christchurch residents' mail showed that about 20,000 people relocated their address within the city and a further 5000 relocated to addresses outside of the city (Newell, 2012). Overall, it is estimated that the population of Christchurch decreased by 3.6% in the 2 years up to June 2012 (Thornley et al., 2015).

After the earthquakes, a need for more workers to help with the rebuild was realised. Various schemes have enticed relevant workers and their families from across the country and the world to move to Christchurch for this opportunity. How this has impacted the demographics of the population over the longer term is still unclear.

2.1.5 Impacts on the health care system

Typically, following a disaster, a lot of the health care supplied is sourced from external emergency relief providers. In the case of the Canterbury earthquakes, the majority of health care provision was conducted and managed by existing, local providers. While Christchurch's main public hospital, the only provider of acute hospital-level care in the region, was damaged by the earthquakes, other hospitals (both locally and in other regions), as well as primary care providers compensated for much of the shortfall created by this damage (Ardagh et al., 2012). The benefit of this was that care provision was not delayed excessively and was provided in a familiar context by local, trusted services.

2.1.6 Impacts on the education system

There were around 150,000 students of all ages engaged in education across 750 providers at the time of the February earthquake. An estimated NZ\$100 million or more worth of damage was done to educational facilities. Consequently, the Ministry of Education (MoE) faced a substantial challenge in

providing high quality, accessible and safe educational services to the students of Canterbury (Ministry of Education, 2011).

Despite the ongoing challenges, it was recognised by the MoE that prompt restoration of educational services would be vital to the recovery of the people in Canterbury (Ministry of Education, 2011). Accordingly, immediate, practical support was provided to those involved in local education communities. The MoE has reported that “within 12 days of the September earthquake, 99% of early childhood education services and 98% of schools had reopened” and “within 3 weeks of the February earthquake, 62% of early childhood education services were operating and schooling was available for 84% of all students” (Ministry of Education, 2011). Following the first earthquake, over 1000 leaders in the education sector attended a MoE-arranged presentation to respond to concerns, provide assistance and communicate the plans for the education community (Brown, 2011). These early interventions proved valuable when the February earthquake struck as providers were well prepared and skilled for managing the crisis (Brown, 2011).

Aid through extra funding, assistance with relocation, psychological support resources, assessment of facility safety and provision of site-based infrastructural solutions were all provided by the MoE (Ministry of Education, 2011). A wide variety of evidence-based resources to help children, families, teachers and other staff to cope with the situations experienced and prepare for future possible events were also made available to all education providers across many platforms (Dean, 2011) (Mutch, 2014).

Many schools quickly became hubs for community support and assistance following earthquakes; providing shelter, social support, and accommodating emergency provisions such as water and portable toilets. School staff across the region courageously responded to the needs of their communities despite their own personal challenges (Mutch, 2014) (New Zealand Government, 2012). In the face of the multitude of challenges experienced by schools, many reported that an improved relationship with the local community was a positive outcome (Mutch, 2014). Further, this strengthened relationship had long-lasting effects with schools often becoming informal sources of community support and development (Mutch, 2014).

Routine and consistency have been recognised as important protective factors for the maintenance of wellbeing in a disaster situation. Despite the best efforts of everyone, children experienced disruptions in their education. Relocation, site sharing, teaching through the internet and teaching from temporary structures such as tents were just some of the ways education providers ensured the continuation of their education provision (Mutch, 2014). In many cases, children either could not or would not retain consistency in their education. As of August 2011, 11, 572 students had at some stage enrolled in a different school from the one they were at on February 22, 2011 and of these, only 6, 665 students had returned to their original school (Ministry of Education, 2011). Even for children who did remain at

their pre-earthquake provider, drastic changes would occur in who the school community was made up of. Returning to school appeared to cause a number of difficulties for some people. Following the earthquakes, there was an increase in reports of fatigue and stress among school staff and students, as well as an increase in negative student behaviours as what is believed to be a result of stress (New Zealand Government, 2012).

2.1.6.1 Early Childhood Education Providers

Before starting primary school, most children in New Zealand will attend some type of Early Childhood Education Centre (ECE). These facilities are important for preparing children socially, cognitively and emotionally for school. A 2012 document released by the government stated that 21 of Canterbury's ECEs were permanently closed due to earthquake damage (New Zealand Government, 2012). Many more suffered significant physical damage as well as financial and human resource costs. Enrolments decreased overall across the city as families emigrated or decided to withdraw their children from ECEs with reasons including anxiety of separation (from either the family or the child) and as a cost saving measure (New Zealand Government, 2012). It is likely also that many families will have reduced the hours of attendance of their children at ECEs without entirely de-enrolling them. As a result, these children may have missed out on an important aspect of their early education. A major challenge in supporting ECEs and their enrolled children during and after the earthquakes was the lack of an established, centralised register detailing either the ECEs or the children who attend them (Dean, 2011). Resources to aid recovery were under-utilised by ECEs compared with primary and secondary schools (Dean, 2011).

2.1.7 Post EQ mental health in Canterbury families

Concerns about the psychological impact of the earthquakes and their sequelae on the Canterbury population has been widely considered. Residents have reported sleeplessness, cognitive dysfunction, heightened stress, depression and anxiety as results of their traumatic experiences (Kemp, 2011). Various interventions have been implemented to help individuals, families and communities cope and recover (McColl & Burkle, 2012). Resilience was continuously challenged with each new earthquake, aftershock or flood requiring yet another clean-up, further costs and additional repairs (McColl & Burkle, 2012). Anxiety about if or when the next earthquake might strike was pervasive, with each subsequent event leaving people more tired and stressed to cope with the next (Brown, 2011). Stories from friends, family, colleagues, the media and even strangers were shared persistently and inescapably, leading in many people to a kind of 'earthquake fatigue' (Brown, 2011). There were also anecdotes that suggested some people didn't access assistance as they felt that many people were worse off.

Some geographical regions and possibly particular societal groups were more severely exposed to direct earthquake loss and damage. Hogg et al. (2014) examined the effect of exposure level on the

stress impact that the Canterbury earthquakes had on people based on their location of domicile and demographic characteristics. They found that people living in worse-affected areas generally had an increased risk of having a mood or anxiety related disorder by 23% compared with residents living in less affected regions. Further, they found that being female, older or of NZ European ethnicity also increased this risk.

Available data regarding the demand for mental health services following the earthquakes are conflicting. Following the earthquakes, the widespread perception was that demand would increase due to disaster-related illness; conversely, overall psychiatric inpatient service use has markedly decreased since the earthquakes and furthermore has remained at a lower than pre-earthquake levels (Beaglehole, Bell, Beveridge, & Frampton, 2015). While it is important to note that this data reports on total inpatient service use, not child-specific or out-patient use or demand, the authors of this study reported that “referrals to outpatient specialist mental health services appeared to mirror the inpatient findings with a marked reduction in referral rate in the short term following the February earthquake”, but that complexities with the data collecting system for this service prohibited in-depth historical comparisons (Beaglehole et al., 2015).

Resilience and post-traumatic growth (PTG) have become important topics of discussion in the disaster literature. Thornley et al. (2015) studied the presence of resilience and PTG in selected Christchurch neighbourhoods. Overall, the studied communities reported that community connectedness had improved as a result of the collective experience. New networks, partnerships and natural leaders emerged as communities came together to face challenges. In some cases, participants reported that the existing high levels of community connectedness before the earthquakes occurred helped them to cope afterwards (Thornley et al., 2015). Furthermore, findings from the Christchurch Health and Development Study showed that in their sample of 35-year-old women, higher levels of exposure to disaster were associated not only with higher levels of distress but also with higher levels of self-reported positive outcomes (Fergusson, Boden, Horwood, & Mulder, 2015).

It is clearly a complicated picture but it is fair to say that the Canterbury earthquakes have changed the psychosocial landscape over the past 5 years. Both positive and negative outcomes have been studied in the wider community as well as their respective risk and protective factors. It is apparent that traumatic events such as earthquakes can have significant impacts on children through various mechanisms. We know that the long term outcomes of these impacts are potentially of great consequence. We know that the Canterbury earthquakes greatly disrupted the lives of young children. And yet, while we have a relatively good understanding of how the Canterbury earthquakes have impacted the general population, we know little of how our vulnerable younger population has fared. This study aims to address this gap in knowledge.

2.2 Natural Disasters and Child Health

2.2.1 Disaster Sequelae

Post disaster sequelae are well described in models with progression from an acute response of shock and disorientation, through a period of philanthropy, gratefulness and self-sacrifice. As bureaucratic and institutional challenges arise and people become weary from the stress, a stage of demoralisation, and frustration is typical. Eventually, renewal and development instils in people feelings of hope and recuperation (Mutch, 2014). While these models show a general progression over time, it is important to remember that recovery is seldom a linear process but rather a dynamic and context dependent one (Brown, 2011). This model fits well with the general experiences held by the community in Canterbury (McColl & Burkle, 2012).

2.2.1.1 Types of disruptions

Disasters typically cause disruptions in all domains of family life: physical, social, economic, and cultural (Cherry, 2009; Terranova, Morris, Myers, Kithakye, & Morris, 2015). Families may face a multitude of losses, related to: relationships, homes, employment, possessions, financial security, familiar surroundings, and habitual patterns (Laor et al., 2002). Pre-existing challenges such as illness, conflict or financial strife are generally exacerbated by the occurrence of a disaster. All of these expose young children to a cascade of secondary stressors.

2.2.2 The impact of natural disasters on children

Children are particularly vulnerable to disaster effects on emotional and behavioural wellbeing (Mooney et al., 2011; Mutch & Gawith, 2014; R. Williams, Alexander, Bolsover, & Bakke, 2008). Their developmental stage and reliance on others for support put them in the unique position of particular susceptibility to negative impacts (Ann S. Masten & Osofsky, 2010; Wiguna, Guerrero, Kaligis, & Khamelia, 2010) (Buchanan, Casbergue, & Baumgartner, 2009). It has now been established that disasters can have serious implications for the mental health of child victims (Mutch, 2014) (Şahin, Batıgün, & Yılmaz, 2007). Post-traumatic stress disorder (PTSD), depression, anxiety and specific phobias are some of the clinical diagnoses that have been attributed to child disaster victims, as well as a plethora of other harmful reactions. Various studies across a range of different disaster types with differing study populations have identified a range of disaster-related ill-health and impairment in children. For example, Burke et al. (1982) reported that aggressive conduct and antisocial behaviours in school children increased significantly in the year following a disaster. A different study of children who were 4 to 9 years old at the time of a disaster found that victims had more externalising psychological and general health problem than non-exposed peers 5 years after the occurrence of the disaster (Boer, Smit, Morren, Roorda, & Yzermans, 2009). Another study of disaster exposed children found an increase in a wide range of problem behaviours as reported by teachers (Smilde-van den Doel, Smit, & Wolleswinkel-van den Bosch, 2006). Further findings from this study were that 2 to 3 years after the event, school doctors expressed concerns about the

wellbeing of more than a third of the children who had been 1- to 4-years-old at the time of the disaster. More than 3 years after Hurricane Katrina, a study found that 40-50% of parents were reporting emotional or behavioural problems in their children that had not been present prior to the disaster (Abramson, Park, Stehling-Ariza, & Redlener, 2010). A detailed review of relevant disaster studies is supplied at the end of this chapter.

Structure and consistency are important conditions for the healthy existence and development of young children, and disasters can cause disruption across all domains of a child's life (Murray, 2006; Terranova et al., 2015). Most children respond to these disruptions with considerable distress but succeed in remaining functional with only temporary debilitation (McFarlane, Policansky, & Irwin, 1987; R. Williams et al., 2008). Some of these children, however, will experience more sustained and debilitating effects which impair their ability to function normally (Terranova et al., 2015). Even when disaster-related difficulties experienced by children do not reach a level of clinical significance, it is likely that the child's quality of life is diminished and this may result in some impairment (Alisic, Jongmans, van Wesel, & Kleber, 2011). Further, this impairment experienced by the child can also create substantial burden for others such as parents, teachers, siblings and friends (Meltzer, Gatward, Goodman, & Ford, 2003).

2.2.2.1 Common trauma reactions and symptoms

The effects on children of traumatic disasters varies by child and across time (Connor, Ford, Arnsten, & Greene, 2014). (Alisic et al., 2011) (Furr, Comer, Edmunds, & Kendall, 2010). Some children experience no or few maladaptive responses, while others experience protracted and severe impairment (Connor et al., 2014; Nolen-hoeksema & Morrow, 1991).

Common post-traumatic stress responses include:

Table 1 Common trauma reactions of children

Emotional	Behavioural	Somatic	Cognitive
Fear (Lubit, Rovine, DeFrancisci, & Eth, 2003; Pfefferbaum & North, 2013; Yule & Williams, 1990) (S. J. Dollinger, O'Donnell, & Staley, 1984; Erkan, 2009; Laor et al., 2002; Murray, 2006; Thabet, Karim, & Vostanis, 2006; Yule & Williams, 1990)	Regressive behaviour (Yule & Williams, 1990) (Coffman, 1998) (Lubit et al., 2003; Robert S. Pynoos, Steinberg, & Piacentini, 1999) (Gurwitch, Kees, & Becker, 2002; Laor et al., 2002; Murray, 2006; Smilde-van den Doel et al., 2006; R. Williams et al., 2008)	Sleep disturbance (Pfefferbaum & North, 2013; Yule & Williams, 1990) (Coffman, 1998; Lubit et al., 2003) (S. J. Dollinger et al., 1984; Durkin, Khan, Davidson, Zaman, & Stein, 1993; Nolen-hoeksema & Morrow, 1991) (Saylor 1993). (S. Dollinger, 1986; Gurwitch et al., 2002; Murray, 2006; Mutch, 2014; Smilde-van den Doel et al., 2006; Sugar, 1989)	Impaired concentration/easily distracted (Erkan, 2009; Gurwitch et al., 2002; Lubit et al., 2003; Mutch & Gawith, 2014; Nolen-hoeksema & Morrow, 1991; Smilde-van den Doel et al., 2006; Thabet et al., 2006) (Sugar, 1989)

Emotional**Anxiety (including separation anxiety)**

(Durkin et al., 1993; Lubit et al., 2003; Yule & Williams, 1990) (S. J. Dollinger et al., 1984; Nolen-hoeksema & Morrow, 1991) (Saylor 1993). (Gurwitch et al., 2002; Laor et al., 2002; Mutch, 2014; Smilde-van den Doel et al., 2006), (Lubit et al., 2003)

Anger/aggression

(Durkin et al., 1993) (Lubit et al., 2003) (Mutch, 2014) (Gurwitch et al., 2002; Sugar, 1989) (Laor, 2002 #244; R. Williams et al., 2008)

Anhedonia/depression

(Durkin et al., 1993; Lubit et al., 2003; Nolen-hoeksema & Morrow, 1991) (Saylor 1993). (Gurwitch et al., 2002; Laor et al., 2002; Murray, 2006; Mutch, 2014)

Restricted affect/numbing

(Laor et al., 2002; Pfefferbaum & North, 2013)

Phobias

(Lubit et al., 2003; Mutch, 2014; Sugar, 1989) (Murray, 2006)

Negativism

(Coffman, 1998)

Irritability

(Coffman, 1998; Gurwitch et al., 2002; Murray, 2006; Mutch, 2014; Mutch & Gawith, 2014)

Heightened arousal/startle

(Murray, 2006), (Yule & Williams, 1990)

Guilt/shame

(Laor et al., 2002; Murray, 2006; Nolen-hoeksema & Morrow, 1991)

Detachment

(Pfefferbaum & North, 2013) (R. Williams et al., 2008) (Murray, 2006)

Apathy/passivity

(Erkan, 2009; Sugar, 1989) (Murray, 2006)

Mood swings

(Gurwitch et al., 2002)

Behavioural**Clinginess/attention seeking**

(Yule & Williams, 1990) (Coffman, 1998; S. J. Dollinger et al., 1984; Mutch, 2014; Thabet et al., 2006) (Gurwitch et al., 2002; Murray, 2006)

Repetitive play

(Lubit et al., 2003; Pfefferbaum & North, 2013) (Popović & Petrović, 1964; Sugar, 1989; R. Williams et al., 2008)

Problematic social behaviour/misconduct

(Coffman, 1998) (Saylor 1993). (Smilde-van den Doel et al., 2006; Takada, 2012)

Withdrawal

(Gurwitch et al., 2002; Laor et al., 2002; Murray, 2006; Mutch, 2014)

Increased**dependency**

(Erkan, 2009; Lubit et al., 2003)

Temper tantrums

(Erkan, 2009; Lubit et al., 2003; Murray, 2006; Thabet et al., 2006)

Hyperactivity

(Coffman, 1998; Gurwitch et al., 2002; Thabet et al., 2006)

Avoidance and aversion to novel experiences

(Laor et al., 2002; Lubit et al., 2003)

Immobility

(Coffman, 1998)

Thumb sucking

(Mutch, 2014), (Coffman, 1998)

Re-enactments

(Pfefferbaum & North, 2013) (Laor et al., 2002) (Popović & Petrović, 1964; Sugar, 1989)

Agitated behaviour

(Pfefferbaum & North, 2013)

Somatic**Enuresis**

(Yule & Williams, 1990) (Coffman, 1998; S. J. Dollinger et al., 1984; Durkin et al., 1993; Erkan, 2009; Mutch, 2014; Popović & Petrović, 1964; Sugar, 1989)

Eating problems

(Durkin et al., 1993; Erkan, 2009; Gurwitch et al., 2002; Murray, 2006; Sugar, 1989)

General somatic complaints such as pain

(S. J. Dollinger et al., 1984; Laor et al., 2002; Lubit et al., 2003; R. Williams et al., 2008) (Sugar, 1989) (S. Dollinger, 1986; Murray, 2006)

Incontinence

(Coffman, 1998; Erkan, 2009; Lubit et al., 2003)

Cognitive**Disorganisation**

(Pfefferbaum & North, 2013)

Loss of verbal skills/speech difficulties

(Erkan, 2009; Lubit et al., 2003)

Confusion

(Coffman, 1998)

Loss of interest/responsiveness

(Coffman, 1998) (Murray, 2006; Mutch, 2014)

Dissociation

(Laor et al., 2002; Sugar, 1989)

Emotional	Behavioural	Somatic	Cognitive
Grief (Laor et al., 2002)	Irresponsibility (Sugar, 1989)		
Helplessness (Erkan, 2009),(Pfefferbaum & North, 2013)	Whining (Gurwitch et al., 2002), (Lubit et al., 2003)		
Insecurity (Erkan, 2009)	Impulsiveness (Mutch, 2014)		
	Crying (Coffman, 1998)		

2.2.2.2 *Impact mediators*

The degree of exposure alone does not fully explain the wide variation of responses seen in children (Claessens et al., 2011; Ann S. Masten & Osofsky, 2010). The impact of disasters on children may be mediated by complex, setting-specific (often multi-setting) interactions between multiple factors (March, Amaya-Jackson, Terry, & Costanzo, 1997; Thornley et al., 2015). These factors may include:

- Pre-existing characteristics of both the child and their parents such as: educational status, socioeconomic status (SES), sex, ethnicity, age, health status, family functioning and structure, genetics, and culture (Alisic et al., 2011; Ayub et al., 2012; Burke et al., 1982; Davis, Sawyer, Lo, Priest, & Wake, 2010; Furr et al., 2010; Jia et al., 2013; Johnson & Galea, 2009; Jones et al., 2009; Laor et al., 2002; Lubit et al., 2003; Mutch, 2014; Rutter, 1987; Şahin et al., 2007; Sugar, 1989; R. Williams et al., 2008)
- Disaster exposure details including: death toll, proximity to disaster, personal loss, duration of disaster, perceived threat from disaster, objective and subjective experiences, and type of disaster (Alisic et al., 2011; Ayub et al., 2012; Furr et al., 2010; Gurwitch et al., 2002; Jia et al., 2013; Jones et al., 2009; Laor et al., 2002; Lonigan, Shannon, Finch, Daugherty, & Taylor, 1991; McFarlane et al., 1987; McLaughlin et al., 2010; Şahin et al., 2007; Sugar, 1989; Terranova et al., 2015; Thabet et al., 2006; R. Williams et al., 2008; Ying, Wu, Lin, & Chen, 2013)
- Post-disaster factors such as: comorbidities, routine disruption, caregiver separation, family functioning and structure, social support, information and assistance available to children, cumulative traumatization, availability of support, peer-responses, parental reaction, and coping mechanisms (e.g., active, avoidant, distraction, social support seeking) (Abramson et al., 2010; Alisic et al., 2011; Ayub et al., 2012; Chemtob, Nomura, & Abramovitz, 2008; Coffman, 1998; Connor et al., 2014; Furr et al., 2010; Galante & Foa, 1986; Jones et al., 2009; Laor et al., 2002; Ann S. Masten & Osofsky, 2010; McLaughlin et al., 2010; Mutch,

2014; Najarian, Goenjian, Pelcovitz, Mandel, & Najarian, 2001; Robert S. Pynoos et al., 1999; Rutter, 1987; Terranova et al., 2015; Thabet et al., 2006)

2.2.3 Impact over time

As outlined above, there are a range of possible responses to a natural disaster which children may exhibit. However, most negative effects on the emotional and behavioural wellbeing in children usually diminish over time (McLaughlin et al., 2010; Mutch, 2014). Stress may affect child emotional and behavioural wellbeing both short and potentially long-term (Alisic et al., 2011). Negative impacts from traumatic experiences can affect children for different durations and may also change qualitatively and quantitatively over time (Connor et al., 2014). These disruptions may cause substantial impact and alter normative developmental trajectories (Cherry, 2009). Trauma-resultant problems may or may not resolve spontaneously (Yule & Williams, 1990).

A scarcity of empirical research means that as of yet we have an under-developed knowledge-base regarding the relationship dynamics between childhood disaster exposure and long-term impacts on psychosocial wellbeing (Buchanan et al., 2009; Roberts, Ferguson, & Crusto, 2013). For example, a meta-analysis of disaster-related post-traumatic stress (PTS) symptoms in people 18 years and under found that the long-term impact of disasters is under-studied and not well understood (Furr et al., 2010). Indeed, the factors impacting stability of psychosocial problems in non-disaster exposed children have not even been clearly determined (Fischer, Rolf, Hasazi, & Cummings, 1984). Depending on the age of the child, long-term explicit memories of the event may not be formed but whether this has a positive effect in the long-term or a negative effect is unclear.

The 0 to 5 age range is a time of significant growth and development in which many crucial capabilities and skills are attained (S. J. Williams, 2013) (National Research Council, 2000). This development is fundamentally affected by intrinsic and extrinsic psychosocial factors (S. J. Williams, 2013). Given the influence of early experiences on the trajectory of child wellbeing and development, it follows that efforts to mitigate potential risks arising in this period are an important tool in the arsenal of preventative public health (Mensah, 2014).

Shonkoff et al. (2012) explains how early experience of a traumatizing event such as a natural disaster may form long term effects: “significant adversity can produce physiologic disruptions or biological memories that undermine the development of the body’s stress response systems and affect the developing brain, cardiovascular system, immune system, and metabolic regulatory controls; and these physiologic disruptions can persist far into adulthood and lead to lifelong impairments in both physical and mental health” (Shonkoff et al., 2012). Delays in emotional and behavioural competencies increase the risk of further difficulties due to maladaptive patterns of behaviour during the developmental period, commonly leading to persisting psychosocial problems (Carter et al., 2004) (Fischer et al., 1984; A. K. Goenjian et al., 2001). This is partly because early psychopathology

prevents normal engagement in stage-salient experiences and may cause increased future vulnerability to normal life stresses (Lubit et al., 2003).

2.2.4 Emotional and Behavioural problems in children

2.2.4.1 Prevalence of emotional and behavioural problems

Although often under-diagnosed, there is a baseline prevalence of psychopathology in populations of young children (Stone et al., 2010). Often the presentation of psychopathology and subclinical difficulties in these populations present as emotional and behavioural problems. Various attempts have been made to estimate what a normative prevalence of these problems might be in a range of populations. Carter (2004) reports that prevalence estimates of parent-reported social, emotional and behavioural problems in 2- and 3-year-old children have ranged from approximately 7% to 24%, with the majority falling between 10% and 15%” (Carter et al., 2004). In the local context, a study of New Zealand preschool children found that the prevalence of behaviour problems based on clinical diagnosis in 2.5- to 5-year-olds was 22.5% (Pavuluri, Luk, Clarkson, & McGee, 1995). Thus it is important to recognise that significant emotional and behavioural problems in young children are not uncommon, but perhaps, rather, are an under-appreciated source of burden within the community. The above estimates give us no explanation of causality for disorder, but rather demonstrate that even in populations upon which no universal traumatic exposure has been experienced, it will be possible to identify a significant proportion of children with heightened psychosocial needs.

2.2.4.2 What is “normal”?

As is well explained by Carter (2004) “determining the boundary between typical development and diagnosable psychopathology can present challenges, particularly when symptom presentation is not extreme. Indeed, it is quite likely that the absence of sufficient normative data contributes to the under-identification of psychopathology in young children” (Carter et al., 2004). Indeed, cultural variations in parental perceptions of what is “normal” for a child at each age are a prime example of how a continuum of acceptability for emotional and behavioural problems may come about (Briggs-Gowan, Carter, Skuban, & Horwitz, 2001). In one context, a child’s problems may be regarded as significantly impairing, while in another those same problems may be accepted as normal variation. This necessarily makes the measurement of mental wellbeing an estimation at best.

2.2.4.3 Emotional and behavioural problems following trauma exposure are often ambiguous

Emotional and behavioural problems in very young children following exposure to a traumatic experience may evidence a consequent decline in wellbeing (Pfefferbaum & North, 2013). Adverse post-traumatic stress reactions in very young children can be quite non-specific, compared with the more typical symptoms seen in older children and adults, making them difficult to identify and diagnose (Pfefferbaum & North, 2013; Thabet et al., 2006). This difficulty in recognising children’s

difficulties or attributing them to normal developmental comportment is thought to explain a tendency towards under-diagnosis and under-treatment of trauma-related illness in children (Lubit et al., 2003).

2.2.4.4 Emotional and behavioural problems in children as a manifestations of post-traumatic stress disorder

At the more serious end of the spectrum, children can now be diagnosed with PTSD, for which the diagnostic criteria include a range of developmentally specific manifestations of symptoms (Alisic et al., 2011; Connor et al., 2014). PTSD is a serious illness which can significantly hinder wellbeing and development (Alisic et al., 2011), but sub-diagnostic problems may also be considerable cause for concern.

2.2.5 Positive Psychology

A change in focus has occurred over recent years from a focus on deficit psychology in the child-disaster context to a greater emphasis on aspects of positive psychology (R. Williams et al., 2008).

2.2.5.1 Resilience

Although many definitions of resilience in the context of positive mental health exist, they commonly agree that resilience refers to a dynamic developmental process reflecting positive adaption or competence in the face of challenging life conditions (A. S. Masten, 2001). Despite an historical focus on the need for external intervention to promote, retain and regain mental wellbeing in children after disaster exposure, it is now becoming recognised that ultimately, provided the right conditions, most children are capable of healing themselves (Connor et al., 2014; R. Williams et al., 2008). Although not fully understood, resilience in children following disaster experience is believed to be facilitated by a range of both internal and external protective factors (Connor et al., 2014). Availability of support, the re-establishment of routines and the opportunity to discuss and work through disaster-related concerns in a structured environment all appear to be important provisions for the establishment and maintenance of resilience in children (Galante & Foa, 1986).

2.2.5.2 Post-traumatic growth

A further mode of positive psychology is that of PTG, described as positive psychological growth in the aftermath of trauma through an increase of appreciation, meaningfulness, personal or community strength or new possibilities (Vigna, Hernandez, Paasch, Gordon, & L., 2009). PTG is transformative in that it involves “movement beyond pre-trauma adaptation” (Cryder, Kilmer, Tedeschi, & Calhoun, 2006). Although PTG has been demonstrated in older children (Vigna et al., 2009), it is as of yet unclear whether it is possible in very young children, or even if it is, how it might be demonstrated scientifically. One suggestion of a possible PTG behaviour in young children is re-enactment play, which may be a helpful mechanism by which children can process and develop from their traumatic experience (Buchanan et al., 2009). However, it has been posited that a certain level of cognitive

and/or emotional maturity may be necessary for the processes underpinning PTG to occur (Cryder et al., 2006).

2.2.6 Literature Review

Through a thorough search of the literature, a number of scientific studies were found in which mental-health related outcomes among children were examined in the context of a disaster. Table 2 summarises the qualities of each study as well as a brief note on the findings.

Table 2 Scientific studies regarding child mental health in the disaster context

Reference	Type of disaster	Was there a non-disaster-exposed control?	Outcome(s) of interest	Was the SDQ used?	Age of participants	Country of residence of participants	What was the length of follow-up time?	Who was the informant for subjective judgements?
<i>Trauma exposure in pre-school children in a war zone</i>								
(Thabet et al., 2006)	War	No	Emotional and behavioural problems	Yes	3-6 years	Palestine	Cumulative over life-time, ongoing	Parent
Direct and non-direct exposure to war trauma increases the risk of behavioural and emotional problems among pre-school children, which may present as non-specific psychopathology.								
<i>Impact of a natural disaster on preschool children</i>								
(Swenson et al., 1996)	Hurricane	Yes	Behaviour problems, trauma symptoms	No	2-6 years	USA	14 months	Parent
Hurricane exposed children had worse behaviour.								
<i>Preschool children's adjustment following a hurricane: Risk and resilience in the face of adversity</i>								
(Terranova et al., 2015)	Hurricane	Yes (pre-exposure)	Emotional and behavioural problems	Yes	5-6 years	USA	5 months	Parent, teacher
The link between disaster exposure and adjustment is complex. Family and personal factors, particularly emotional regulation, were found to mediate the link between exposure and outcome.								
<i>School performance and social-emotional behavior of primary school children before and after a disaster</i>								
(Smilde-van den Doel et al., 2006)	Fireworks disaster	Yes	School performance, social and emotional behaviour	Yes	1-9 years at the time of disaster	Netherlands	3 years	Parent, teacher, school doctor
School performance in exposed children during the 3 year period after the disaster was as good as or better than non-exposed peers. Significantly more problematic behaviour was reported by parents, teachers and the school doctor regarding exposed students 2 to 3 years after the disaster.								
<i>Impact of a technological disaster on young children: A five-year post-disaster multi-informant study</i>								
(Boer et al., 2009)	Fireworks disaster	Yes	Anxiety, depression, PTSD, physical symptoms	Yes	4-9 years at the time of disaster	Netherlands	5 years	Child, parent
Exposed children had more psychological (predominantly externalising) and health problems than non-exposed peers 5 years after the disaster.								
<i>Trends in serious emotional disturbance among youths exposed to Hurricane Katrina</i>								
(McLaughlin et al., 2010)	Hurricane	No	Serious emotional disturbance	Yes	4-17 years	USA	18-27 months and 36-39 months	parent
The prevalence of serious emotional disturbance decreased between the first and second follow-up but was thought to still be higher than the estimated pre-hurricane prevalence.								

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.3 Problems with What we Know

2.3.1 Disaster Study Design Issues

Significant research has gone into finding how disasters and other traumas may impact emotional and behavioural wellbeing in children. Despite this, there remains a lack of conclusive knowledge about the processes and factors involved. Below, study design challenges which have explain many our current gaps in understanding are discussed.

2.3.1.1 Mixed results of past studies

Reviews of studies on the effects of traumatic events on child wellbeing have reported wildly varying and often contradicting findings across the literature (R. Williams et al., 2008). Indeed, the importance of the potential impact of disasters on child emotional and behavioural wellbeing was not widely recognized or considered until the mid-1980s due to methodological problems with early studies (Gurwitch et al., 2002). One review that found the prevalence rate of PTSD in children and adolescents exposed to disaster ranged from 3% to 100% (Şahin et al., 2007). The severity of population PTSD findings in other child-disaster studies have ranged from mild to severe (Jia et al., 2013). Different study methodologies have resulted in widely varying findings which mean that there is generally a lack of consensus regarding what to expect following a disaster (Lonigan et al., 1991). Even different studies on the same disaster have been found to produce inconsistent results (Ying et al., 2013). Some studies have even indicated improvement in emotional and behavioural wellbeing of some children following disasters (Nolen-hoeksema & Morrow, 1991). This overall lack of coherence is typically explained as being an artefact of study design differences. For example, it has been noted that sociological and psychological studies have provided less evidence for a negative impact than have psychiatric studies (Durkin et al., 1993).

2.3.1.2 Design affects outcome

The fundamental qualities of the design of a study can substantially impact the resultant findings and explain a significant amount of this variation (Furr et al., 2010) (R. Williams et al., 2008). While there is no single “gold standard” design for optimal research, it is important to consider how the ways in which any given study is designed may impact on the findings of the study. Empirical evidence, resulting from sound methodology is imperative if progress is to be made in understanding this important topic.

2.3.1.2.1 Studies are done in context

Not any two children, nor any two disasters are the same (Soeteman et al., 2007). This presents a major challenge in the design and interpretation of studies on this topic of child health in the wake of a disaster. It is not possible to isolate “pure” incidences of child trauma to study the way one might wish from a theoretical standpoint. Children and their emotional and behavioural wellbeing exist in the context of family, community and cultural expectations and experiences (Thabet et al., 2006). Nor

do the risk and protective factors of interest exist in isolation (Thornley et al., 2015). Culture is a particularly salient example of this. Culture is an inextricable and largely unquantifiable influence present in the study of child emotional and behavioural wellbeing. However, inter- and intra-population culture differences and similarities may explain a significant amount of the variance within the literature (Johnson & Galea, 2009). As a result, the potential role of context-specific factors must always be considered when exploring the correlations described in the literature. Although this complicates study design and interpretation, it is in itself a matter of great importance and interest. Population health does not occur in a test-tube, and nor should population health research.

A result of the context specificity of disaster studies is that one can never be sure whether findings are due to an underlying universal mechanism or due to context-specific aspects. Most likely the results of studies investigating the effects of disasters reflect both context-specific and universal mechanisms. Separating out these factors to understand the generalizable issues that occur broadly across all disasters is a major challenge. The cultural norms of parenting and teaching are likely to have a significant influence on child wellbeing following disasters (Thabet et al., 2006).

Individualistic approaches have been the norm in previous studies, but considering that child wellbeing is embedded in the context of family and community relationships, it is logical to take a more population-based, ecological approach (Carter et al., 2004). Slowly the literature is beginning to show some recognition of this need.

2.3.1.2.2 Developmental and transitional period

Early childhood is a difficult time in which to measure developmentally-sensitive outcomes. Defining and assessing 'problems' has to be done within the context of biopsychosocial developmental pathways which in turn requires some normative age-appropriate standard to be set (Carter et al., 2004). During early childhood, development occurs at a fast pace and is often non-linear. Further, the 'healthy' timing for reaching developmental milestones is not always clear. Determining whether changes in a young child are outcomes of disaster exposure or 'normal' aberrations in development is not always obvious at the individual level. Population-level studies offer the benefit of averaging this 'noise' over time to allow for any true signal to emerge.

2.3.1.2.3 Sample selection

Study samples should ideally be representative of the study population and large enough to provide statistical power in analyses. Researches often struggle to meet these criteria in the best of times. Following a disaster, however, these challenges are often amplified. The infrastructural, procedural and personal disruptions caused by disasters may hinder the obtainability of an appropriate sample. As a result, the majority of research in this sector relies on samples of convenience or subpopulations (Ann S. Masten & Osofsky, 2010). Different people are affected differently by disasters due to a wide range of factors. The sampling method of a study can thus have a substantial impact on outcome

(McFarlane et al., 1987). Rowney et al. (2014) for example argues that the high rates of post-disaster PTSD reported may be due to sampling bias wherein those who are more likely to experience PTSD following a disaster are also more likely to be included in studies about PTSD following disasters, thus distorting the representation of PTSD in the wider population (Rowney, Farvid, & Sibley, 2014). A further factor in disaster research which may compromise the quality of a sample is the propensity for low participation rates. Disaster studies, understandably, often have low participation rates which are a further threat to the representativeness of a study sample.

While adults and older children have been extensively studied, research on infants and young children has lagged behind (Buchanan et al., 2009; Roberts et al., 2013; Scheeringa & Zeanah, 2008). Young children make up a substantial and important portion of the population, yet there is a lack of studies and subsequent understanding of their emotional and behavioural wellbeing following disasters (Boer et al., 2009; Buchanan et al., 2009; Mutch, 2014; R. Williams et al., 2008). There are a number of challenges implicit in studying very young children such as the lack of accessible registers, ethical matters surrounding their vulnerability status, and practical complications of assessment due to their developmental stage. However, the literature that does exist tends to argue for the plausibility of equally or perhaps more substantial and important disaster-outcome relationships in very young children that deserves further investigation (Thabet et al., 2006).

2.3.1.2.4 Exposure measurement

The definition of what comprises a ‘disaster’ and how ‘exposure’ to a disaster is defined have been debated amongst authors in the sector (Harville, Xiong, & Buekens, 2010). As discussed earlier, all disasters are in some ways unique and so too are the experiences of those affected by them. Various methods have been devised to measure degree of exposure to a disaster, from objective and subjective experience checklists to distance of residence from the epicentre, either as categorical or continuous measures. Individual-level measurements provide the benefit of avoiding ecological fallacy and can give a more detailed picture of exposure status but may not be an economically worthwhile pursuit due to the intensive use of resources required and the undetermined sensitivity of wellbeing outcomes to exposure status and crude measurement options (Harville et al., 2010).

Exposure measurements in which participants are asked to provide details of their subjective and objective earthquake experiences may provide good detail but come at the cost of introducing error from mis-recollection or recall bias. Trauma may impair memory function by both altering the formulation of new memories in a time of trauma or in recalling memories about times of trauma (Weems et al., 2014). The impact of this is that the sensitivity gained by obtaining detailed exposure status may be negated by the introduction of bias and error, thus invalidating the worth of expending the extra effort.

A challenge when studying the impacts of disasters on wellbeing is the inability to separate the effects of other stressors, such as normal daily stress or prior trauma, from the disaster-specific stressors (Ann S. Masten & Osofsky, 2010). Although we can compare wellbeing measurements taken in times of normalcy and compare these with measurements taken in times of disaster to assess the differences between these two time periods, it is much more difficult to compare the effect of experiencing a disaster from the experience of living in a post-disaster environment to assess how each experience contributes to overall wellbeing compared with the normal everyday stressors of life in non-disaster times. Further, most studies do not take into account the possible effects of prior trauma and how these experiences might alter the relationship between the disaster of interest and wellbeing outcomes (Chemtob et al., 2010).

2.3.1.2.5 Effect of follow-up time

The follow-up period of a study likely affects what results are found. For example, a meta-analysis of post-disaster youth PTS studies found small-to-moderate effects among studies conducted 3 to 12 months post-disaster, whereas studies conducted more than a year after a disaster did not collectively find a significant effect (Furr et al., 2010).

Point prevalence is roughly equated to incidence multiplied by average duration of illness. In the case of disaster-related mental health problems, the simplified implication of this is that the distance in time between the event and the point of outcome assessment will largely influence the subsequent prevalence measurement. If the assumptions made in describing this relationship hold true, we would then generally expect to see a decrease in the prevalence of illness with increasing length of follow up period in a disaster-exposed population. Some of the problems with assuming this relationship in this context are that (1) incidence may not occur immediately following the event, as in, there may be a delay in problem development; (2) the population of interest may change during the follow up period. This is a particularly salient issue in disaster-affected populations who may need or wish to relocate; (3) average duration is a reasonable variable to include in the typically infectious, acute illnesses for which this epidemiological equation was originally developed; however, psychosocial problems do not commonly have clearly defined start and end points: they are often chronic, fluctuating, transforming, developmental, and highly contiguous of external context (such as the stage of post-disaster environmental recovery). The result of the above is that one cannot expect to see consistently clear trends in the nature or magnitude of disaster-related problems dependent on the length of follow-up time, and yet must accept that the duration of follow-up plays an important role (Furr et al., 2010; McFarlane et al., 1987).

2.3.1.2.6 Lack of an appropriate control group

Studies on child emotional and behavioural wellbeing following disasters often have no (or poor quality) comparison or control group data. Temporality is a key element in exposing a causal

relationship, that is, the exposure of interest must precede the outcome of interest if the exposure is to explain the outcome. The implication for disaster research is that researchers would ideally compare pre-disaster outcome measurements with post-disaster outcome measurements within subjects (Ann S. Masten & Osofsky, 2010). Of course, the unpredictable nature of disasters makes this a very challenging criteria to satisfy and is typically only possible when systematic surveillance or fortuitous coincidence of other studies focussing on the outcome of interest are present. Even when this does occur, the design of the processes has not typically been done with the objective of determining disaster effects in mind, so researchers can only use what information is available rather than plan for the best possible design in advance.

If temporal controls are not obtainable, researchers may select a concurrent non-affected control group (usually from a different area) for between-subject comparison. This introduces significant opportunity for confounding factors to obscure the characteristics of any true relationship. Indeed, one review found that studies using a between subject design showed a “significantly lower PTS effect size than studies using within-subject design ($r=0.19$, $SD=0.18$, $p<0.001$ compared with $r=0.31$, $SD=0.15$, $p<0.001$ respectively)”, (Furr et al., 2010). The same review found that only about 44% of studies included any comparison data, highlighting the need for better quality study design.

2.3.1.2.7 Types of tools used

A wide range of tools have been used to measure the mental health impact of traumas on young children. The tools vary in exactly which aspect of impact they measure as well as the ability of each to accurately and consistently measure these impacts. Some tools have multiple modes of use or interpretation which further broadens the differences in how study outcomes are measured. Some studies make up their own tools or use tools that are not well validated or have been significantly altered (e.g. through translation). Tools used are not necessarily designed for disaster use and may overlook important disaster impacts. Studies often screen for illnesses like PTSD or depression rather than trying to assess the impact on wellbeing as these are the well-established tools available. Symptomatology is a common target of these tools but may not adequately cover impacts by failing to assess in any way non-symptomatic problems present (McFarlane et al., 1987).

Findings of studies on the effects of disasters on child emotional and behavioural wellbeing may depend on the type of tool used and how it is used. Some studies have used multiple tools to assess outcome and found substantial differences between how each supposedly similar measurement tool rates the severity of victim impact. Some of the variance of impact outcomes in the literature may then be due to different tools being used to measure the same or similar constructs.

Tools ought to be well established, empirically tested and validated in the study population before they are used to measure disaster outcomes (Furr et al., 2010; Pavuluri et al., 1995). This includes having high quality baseline normative data for the population of interest to which the study data can

be compared (Smilde-van den Doel et al., 2006). Carter et al. (2004) for example argue that the lack of sufficient normative data may contribute to the under-identification of important mental health problems in young children. Outcomes need to be clearly defined, relevant, comprehensive enough to cover all major applicable impacts, and display good construct validity as psychometrically sound markers of mental health impact (Abramson et al., 2010; Lonigan et al., 1991). Indeed, it has been posited that the impacts of disasters on very young children may not be adequately assessed through the use of tools that have been designed for use in other age groups because of the peculiarities of young children's responses and impacts (Buchanan et al., 2009).

Interpretation methods of outcome measurement tools may be another key issue when considering tool validity. For example, many tools use cut-off values to ascertain 'caseness'. Cut-off values which are too high will result in the underreporting of important impacts while cut-off values which are too low will over-identify 'cases'. Further, the meaning of caseness in terms of practical application is often not clear. It may be used as a proxy for the presence of psychopathology, which is misleading, or as an indication of people with problems deemed by the tool to be 'important'. The likelihood of type I and II error for tools used should be explored.

Administration procedures of measurement tools are known to impact results. For example, multiple administrations of the same tool over time to participants may result in diminishing sensitivity (McFarlane et al., 1987). The method of administration (e.g., whether administration is written or spoken, presence of a clinician or researcher, location of administration) may also impact the results.

2.3.1.2.8 Means vs. proportions

In population health studies, it is necessary to determine what an appropriate population health measure might look like. Means of population scores or proportions of the population in various categories can be used to assess overall population health (A. Goodman et al., 2012). Further, this issue of measurement ought to tie in with implications, for example, whether a population-level intervention or a high-risk-targeted intervention should be used.

2.3.1.2.9 Adults as informants

While self-informant methods are favoured (Roberts et al., 2013), typically when studying very young children it is either not practicable or possible to gather outcome measurements from the children themselves due to their developmental stage. Caregivers and teachers are commonly used informants when assessing child outcomes (Boer et al., 2009). This presents problems of the potential for error, bias, and confounding, particularly when assessing subjectively identified outcomes.

There is evidence within studies of older children that the reporting of subjective effects on a child differs by who the informant is (Furr et al., 2010). One explanation of this is the inability of external informants to accurately interpret the internalised feelings of the child. Adults do not necessarily understand the meanings of young children's post-disaster responses: they can be quite different to

responses in older children and adults and often do not appear as ‘problems’ and thus are not noticed or attended to (Thabet et al., 2006). Other explanations include bias resulting from treatment-seeking or stigma-avoidant behaviour; or contamination effects of the informants own experiences and beliefs on their reporting on that of the child (Carter et al., 2004; Chemtob et al., 2008; Davis et al., 2010; Gurwitch et al., 2002; Yule & Williams, 1990). In the wake of a disaster it is possible that adult informants become more attuned to signs of problems in children due to the expectation that they might occur (Hogg et al., 2014). Conversely, the barrage of disaster-related stressors faced by adult informants following disasters may distract them from attending as closely to subtle cues from their dependent children, thus resulting in under-reporting.

When distortions do occur, it can be difficult to infer the directionality or mechanism of effect (Boer et al., 2009). For example, a study using the Child Behaviour Check List (CBCL) to investigate emotional and behavioural problems in children following an earthquake in Turkey showed that mothers with a low level of education reported more problems than mothers with a high level of education. It was not determined whether this was because of a bias toward higher perception of problems in the mothers or whether this was a true effect that children with less educated mothers experienced greater problems following the earthquake (Erkan, 2009). Ideally the inclusion of multiple informants and assessment of the informants themselves should address these issues, though this is seldom done (Sugar, 1989).

It seems that mothers are the most commonly used informants of child emotional and behavioural wellbeing. Conversely, fathers and other family members are seldom questioned by researchers about their interpretations of the child’s wellbeing (Ann S. Masten & Osofsky, 2010). Indeed, little literature exists around the specific impacts of non-mother relationships on very young children following disasters. This reflects the importance of the mother-child relationship but also presents a significant gap in knowledge.

Parents and teachers are useful sources of objective information regarding measures of exposure, impairment and impact (Gurwitch et al., 2002). An example is that parents and teachers are useful sources of information regarding a child’s history (Pfefferbaum & North, 2013). Conversely, subjective parental and teacher responses are influenced by personal characteristics (Tees et al., 2010) (Pfefferbaum & North, 2013). In other words, parents’ and teachers’ own experiences, beliefs and mental wellbeing may affect how they report on child measures (Briggs-Gowan et al., 2001; Erkan, 2009; Tees et al., 2010). As a result, children are generally better reporters of internalising symptoms because they are the best observers of their own internal feelings, whereas parents are better reporters of externalising problems. (March et al., 1997) (Pfefferbaum & North, 2013). Non-parental informants can also be useful as they provide objective information about the child’s behaviour from a different contextual standpoint (Pfefferbaum & North, 2013).

Overall, parents tend to underestimate the psychosocial effects of disasters on their children, although there have also been instances where researchers have found parents to over-report child problems (Pfefferbaum & North, 2013) (Boer et al., 2009; Coffman, 1998; Yule & Williams, 1990).

McFarlane's 1987 study showed a delayed response in behavioural impacts of children following a bushfire. Further, they present evidence that children may behave more obediently for the adults around them in a time of crisis and thus adults may fail to notice emotional damages occurring in these children (McFarlane et al., 1987). This is one example of the many reasons that adults informing on child mental status are prone to error.

2.3.1.3 Focus on pathology

The vast majority of studies considering the mental health of children following disasters focus on pathology and other negative outcomes (R. Williams et al., 2008). This emphasis on disorder is largely a reflection of how mental health as a whole has been popularly conceptualised. The result has been a significant gap in knowledge regarding positive outcomes and non-pathological outcomes from disasters which has only recently begun to be commonly addressed. Although this issue is now broadly recognised in modern literature, there remains a lack of empirical data due to the reliance of disaster studies on typically "piggy-backing" study designs using existing samples, surveillance data and retrospective reporting (Mensah, 2014).

2.3.1.3.1 PTSD commonly studied

PTSD is the most commonly studied disaster outcome (Alisic et al., 2011; Johnson & Galea, 2009). While it is an important outcome which deserves attention, it is by no means the only or even the 'typical' response to traumatic events such as disasters. PTSD occurs at the clinical extreme. While most people will not experience PTSD following a disaster, they will most likely experience negative or challenging circumstances which may have substantial impacts on their wellbeing or broader quality of life. For example, a study by Kuijer et al. (2014) of Canterbury residents following earthquakes found that "although the level of posttraumatic stress was on average low in our sample, only 37% of the sample reported that their lives had returned largely back to normal 3 months after the 2011 earthquake... The narrow focus on PTSD symptoms in the trauma literature does not do justice to the wide variety in experiences of trauma survivors... Although it is reassuring that only a small minority of people exposed to disasters develop PTSD, this does not mean that the rest of the people exposed are unaffected" (Kuijer, Marshall, & Bishop, 2014).

2.3.1.4 Use of screening tools in psychopathology

Although important for identifying people in need of support, screening for psychopathology, particularly in children, raises a number of concerns. The World Health Organisation (WHO) applies a set of guidelines for whether screening should be undertaken for a specific condition (Wilson, 1968):

1. The condition should be an important health problem.
2. There should be a treatment for the condition.
3. Facilities for diagnosis and treatment should be available.
4. There should be a latent stage of the disease.
5. There should be a test or examination for the condition.
6. The test should be acceptable to the population.
7. The natural history of the disease should be adequately understood.
8. There should be an agreed policy on whom to treat.
9. The total cost of finding a case should be economically balanced in relation to medical expenditure as a whole.
10. Case-finding should be a continuous process, not just a "once and for all" project.

While a critique of possible screening programmes for child mental health is beyond the scope of this thesis, it is important to recognise that the use of any given screening programme may not go without contention on many, if not all of the above guidelines.

2.4 The Canterbury opportunity

2.4.1 The B4 School Check

2.4.2 General

In response to a review of barriers and influences linked to poor learning outcomes that was commissioned by the MoE, in 2006, the New Zealand Government announced that a comprehensive health check called the B4 School Check would be provided for all 4-year-olds as the final check of the greater “Well Child” early health programme. The B4 School Check would replace the former School New Entrant Check for which coverage and consistency problems had been identified. According to a MoH publication, “children often reach primary school with undetected or untreated developmental or behaviour problems... There is evidence that early identification and intervention improves developmental and social outcomes for the child and family/whanau and the earlier the intervention the better” (Ministry of Health, 2008). The B4 School Check would aim to function as both a health promotion and early detection tool to enable children to begin formal education in the healthiest possible condition. Congruent with the contemporary understanding of health as holistic and contextual entity, it was specified that this new check would consider community and environmental circumstances of each child (Ministry of Health, 2008).

The B4 School Check includes (Ministry of Health, 2008):

- Advice and support for parents about child health and development
- A child health questionnaire (CHQ)
- A hearing screen
- A vision screen
- An oral health screen
- Questionnaires to identify developmental and behavioural problems (the Parental Evaluation of Developmental Status (PEDS) and Strengths and Difficulties Questionnaire (SDQ) tools respectively) completed by parents and teachers in discussion with health professionals
- Height and weight measurement as well as routine provision of advice to parents about healthy eating and exercise
- Referral of the child to specialist services if the child appears to have problems that need further investigation

It is intended that most children be assessed as soon after their 4th birthday as is practicable so that any issues identified can be adequately addressed before the child starts school. Children who for whatever reason do not complete the check while they are 4 years old are offered it upon school entry at age 5 years (Ministry of Health, 2008).

Registered nurses are the primary administrators of B4 School Checks. The setting of checks varies by DHB but it is encouraged by the MoH that the location should be based on the needs of each community. All relevant caregivers are encouraged to attend the B4 School Check visit (although they are most commonly attended by mothers), which usually takes around 45 to 60 minutes (Ministry of Health, 2008).

Before nationwide rollout in 2008, the B4 School Check programme was piloted in the Whanganui and Counties Manukau District Health Boards in 2007 to allow for evaluation and adjustment (S. J. Williams, 2013).

2.4.3 Strengths and Difficulties Questionnaire

2.4.3.1 General information about the SDQ

The SDQ was developed by child psychiatrist Dr Robert Goodman (Youth In Mind, 2015). It is made up of five questions regarding child behaviours from the past six months for each of five sub-scale domains: emotional attributes, conduct, hyperactivity, peer relations and prosocial behaviour. Each of the 25 questions is answered using a Likert scale of possible responses: “not true” “somewhat true” and “certainly true”. Answers to each question correspond with numerical scores, which can be summed to find the overall score for a child within each of the domains, as well as a total difficulties

score which is calculated by adding the total emotional, conduct, hyperactivity and peer problems scores. For all but the prosocial scale, a higher score implies a greater level of difficulty. Children without psychopathology should theoretically score low scores. The prosocial scale is not included in the total difficulties score because this domain assesses a child's strengths rather than difficulties, and is thus interpreted on its own. When scoring the prosocial score, a lower score implies a lack of prosocial behaviours. Children without psychopathology should theoretically score high scores on this scale. A further interpretation of scores is by indicative disorder type: internalising disorder (such as anxiety or depression where problematic behaviours are directed towards the self), which is determined by summing the emotional and peer problems scales; or externalising disorder (such as attention-deficit hyperactivity disorder (ADHD) or oppositional defiance disorder (ODD) where problematic behaviours are directed towards others), which is determined by summing the conduct and hyperactivity scales. A supplementary section (referred to from herein as the impact scale) questions the overall presence, duration and impact of child difficulties which can be used as a measurement of problem-related impairment. There are multiple ways of using the SDQ to screen for potential psychosocial problems: use of each of the subscales as identifiers of specific types of problems or as indicators for specific disorders, use of the prosocial scale as a measure of mental health competence, use of the internalising and externalising scales to indicate the two general poles of disorder type, use of the total problems score as an overall indication of problem behaviour and use of the impact scale score to inform the extent of functional impairment caused by problem behaviours experienced by a child (Ezpeleta, Granero, la Osa, Penelo, & Domènech, 2012).

The SDQ is preferably used as a multi-informant tool, that is, the tool works best when multiple parties complete the questionnaire about a child of interest. Two versions of the SDQ have been designed for use in young children, both of which are employed in the B4 School Check: the Strengths and Difficulties Questionnaire Teacher Version (SDQT), which is completed by a child's teacher or early childhood educator; and the Strengths and Difficulties Questionnaire Parent Version (SDQP), which is completed by a parent or caregiver (S. J. Williams, 2013). Various SDQs and their associated scoring schedules have been developed for children of different ages. The version of the SDQ used in the B4 School Check is the version written for three and four year olds because (as opposed to the version for 4 to 10 year olds which could also technically be used) the wording is more suitable for behaviour in the pre-school-aged context (Ministry of Health, 2008).

For each scale and subscale, 'normal', 'borderline' and 'abnormal' scores are categorised using cut-off scores. Each category indicates the likelihood of a child having a diagnosable disorder (where normal indicates a low likelihood, borderline a moderate likelihood and abnormal a high likelihood). Ideally these cut-off points should be determined by sampling a population of interest and comparing SDQ scores with gold-standard diagnostic measurements of psychosocial problems to find population-specific markers of the likelihood of illness (A. Goodman et al., 2012). Due to the resource

intensiveness of this process, however, SDQ scores are typically categorised using generalised cut-off points that were determined by the creator of the tool. At the time of implementation of the B4 School Check in New Zealand, there were no national norms or population-specific cut off points. Upon roll out of the programme, the MoH claimed that “New Zealand norms will be developed once the B4 School Check programme has been established and there is sufficient data for a robust study” and “the cut-off for referral will be reviewed once the B4 School Check is rolled out across the country and more information about referrals becomes available” (Ministry of Health, 2008). At the time of writing (December 2015), no changes have been made regarding national norms or the position of cut-off points. Currently, the cut-off points used for the B4 School Check are those suggested by Goodman for use with the 4-to 17-year-old version of the SDQ (not the 2-4 year old version as would be coherent with the screen used) which “were defined based on a population-based UK survey, attempting to choose cut points such that 80% of children scored ‘normal’, 10% ‘borderline’ and 10% ‘abnormal’” (Youth In Mind, 2015).

Copies of the parent and teacher SDQ report forms used in the B4 School Check are attached as an appendix.

2.4.3.2 Advantages of the SDQ

The SDQ was chosen as the screening tool for emotional and behavioural wellbeing in the B4 School Check due to its holistic view of child development and its focus on both the strengths and difficulties a child may be experiencing (S. J. Williams, 2013). A further benefit is the accessibility and ease of application thanks to its brevity and simple structure. The tool is publicly available and has been comprehensively used worldwide (Ezpeleta et al., 2012). The use of parents and teachers as informants has been identified by the MoH as yet another advantage of using the SDQ because the identification and management of problems is done in a relational context, which is particularly important in young children. Also, the process is less resource intensive than it would be if full diagnostic interviews were done instead (Ministry of Health, 2008). The MoH also cites the validity, sensitivity and specificity of the tool as reasons for selecting it over other tools (Ministry of Health, 2008).

2.4.3.3 Uses of the SDQ

The SDQ was developed by Goodman in the 1990s as a screening tool for positive and negative psychosocial attributes in children for use in research and practice (Stone et al., 2010). Goodman based the SDQ on the Rutter Questionnaires of the 1960s. Items from the Rutter Questionnaires were updated to reflect the present foci of child psychopathology (Stone et al., 2010). The prosocial scale was introduced to reflect the change in emphasis within the sector towards a multi-dimensional view of health with both positive and negative aspects, as well as having the benefit of making the tool more acceptable to users (Stone et al., 2010). The focus of the screen is to capture common forms of

psychopathology found in children and relies on the usual presence of comorbidities to detect less common problems such as autistic or psychotic syndromes (R. Goodman, Renfrew, & Mullick, 2000). Importantly, the SDQ was not designed as a diagnostic tool, that is, its uses are limited to screening for possible problems only, and as such the results should not be taken as diagnosis, but rather as an indication as to the likely usefulness of further assessment (Stone et al., 2010).

2.4.3.4 Psychometric Properties

The SDQ has been well studied internationally and results have generally indicated that it is an acceptable, reliable and valid screening tool for child and youth psychosocial problems. There is, however, a paucity of studies focussing on the use exclusively in pre-school aged children (Ezpeleta et al., 2012) (Davis et al., 2010).

Cicchetti (1994) provides guidelines for the interpretation of acceptability, reliability and validity measurements which are commonly used:

- Sensitivity (i.e., the proportion of children who are correctly identified by the SDQ as having psychosocial problems) and specificity (i.e., the proportion of children who are correctly identified by the SDQ as not having psychosocial problems) and levels of agreement: 90-100% is excellent, 80-89% is good, 70-79% is fair and less than 70% is poor
- Cronbach's alpha: 0.90-1.0 is excellent, 0.80-0.89 is good, 0.70-0.79 is fair and less than 0.70 is poor
- Kappa, weighted kappa and intraclass correlation coefficients: 0.75-1.0 is excellent, 0.60-0.74 is good, 0.40 to 0.59 is fair and less than 0.40 is poor

These guidelines will be followed in describing the outcomes of studies considering the psychometric properties of the SDQ.

A nationwide epidemiological sample of British 5- to 15-year-olds confirmed the validity of the five-factor structure and found that reliability of the tool was satisfactory in the domains of internal consistency (mean Cronbach's alpha = 0.73), cross-informant correlation (mean: 0.34) and retest-stability at four to six months (mean: 0.62) (Robert Goodman, 2001). The study found that specificity and negative predictive value were high (around 95%), the compromise for this being that sensitivity and positive predictive value were lower (around 35%). Over-inclusiveness is generally acceptable for a screening tool where the aim is to identify people likely to benefit from further assessment. The cost of this is that false positives become relatively more common. The prosocial scale was the least predictive of psychiatric disorder (Robert Goodman, 2001).

A further study by Goodman (A. Goodman & Goodman, 2009) using a large nationally representative sample of children aged from 5 to 16 years was conducted to evaluate the validity and reliability of

the SDQ which found that the greater the SDQ total difficulty score, the greater the likelihood of a child having a clinically diagnosable psychopathology. Interestingly, the odds of disorder increased linearly and consistently across the range of possible SDQ total scores (OR increase= 1.14-1.28 per single point increase in SDQ total difficulty score). The implication of this is that the use of cut-off points, although useful for screening and service provision purposes, is somewhat arbitrary in assessing the likelihood of a tested child showing disorder, as no threshold effects were found. Further, retesting of participants three years subsequent to the initial administration showed that the stability of SDQ-based probabilities for impairment was good over time. Goodman concluded that the SDQ is suitable for comparing the mental health status of children between groups, over time or following an intervention.

Goodman also used the above study sample to assess the SDQ as a detection tool for specific undiagnosed child psychiatric disorders in the community (R. Goodman, Ford, Simmons, Gatward, & Meltzer, 2000). Multi-informant SDQs showed a specificity of about 94.6% and a sensitivity of 63.3%. Sensitivity was further reduced when only one informant was used. The predictive values that each parent-informant and teacher-informant provide are roughly equal, although information provided by parents tends to be better at detecting internalising disorders whereas teacher reports are more useful in detecting externalising disorders. The SDQ, when completed by both parents and teachers, was found to be very good at identifying conduct, hyperactivity, depressive and some anxiety disorders but missed at least half of the cases of specific phobias, separation anxiety and eating disorders.

Responding to the lack of validation data for use of the SDQ in young children, Ezpeleta (2012) studied sampled Spanish three year olds using both the parent (n=1341) and teacher (n=622) reports. They found that the model adequately fitted the original structure using confirmatory factor analysis and internal consistency (as indicated by the omega coefficient) was 0.87 for parent reports and 0.91 for teacher reports. The scale with the lowest internal consistency was the prosocial scale. Convergent validity with other established tools was good for the parent-reported SDQ but poor for the teacher-reported version. The predictive accuracy for the use of mental health services and for functional impairment was found to be good. Overall Ezpeleta found the use of the SDQ in three year old children to show acceptable psychometric properties for use as a screening tool for the early identification of psychosocial problems in children.

A review of the literature on the psychometric properties of the SDQ (Stone et al., 2010) found that internal consistency for the total difficulties and impact scales (both parent- and teacher-rated) were generally acceptable. The sub-scales, however, showed substantial variation of internal consistency measures across studies, with typically moderate to adequate consistencies. The parent version was found to be less reliable than the teacher version with correlations mostly below $r=0.70$ for the SDQP

and all above $r=0.70$ for the SDQT. Test-retest reliability was found to be good in all domains except for the impact scale which was found to become less reliable with time. Reliability, as indicated by inter-rater agreement was found to be modest, although mostly better than other measures of child psychopathology. Overall the original five-factor structure of the SDQ was supported by confirmatory factor analysis in the literature, with corroboration from 15 out of the 18 studies which studied it. The total difficulties and impact scales were found to have high sensitivity and specificity and good capacity to discriminate. Correlations with other measures of child psychopathology were high. The total difficulties scales showed stronger properties generally than did the sub-scales. Findings of the review supported the multi-informant method due to the various strengths and weaknesses identified for each informant type.

2.4.3.5 Impact section

The version of the SDQ used in the B4 School Check contains the impact supplement questionnaire. This section asks the informant whether they believe the child to have a problem, and if so, how this affects distress and social functioning (R. Goodman, Ford, et al., 2000). This is useful for determining the level of impairment caused by problem behaviours in a child which is important clinically (Lai, Leung, Luk, & Wong, 2014). The impact scale has been less-well studied than the core questionnaire and thus the psychometric properties have been less-clearly defined. One study evaluating the use of the impact scale in Chinese school children found that the impact supplement score was a better predictor of clinical status than the total difficulties score was. Further, it was useful in detecting false negatives that would have occurred had symptom scores only been used (Lai et al., 2014). The study also found that the impact scale showed good internal consistency, discriminant validity sensitivity and specificity. In accordance with the symptom scales, it was found that the impact scale performed best when both teacher- and parent-rated SDQs were available. However, the correlation between impact scores and internalising disorders was weaker than that of externalising disorders. The implication of this is that internalising symptoms may not be seen as being as problematic or burdensome by parents and teacher, possibly leading to under-detection.

2.4.3.6 Not suitable for all diagnoses

As indicated above, the SDQ is generally a good indicator of the most common child psychiatric problems, however, it may not be appropriate for detecting some of the more peculiar psychopathologies. The SDQ contains only one question on each fears, misery and separation anxiety, while no questions are included about obsessions, compulsions, dieting, panic attacks or 'core' autistic symptoms. As put by Goodman (2000), the SDQ "is not good at detecting 'islets' of severe symptoms, it is much better at detecting children with more generalised symptomatology" (R. Goodman, Renfrew, et al., 2000). As most child psychopathology presents with quite generalised symptomatology and since comorbidity is common in child psychopathology, most children with

diagnosable illnesses are detected by the tool, however, as illustrated by some studies, this may make the SDQ inappropriate for use when screening for some context-specific impairments.

2.4.3.7 Cultural appropriateness

The distribution and expression of psychosocial problems is fundamentally impacted by the multitude of cultural facets (Stone et al., 2010). Thus, culture undoubtedly has an impact on the functioning of a tool such as the SDQ which is concerned with these problems (A. Goodman et al., 2012). To address this issue, one study considered whether the SDQ can be applied cross-nationally without the need for culturally-specific norms. Nearly 30,000 5- to 16-year-olds across seven countries were sampled with the SDQ as well as a comprehensive structured diagnostic interview by way of comparison. Findings indicated that population-specific norms are needed due to the high level of cross-cultural disparity, that is, the SDQ functions differently across different cultural groups (A. Goodman et al., 2012). With this in mind, studies of validity, reliability, and cut-off points for the SDQ that have been set in other countries may be of little applicability in the New Zealand setting. Further, this study also found that the prevalence of mental disorders varied greatly across the studied countries, from 2.2% in India to 17.1% in Russia. Considering that this study considered only seven countries, the implication is that childhood mental illness prevalence likely varies a great deal globally. The SDQ is designed with the intention that 80% of children will score in the 'normal' range, 10% in the 'borderline' range, and 10% in the 'abnormal' range. However, clearly this does not accurately reflect the true prevalence of disorder in many populations, meaning that the population prevalence of disorder must first be determined for a population and then cut-off points set to reflect the distribution of underlying illness in tested children. This has not occurred in New Zealand. The relationship between indicators of problems as measured by the SDQ, and the true prevalence of illness varies by population (A. Goodman et al., 2012). Further, symptomatology in one population may have a different clinical implication to what it does in another population, that is, the burden and impact of similar problems may vary by population (A. Goodman et al., 2012).

Indigenous populations are particularly prone to cultural inappropriateness using subjective health screens. The use of the SDQ on New Zealand Māori children has not been studied for appropriateness, yet there is reason to question its use in this population. Oliver et al. (2009) studied the use of the SDQ in Aboriginal Canadian children and found a number of problems with the reliability and validity of the tool in this group, despite the fact that it generally functions well in non-indigenous Canadian child populations. The impact of this finding was well articulated by Carter (2004) who argued "It is not appropriate to assume that the internal consistency or factor structure obtained in a dominant culture population will be comparable when a scale is employed with ethnic/racial minority groups". Whether or not this finding is applicable to New Zealand Māori children is unclear without local research available.

While the SDQ is available in many languages, it is not available in some of the more commonly spoken non-English languages in New Zealand. This presents a problem for people involved with the SDQ who have limited English-speaking abilities. Further, it has been argued that some of the wording used in the SDQ is culturally inappropriate for the New Zealand context, which may undermine its soundness of use (S. J. Williams, 2013).

2.4.3.8 *User Perceptions*

Use of the SDQ as part of the B4 School Check in New Zealand has not gone without controversy. Williams qualitatively studied the perceptions of B4 School Check providers regarding their experiences with the use of the SDQ (S. J. Williams, 2013). Adherence to the programme was discussed. One difficulty that was consistently experienced by interviewed providers was that some teachers and some early childhood education centres refused entirely to complete the SDQT. Participants reported how the reason for refusal was often regarding the unwillingness of these teachers to participate in a programme that would 'label' children with regards to their identified mental health status. Other reasons for not obtaining an SDQT included the child in question not attending any educational facility, the child attending a 'day care' centre which do not have specific teaching staff, or other non-refusal loss to follow-up such as forgetting to have it done. Cultural appropriateness of the tool was also discussed by participants, who were "apprehensive that the collective format of the check was not always culturally appropriate"(S. J. Williams, 2013). Troublingly, some participants in Williams' 2013 study also aired concerns about the provision of training for providers and availability of follow-up resources for families (S. J. Williams, 2013).

2.4.3.9 *Use in the B4 School Check*

According to governmental policy, when a child turns 4, the relevant district health board (DHB) provider for Well Child Checks in the region should make contact with the parents or caregivers to initiate the B4 School Check process. A pack is sent to the family with information about the check as well as forms for the family to complete before the time of appointment. Included in these forms are the SDQP and SDQT. Families are asked to have a teacher complete the SDQT prior to the appointment so that it can be brought along. However, it is generally asked of families that they do not complete the SDQP until the appointment where it will be completed under supervision of the provider (Ministry of Health, 2008).

2.4.4 *Parental Evaluation of Developmental Status*

The PEDS form is a ten item questionnaire designed to prompt parents to discuss concerns they may have about their child's development (Glascoe, 2013). Responses are used to determine whether further screening for developmental problems is indicated. The MoH advise B4 School Check providers to administer the PEDS as part of a face-to-face interview.

2.4.5 Child Health Questionnaire

The CHQ is a one page questionnaire for parents to fill in asking eight general health questions about the child. It is used for the provider to gain a quick overview of the child's health status and of any major issues that may be present. Parents are asked whether they have concerns about toileting, sleeping and eating problems of their children as these can be a useful gauge for the need for deeper investigation. Space is also provided for the informant parent to give comments or request support regarding any concerns they may have about the child's health.

2.5 Current Study

2.5.1 Aims of the study

Presently, the understanding of how natural disasters may affect child mental health is based on data that contain some serious flaws. As a result, there is a lack of understanding about what one might expect to occur when a population of young children experience disaster exposure. The aim of the current study was to expand on the evidence currently available by investigating the long-term effects of the Canterbury earthquakes and their sequelae on the emotional and behavioural wellbeing of resident 4-year-olds. Specifically, data from the B4 School Check collected from a near-complete sample of sequential cohorts of 4-year-olds in the affected region are compared with comparison data from non-affected regions over a period of five years.

The primary objective of the current study was to gain a better insight into the needs of Cantabrian children in the wake of the earthquakes. Considerable speculation regarding the mental health status and needs of children in the area has arisen as anecdotal and proxy evidence has surfaced following the earthquakes. However, whether this evidence points convincingly to an earthquake effect or not has not been clearly determined. Consequently, we wished to describe as best we could the trends in population-level child mental health measures so that possible evidence of an earthquake effect could be seen.

The secondary objective of the current study was to investigate the Canterbury experience as a possible example of what child mental health changes may be expected to be seen in a population of young children exposed to a major natural disaster. While many previous studies have described the mental health status of young populations following disasters, few have been able to compare these descriptions with data from the pre-exposure period: a condition that would be necessary to support a temporal link between cause and effect. The setting of the current study allowed for comparison of consecutive cohorts of children to be assessed. Trends found in the data of the current study may prove helpful in determining the normal course of psychosocial wellbeing in children in the wake of a natural disaster, which would be a useful insight to have in terms of supporting future disaster victims.

2.5.2 Rationale

2.5.2.1 *Advantages of the current study*

The circumstances surrounding the current study mean that a number of important shortfalls of previous studies in this area of research can be addressed:

- Baseline data are available for the year prior to the onset of disaster. This is atypical of research on this topic because of the unpredictability of natural disasters and the scarcity of systematically collected child mental health data.
- Four years' worth of post-disaster cross-sectional data are available, allowing for a relatively long-term assessment of effects compared with the predominantly comparatively short-term follow-ups of other studies on this topic. This is important because it allows for investigation into whether difficulties are apparent latently in children.
- The dataset is large and is a near-complete sample of the population of interest. Uptake of the B4 School Check in the region of interest is high, meaning that data are available on the vast majority of 4-year-olds exposed to the disaster. Further, as the target population is large, the sample size is also large- thus reducing the likelihood of any effects found being due to chance or random error.
- The B4 School Check includes a well-validated tool that has previously been used to measure child psychosocial wellbeing both in normal and disaster-exposed populations: the SDQ.
- The retrospective, observational nature of the current study means that research could be undertaken in a non-obtrusive, non-harmful way. Many disaster-related studies involve asking participants potentially sensitive questions when they are in a vulnerable state. Further, participants' and reporters' answers may reflect an awareness of the hypotheses being tested. Because the data for the current study were collected for the purpose of a general health check with no mention of the earthquakes, participants and reporters are essentially blinded to our purpose of data usage and should not experience disaster-related triggering.

2.5.3 Policy Implications

Preschool children are a vulnerable part of the population who are generally under-catered for both in regards to mental health generally, and mental health needs following disasters (Chemtob et al., 2008). Policy-makers need to consider child emotional and behavioural wellbeing evidence in the wake of a disaster to inform what the needs of young populations may be and how to best address these needs. Due to the broad scope of child wellbeing implications, a comprehensive understanding of child population health needs is necessary to inform policy across the many implicated sectors, not just the healthcare sector alone (Shonkoff et al., 2012).

In allocating post-disaster funding, it is important to understand the possible implications and their costs over time of treating or not treating possible issues. Generally child health protection is thought to be cost effective due to the comparatively cheap price of intervention programmes compared with the possible long-term societal costs of having an unwell child population (Miles et al., 2010; S. J. Williams, 2013). Conversely, the scarcity of available resources following a major natural disaster highlights the importance of allocating these resources effectively. If indeed there is not a population-level psychosocial health problem among child victims of the disaster, it is essential that resources not be used unnecessarily in an intervention when they could be better used elsewhere. At a local level understanding is needed about whether there are mental health problems amongst children that need addressing. If there are problems, the need to be quantified and qualified so that they can be addressed effectively. On a broader scale, it is possible that an understanding of the situation in Canterbury could improve the knowledge base internationally to make way for better planning and funding policies for future disaster events.

2.5.4 Summary

Child population health is an issue of great importance. Evidence suggests that natural disasters may have a negative impact on child population health, however, the details of this relationship are unclear. The current study utilised data from a routinely collected surveillance and screening programme of 4-year-olds in New Zealand to assess whether a series of major earthquakes which occurred in the Canterbury region in 2010 to 2011 had an impact on population-level child psychosocial health.

3 Methods

3.1 Design

The design of the current study did not fit the classic descriptions of major study types. In essence, the study followed a repeated cross-sectional design. Continuous near-complete regional cohorts of 4-year-old children made up each cross-section. Trends in the population-level wellbeing of four-year-olds were the outcome of interest. Using this design, it was possible to compare pre-earthquake 4-year-olds with children who were 4 years old at increasingly distant peri- and post-earthquake periods. This provided an opportunity to investigate whether the specific stage of development at the time of disaster might have impacted outcome, as well as whether population-wide effects changed over time. Further, by using a comparison region sample, the outcomes of children living in the affected area could be compared with children from other regions. This provided evidence as to whether trends found were exposure-specific or general to the wider population.

3.2 The Study Sample- Participants

3.2.1 The Sampling Design

The findings of all B4 School Checks performed in New Zealand are recorded and stored by the MoH. This database extends back to 2008 when the programme began. By completing the B4 School Check, parents or caregivers give consent for resulting information to be gathered, and used as seen fit by the MoH. Through a formal application process, access was granted to this database for the purposes of conducting the current study. This database contains data pertaining to measures of wellbeing for most children who have been 4 years old at any point between 2008 and the present (2015) in New Zealand. For the current study, a whole of sample approach was taken, that is, data from every eligible B4 School Check case was included in the sample.

3.2.2 Defining the Exposed Group

For the purposes of this study, an exposed child is one who was residing in Canterbury at the time of the Canterbury earthquakes or during the aftermath. Given the size of the sample and the relative lack of information available regarding each child, exposure status was described by having a B4 School Check administered by the CDHB.

3.2.3 Defining the Control Group

The current study originally intended to make use of three different control categories, each with its own benefit in exploring possible explanations for outcome:

1. B4 School Check data collected by the CDBH after the onset of the earthquake sequence: by comparing pre-earthquake Canterbury data with subsequent post-earthquake Canterbury data, we would be able to assess how trends in child wellbeing were tracking locally.

2. B4 School Check data collected across New Zealand by DHBs excluding the CDHB: comparing the results of those children living in Canterbury with those who lived in other national regions would provide an insight to how living in Canterbury, as opposed to other regions in the country, could impact measures of wellbeing.
3. B4 School Check data collected from a 4-year-old population demographically similar to that of Canterbury: the Canterbury population is quite unique, which means that comparisons at the national level could introduce demographic-related confounding. For example, Christchurch (which makes up the majority of the Canterbury population) is the country's second most populous city, suggesting that a control population should not be predominantly rural. However, Canterbury also has a very low proportion of Pacific Islanders compared with other cities, meaning that ethnic composition could be a confounding factor if Canterbury were compared with other major cities. The Comparison DHB Group was formed by amalgamating DHBs with similar demographics to Canterbury so as to give the most comparable population possible, implicating that any effect found could be explained best by earthquake exposure differences rather than other confounding factors.
 - Firstly, using data from the B4 School Check database it was found that Canterbury had a similar ethnic profile to Capital and Coast, Nelson Marlborough, Otago, South Canterbury, Southland and West Coast DHBs.
 - Next, the SES profiles of B4 School Check populations were examined and it was observed that Canterbury had a similar profile to Capital and Coast, Nelson Marlborough, Otago, South Canterbury, Southland and Waitemata DHBs.
 - DHBs with both similar ethnic and SES profiles to Canterbury thus were Capital and Coast, Nelson Marlborough, Otago, South Canterbury, Southland.
 - The proportion of B4 School Checks performed on females was found to be consistently around 48% in all regions.
 - Statistics New Zealand population information (which is not 4-year-old specific) was then used to find which regions had similar urbanity/rurality profiles to Canterbury. For the sake of simplicity, the eight different levels of urbanity/rurality described by Statistics New Zealand were dichotomised into 'urban' and 'rural' for the purposes of the current study.
 - Of the contending DHBs (Capital and Coast, Nelson Marlborough, Otago, South Canterbury, Southland) Nelson Marlborough, Otago, and Southland DHBs combined

made the group most demographically similar to Canterbury DHB. As such, the ‘Comparison DHB Group’ was formed by combining these South Island regions.

Most descriptive results were considered in relation to both control groups (New Zealand excluding Canterbury and the Comparison DHB Group) because of the interest in understanding national trends. However as the Comparison DHB Group provided a more closely matched (and thus less confounded) comparison for the CDHB sample, statistical modelling was performed using only this group. This was done for the logistic regression analyses and the creation of adjusted regression margins plots. The Comparison DHB Group was chosen for this purpose because it was observed to be less prone to confounding as demographic characteristics more closely matched those of Canterbury. After examining the descriptive results of the data when considering all three control groups, there appeared to be no additional benefit in presenting national trends as an extra control group in this study, as they appeared to match the trends seen in the Comparison DHB Group, only with a greater degree of error. As such, the trends of the New Zealand excluding Canterbury sample have been excluded from the main results for the sake of readability.

3.2.4 Demographics

Understanding the demographic characteristics of the studied population is important for determining internal and external validity of the study as these key factors can play an important role in determining how an exposure may impact an outcome.

3.2.4.1 Ethnicity

In the B4 School Check, caregivers are asked to provide information on the ethnicity or ethnicities of the child. This is then recorded as a single, prioritised ethnicity data entry from a list of 23 possible options, using the standard prioritisation process utilised by Statistics New Zealand. For the purposes of this study, these 23 ethnicity groups were further collapsed into five groups (NZ European, NZ Māori, Pacific Islander, Asian, or Other) or classed as “missing”.

3.2.4.2 Socioeconomic Status

Deprivation quintile scores range from 1 (least deprived) to 5 (most deprived) and describe a person’s socio-economic status based on the average wealth of the neighbourhood in which that person lives. A child’s neighbourhood for the purposes of the B4 School Check database is determined using the home address recoded on the primary health organisation (PHO) enrolment database. Deprivation scores are distributed so that roughly one fifth of the national population falls into each of the five categories.

3.2.4.3 Age

The age at the time of check of each participating child is determined by calculating the length of time between the child’s date of birth and the date of the B4 School Check. Ages are recorded to two decimal places.

3.2.4.4 Sex

Parents and caregivers filling in the B4 School Check forms are asked to identify whether their child is a girl or boy. No other options are available.

3.3 The Research Tools

3.3.1 Independent Variable

Exposure to the Canterbury earthquakes was the independent variable of this study. This was measured dichotomously by proxy using data regarding the DHB in which each child had their check completed. Any child who had a B4 School Check done in the CDHB at any time after August 2010 was considered to have been exposed.

3.3.2 Dependent Variables

3.3.2.1 Strengths and Difficulties Questionnaire

The scores derived from the SDQ tool were the main dependent variables of interest in the current study. The SDQ is a multi-dimensional measurement of child wellbeing that has been previously used in other studies of children in a disaster context, making the findings relatable to the existent literature (Robert Goodman, 2001). Due to the many ways in which the SDQ can be used, a range of SDQ-based outcomes of interest were employed to cover as many potential earthquake impacts on child population health as possible.

3.3.2.1.1 SDQ Total Score

The SDQ total difficulties score is a measure of overall child mental health problems which is generated by adding together the SDQ emotional symptoms score, conduct problems score, hyperactivity score and peer problems score (A. Goodman, Lamping, & Ploubidis, 2010). Scores for this measure can range from 0 to 40.

3.3.2.1.2 SDQ Internalising Score

The SDQ internalising score is a measure of internalising-type child mental health problems (such as anxiety- and depression-related disorders) which is generated by adding together the SDQ emotional symptoms score and peer problems score. This form of SDQ scoring has been recommended for use in epidemiological studies (A. Goodman et al., 2010). Scores for this measure can range from 0 to 20.

3.3.2.1.3 SDQ Externalising Score

The SDQ externalising score is a measure of externalising-type child mental health problems (such as attention deficit-, hyperactivity and opposition/defiance- related disorders) which is generated by adding together the SDQ conduct score and hyperactivity score. This form of SDQ scoring has been recommended for use in epidemiological studies (A. Goodman et al., 2010). Scores for this measure can range from 0 to 20.

3.3.2.1.4 *SDQ Impact Score*

The SDQ impact score is generated by adding together the scores from the impact section regarding apparent distress and impairment caused by a child's difficulties. This score indicates the impact of the emotional and behavioural difficulties identified on home, school, peers and family life. Scores for this measure can range from 0 to 6 for the teacher-reported version and from 0 to 10 for the parent-reported version. A score of 0 is normal, 1 is borderline and 2 is abnormal for both the parent- and teacher-rated versions. No NZ-specific clinically-relevant cut-off norms are available.

3.3.2.1.5 *SDQ Subscale Scores*

The four main SDQ subscale scores measure each emotional, conduct, hyperactivity and peer problems and can each range from 0 to 10.

3.3.2.1.6 *Prosocial Scale*

As previously explained, the SDQ contains five sub-scales, four of which combine to give the total difficulties score. The fifth subscale, the prosocial scale, aims to measure positive child behaviours that indicate healthy development. The scoring for the prosocial scale is the reverse of the other subscale scorings: whereas a higher score normally indicates greater difficulties in a child, a higher score in the prosocial scale indicates better social behaviour in the child. When used correctly, this is a useful subscale as it assesses a child's strengths, and as such it would have been useful to include its use in the analyses as an indicator of possible positive earthquake impacts on child wellbeing. Unfortunately, the quality of data for this subscale is poor. It appears that mis-recording or mis-coding of prosocial scale scores is common, perhaps due to providers assuming that the same scoring structure applied to this scale as to the others. This problem was recognised when the proportion of children identified as being in the abnormal range for the prosocial subscale was unexpectedly high. Further investigation found that many of the children reported to have an abnormal prosocial score had scored as normal in all other subscales, which is possible but unlikely. As a result of this discovery, it was decided that further analyses of this outcome would not be included.

3.3.2.1.7 *Normative data and the SDQ*

As previously explained, the current cut-off points used for the B4 School Check in New Zealand are those suggested by Goodman for use with the 4-17-year-old version of the SDQ which "were defined based on a population-based UK survey, attempting to choose cut points such that 80% of children scored 'normal', 10% 'borderline' and 10% 'abnormal'" (Youth In Mind, 2015). This is problematic as it does not reflect the cultural specificities of how New Zealanders would respond. Fortunately, a MoH-funded validation and norming study of the SDQ in the New Zealand context has recently been completed (Kersten et al., 2014). From this study it was possible to access the recommended cut-off points specific to the New Zealand population established by the authors. These norms were used in the current study in order to best identify the true prevalence of emotional and behavioural problems in the research sample.

3.3.2.1.8 Modes of assessment for SDQ outcomes

Mean population scores for each outcome can be used to assess average population wellbeing. A change in mean population scores could suggest that the majority of the population had undergone a change. A change in mean indicates a general population-wide effect. Goodman has shown that mean population scores are a useful indicator of population wellbeing (A. Goodman & Goodman, 2010). Mean SDQ population scores have been used in previous disaster studies most commonly.

The proportion of abnormal scores in a population can be used as an indication of the prevalence of illness. A change in the proportion of abnormal scores could suggest that the prevalence of illness had changed. A change in the proportion of abnormal scores alone would suggest that a sub-group of the wider population studied had been impacted differentially from the remainder. An increase in a population's prevalence of abnormal scores would explain an increase in service demand and vice versa, because when used as part of the B4 School Check, a positive SDQ screen should result in a referral for further assessment.

3.3.2.2 Parental Evaluation of Developmental Status

The PEDS form, completed by a parent or caregiver, provides an opportunity for discussion regarding a child's learning, development and behaviour. In the current study two questions on this form were considered: "do you have any concerns about how your child behaves?" and "do you have any concerns about how your child gets along with others?" Each of these questions have possible responses limited to "no", "yes" or "a little", followed by a space for including comments which are not recorded in the B4 School Check database. For the purposes of the current study, results were dichotomised: "no" and "a little" indicated the absence of a problem for the current study, while a "yes" response indicated that the informant felt a problem was present.

The trends in the proportions of children in Canterbury with a positive response were compared over time against the proportion of children with positive responses in the Comparison DHB Group over time.

3.3.2.3 Child Health Questionnaire

The CHQ is answered by the parent or caregiver only. The informant is asked a series of questions regarding the child-in-question's health. The responses to two of these questions were relevant to this study as possible indicators of child psychosocial wellbeing:

- Do you have any concerns about your child's toileting?
- Do you have any concerns about your child's sleep?

All questions have possible responses limited to "no" or "yes", followed by a space for including comments which are not recorded in the B4 School Check database. For each of these questions the proportion of children whose parents or caregivers reported concerns about the topic was identified.

The original intent was to include data recorded in the CHQ regarding toileting and sleep problems in children as a potential outcome measure of the impact of exposure. Toileting and sleep problems are commonly faced by children following traumatic experiences and as such may be a useful indicator of population-level trauma-induced problems. Unfortunately, the responses to these questions are coded by the MoH as either “yes” (informant has concerns regarding this issue) or “no” (informant does not have concerns regarding this issue), with no opportunity to record that these data points were missing. Further, it appears that this measure was introduced partway through the data collection period of the current study, as no concerns are recorded prior to 2012. From 2012, the reporting of problems increases significantly and does not stabilise. Regrettably, this makes data from the CHQ unusable for the current study, and as such, these data were dropped.

3.4 Procedures

3.4.1 Literature Search

Available scientific literature was thoroughly searched using the University of Otago online database system and Google Scholar. The libraries at the local Mental Health Education and Research Centre and School of Medicine were also browsed by hand and experts in the field queried to identify further potentially useful publications. A snowballing search process was utilised whereby the reference lists of relevant publications were searched for further relevant sources of information. Local and national government publications were sourced as reservoirs for technical, audit and region-specific information.

3.4.2 Administration and Scoring of the B4 School Check

PHOs identify and invite four-year-old children and their parents/caregivers to attend a B4 School Check through the local provider (the provider varies by PHO but is typically a public health or practice nurse). Once consent has been obtained, a series of forms are filled in by the informant (parent or caregiver) and a consultation is held with the child, informant and B4 School Check provider present. Typically the check takes about 45-60 minutes and allows an opportunity for the provider to assess the child and the informant to discuss with the provider any concerns they may have. All assessments relevant to the current study are completed during the consultation, however, vision and hearing tests may be completed elsewhere. (Ministry of Health, 2008)

Once complete, data relating to the consent, child, checks (height, weight, hearing, vision, development and behaviour assessments), and any issues identified and referrals made are recorded and stored in the B4 School Check National Information System, the purpose of which is to track improved health outcomes from the B4 School Check. According to the MoH, “the creation of a reliable source of B4 School Check information history for each child at a local and regional level across New Zealand, available to authorised health professionals, will assist in tracking improved health outcomes and reduced inequalities”. (Ministry of Health, 2008)

3.4.2.1 B4 School Check Coverage

It is difficult to be accurate regarding B4 School Check coverage. DHBs and the MoH have differing reports on what their coverage is. DHB annual reports are one source of coverage information.

However, as can be seen in Table 3, these reports may not always be congruent with data provided by the MoH. Personal communication with a staff member at the MoH elucidated somewhat the reasons for the ambiguity of coverage reporting and hence the discrepancies seen between reporters. The eligible population according to the MoH is predetermined before the year starts and is estimated from the PHO capitation based funding database. It can be the case that in real terms the numbers increase or decrease during the year, leading to a difference in the size of the eligible population by the end of the year.

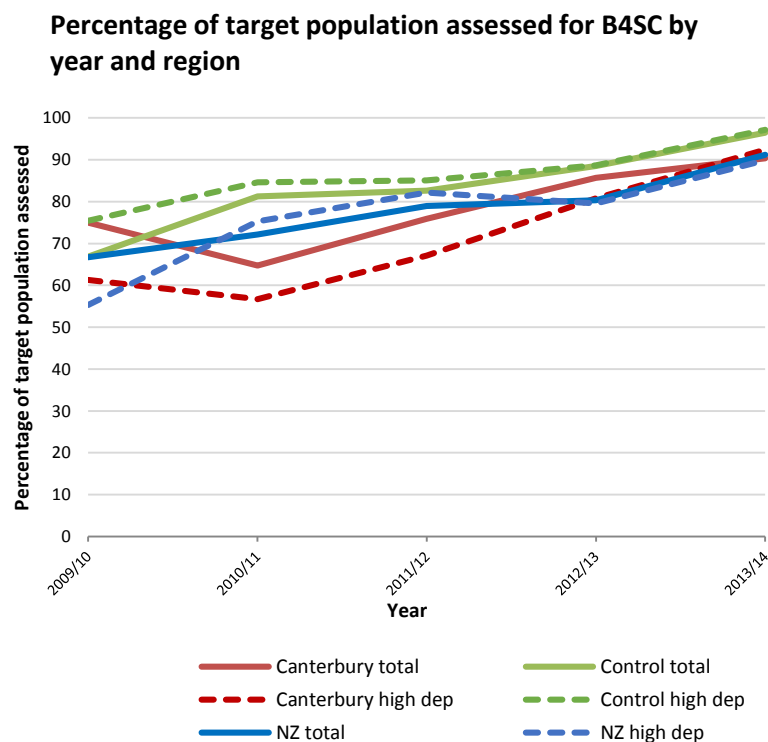
For the purposes of this study, coverage will be described using MoH data to minimise DHB-variant processes in reporting. Generally, as can be seen in Figure 1, coverage is increasing over time for all regions.

The MoH sets targets for DHBs concerning coverage of their B4 School Check programmes. As well as increasing general coverage of the B4 School Check, DHBs are also mandated to identify populations which are not accessing the B4 School Check and target resources to assist those people to access the programme (Ministry of Health, 2008).

Table 3 Canterbury data of coverage according to reports published by the CDHB and data provided by the MoH

Year	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Total population coverage %	0 (2010 CDHB report)	75 (2010 CDHB report) 75 (2011 CDHB report) 75 (MoH Data)	71 (2011 CDHB report) 71 (2012 CDHB report) 65 (MoH Data)	80 (2012 CDHB report) 76 (2013 CDHB report) 76 (2014 CDHB report) 76 (MoH Data)	86 (2013 CDHB report) 86 (2014 CDHB report) 86 (MoH Data)	90 (2014 CDHB report) 90 (MoH Data)
Quintile five (and zero) coverage %	0 (2010 CDHB report)	70 (2010 CDHB report) 61 (MoH data)	67 (2012 CDHB report) 57% (MoH data)	70 (2012 CDHB report) 67% (MoH data)	81% (MoH data)	92% (MoH data)
Maori coverage %				68 (2014 CDHB report)	84 (2014 CDHB report)	90 (2014 CDHB report)

Figure 1 The percentage of the target population assessed for B4 School Checks across regions



3.5 Analysis

3.5.1 Data cleaning

Entries for children who were not aged 4 at the time of their check or who had tests done outside of the study period were removed from the sample as per the exclusion criteria. Next, the SDQ total score variable was created by adding sub-scale scores, and similarly, internalising and externalising scores were calculated for each observation. SDQ result categories were created for each SDQ outcome (normal, borderline or abnormal) and results of each test category were subsequently categorised for each observation (done using NZ population norms as cut-offs). From the full national sample, sub-sample, regional exposure groups were created: the exposed population group (consisting of all eligible B4 School Checks performed in the CDHB); and the un-exposed, Comparison DHB Group (consisting of all eligible B4 School Checks performed in the Nelson Marlborough, Otago, and Southland DHBs). Missing and unknown values were all re-recorded as missing. Variables recorded as string-values were recoded as labelled numeric variables. Ages of children were grouped into quarters. Ethnicity values were simplified into five categories: NZ European, NZ Maori, Pacific Islander, Asian, and Other. Lastly, observations were categorised by which year of the study period each child's test occurred in to allow for temporal analysis.

3.5.1.1 Data organisation

B4 School Check data were sorted into years, each beginning in September for temporal analysis. The included years were all those available with reasonable quality of data:

- September 2009- August 2010 (baseline, participants have experienced no exposure to earthquake-related stressors)
- September 2010- August 2011 (year of major earthquakes, participants aged 3-4 at the time of earthquake, up to 1 year of exposure to earthquake-related stressors)
- September 2011- August 2012 (aftershock year, participants aged 2-3 at the time of earthquake, up to 2 years of exposure to earthquake-related stressors)
- September 2012- August 2013 (recovery year, participants aged 1-2 at time of earthquake, up to 3 years of exposure to earthquake-related stressors)
- September 2013- August 2014 (participants aged 0-1 at time of earthquake, up to 4 years of exposure to earthquake-related stressors)

The data is broken into yearly blocks to control for seasonal effects and the fact that the B4 School Check can be done at any point throughout age 4, meaning that monthly differences could reflect age rather than external impacts. Further, this division allowed for simpler trend analysis and modelling. Where appropriate, results trends were also checked by quarter-year divisions to ensure there was no obvious acute effect masked by the coarse 1-year time-blocks used.

3.5.1.2 Inclusion/exclusion

Children resident in New Zealand who were the subject of a B4 School Check between September 1 2009 and August 30 2014 were considered for inclusion in the current study. To be included, the child had to have been $\geq 4.00 < 5.00$ years of age at the time of the check.

Demographic characteristics of each child were recorded (ethnicity, socioeconomic status, age and sex). If a child's age was missing then they were excluded in case they did not fit the age criteria. However, for all other demographic characteristics, entries with one or more missing data points were maintained for analysis of available data with the characteristic grouped in the "missing/other" category.

To meet eligibility criteria, a participant was required to have at least one complete response on any of the SDQ forms.

To be included in the exposure group, a participant must have had their B4 School Check administered in the Canterbury DHB. To be included in the comparison group, a participant must have had their B4 School Check administered in one of the comparison DHBs.

3.5.2 Descriptive Statistics

3.5.2.1 Demographics

Demographic factors of interest were tabulated by year and region using StataIC 13.

3.5.2.1.1 Means

Local polynomial smooth plots (L-poly graphs) were produced using StataIC 13 to illustrate how average scores changed over time in each region for each measure of interest.

3.5.2.1.2 Proportions

The proportions of abnormal results for each measure of interest were tabulated by year and region using StataIC 13. The data were then transformed into line graphs using Microsoft Excel 2013 to illustrate how the proportions of abnormal scores changed over time in each region for each measure of interest.

3.5.3 Analytical Statistics

Statistical analyses were performed on data pertaining to the proportion of abnormal SDQ total scores to ascertain whether any statistically significant difference was present between the trends in Canterbury DHB and the Comparison DHB Group. The purpose of performing this statistical analysis was to test if apparent differences and similarities in the plotted data truly existed or were a result of chance variation and/or confounding. A 95% confidence interval was used to specify statistical significance.

3.5.3.1.1 Confounding

Based on the current literature, factors were identified that might be associated with both exposure to the Canterbury earthquakes and psychosocial outcomes without being on the causal pathway; these factors were then considered as potential confounders. Univariate logistic regressions were performed to identify whether factors that were suspected to be predictors of the proxy measurement for exposure (having a B4 School Check administered in the CDHB) would also be predictors of outcome (indicators of abnormal psychosocial wellbeing in the B4 School Check). These factors were: sex, SES, age at time of check and ethnicity. Two multivariate logistic regression models (one including and one excluding potential confounders) were built to see if potential confounders might explain any impacts on outcome (e.g. does a change in Canterbury occur over time simply because of a higher SES?)

3.5.3.1.2 Chance and random error

Models were created to assess the effects of year, region and the interaction of year with region for each category (total, internalising, externalising and impact) of both teacher- and parent-reported SDQ scores. Adjusted models controlled for potential confounding by sex, SES, age group and ethnicity. The models were built to see what impact chance or random error might be having on the results that were observed in the plotted data. A similar looking model to source data would suggest that what we

are seeing is not due only to chance or random error. The multivariate logistic regression model was chosen because it has good stability (i.e. results reliably converge to give an answer). The downside of using this type of model is that the output is an odds ratio (OR). Fortunately, the outcomes being considered are rare, meaning that the ORs can be interpreted similarly to relative risks (RRs).

3.6 *Ethics*

Full ethical approval was granted by the Human Research Ethics Committee of the University of Otago through the Category A departmental approval system. The Ethics Committee reference number assigned to this project is HD14/40.

4 Results Part 1: Sample Description

4.1 Sample Characteristics

4.1.1 Inclusion Criteria

4.1.1.1 Canterbury DHB Group

In Canterbury, 26, 979 B4 School Checks were completed over the study period. Of these, 1, 121 (4.16%) of the checks concerned a child who was too young and 147 (0.54%) a child who was too old to be eligible to be included in the study (age recorded as <4.00 or >4.99 respectively). This resulted in a total of 25, 711 (95.30%) eligible B4 School Check entries for the region.

4.1.1.2 Comparison DHB Group

In the comparison DHBs, 23, 424 B4 School Checks were completed within the study period. Of these, 74 (0.32%) of the checks concerned a child who was too young and 320 (1.37%) a child who was too old to be eligible to be included in the study. This resulted in a total of 23, 030 (98.32%) eligible B4 School Check entries for the region.

4.1.2 Population description

The characteristics of the Canterbury DHB Group and Comparison DHB Groups' study populations are presented in Table 4 in relation to the five study years.

4.1.2.1 Ethnicity

The study populations for both the Canterbury DHB Group and the Comparison DHB Group consist of a decreasing majority of children of NZ European ethnicity. By contrast, the proportions of children of Māori, Pacific Island and Asian ethnic groups in both regions have increased. Children of Asian ethnicity are almost twice as prevalent in the Canterbury DHB Group as they are in the Comparison DHB Group, whereas children of Māori ethnicity are more prevalent in the Comparison DHB Group.

4.1.2.2 Socioeconomic Status

The populations of interest in this study (Canterbury DHB Group c.f. Comparison DHB Group B4 School Check participants from 2009-2014) have deprivation scores skewed toward the less deprived end of the scale, that is, compared with the total New Zealand population, participants in the current study are more likely to live in a wealthier neighbourhood and less likely to live in a poorer neighbourhood. Despite this difference from national norms, the two populations of interest in this study have similar deprivation characteristics. Proportions of children in each deprivation group for both study regions were relatively stable, suggesting that drastic changes in population deprivation either did not occur following the earthquakes, or the data were unable to represent these changes.

The largest variance over time was seen in the proportion of children with an unknown deprivation score, which decreased over time for both regions.

4.1.2.3 Age

Children in the Canterbury DHB Group predominantly had their B4 School Checks done in the first quarter of their fifth year of life (4.00-4.24 years old) with over two thirds of participants in this category each year. B4 School Checks were completed in each subsequent quarter respectively less commonly. By contrast, in the Comparison DHB Group children were least likely to have their check completed within the first quarter of their fifth year compared with the subsequent three quarters, with the second or third quarter predominating. These trends remained relatively stable over time.

4.1.2.4 Sex

Sex ratios for both study regions were similar and consistent over time with roughly 51 males to every 49 females. This was consistent with national sex ratios for this age group (data not shown).

Table 4 Study population characteristics over time

Canterbury DHB Group													Comparison DHB Group												
Ethnicity: n, %		01Sep09-31Aug10		01Sep10-31Aug11		01Sep11-31Aug12		01Sep12-31Aug13		01Sep13-31Aug14		Total		01Sep09-31Aug10		01Sep10-31Aug11		01Sep11-31Aug12		01Sep12-31Aug13		01Sep13-31Aug14		Total	
Ethnicity: n, %	NZ Euro	3383	76.25	3509	74.49	3812	73.01	3901	71.59	4005	67.96	18610	72.38	2943	78.54	3507	76.24	3238	75.2	3725	73.53	3736	70.34	17149	74.46
	NZ Māori	344	7.75	453	9.62	525	10.06	527	9.67	673	11.42	2522	9.81	403	10.76	509	11.07	518	12.03	717	14.15	855	16.1	3002	13.04
	Pacific	144	3.25	133	2.82	164	3.14	179	3.29	250	4.24	870	3.38	79	2.11	102	2.22	105	2.44	123	2.43	177	3.33	586	2.54
	Asian	220	4.96	258	5.48	327	6.26	380	6.97	450	7.64	1635	6.36	98	2.62	120	2.61	161	3.74	175	3.45	223	4.2	777	3.37
	Other	306	6.9	323	6.86	369	7.07	421	7.73	475	8.06	1894	7.37	208	5.55	314	6.83	255	5.92	309	6.1	308	5.8	1394	6.05
	Missing	40	0.9	35	0.74	24	0.46	41	0.75	40	0.68	180	0.70	16	0.43	48	1.04	29	0.67	17	0.34	12	0.23	122	0.53
Deprivation Score: n, %	1	1250	28.17	1255	26.64	1459	27.94	1514	27.78	1629	27.64	7107	27.64	869	23.19	1082	23.52	1065	24.73	1273	25.13	1333	25.1	5622	24.41
	2	955	21.52	1024	21.74	1152	22.06	1164	21.36	1223	20.75	5518	21.46	789	21.06	992	21.57	993	23.06	1137	22.44	1229	23.14	5140	22.32
	3	807	18.19	920	19.53	1026	19.65	1083	19.88	1268	21.52	5104	19.85	676	18.04	927	20.15	836	19.41	989	19.52	1043	19.64	4471	19.41
	4	644	14.51	686	14.56	853	16.34	864	15.86	991	16.82	4038	15.71	643	17.16	946	20.57	849	19.72	1025	20.23	1095	20.62	4558	19.79
	5	477	10.75	546	11.59	578	11.07	688	12.63	769	13.05	3058	11.89	431	11.5	530	11.52	494	11.47	576	11.37	554	10.43	2585	11.22
	Missing	304	6.85	280	5.94	153	2.93	136	2.5	13	0.22	886	3.45	339	9.05	123	2.67	69	1.6	66	1.3	57	1.07	654	2.84
Age: n, %	4.00-4.24	3006	67.75	3154	66.95	3507	67.17	3777	69.32	4194	71.17	17638	68.60	667	17.8	871	18.93	662	15.37	544	10.74	1006	18.94	3750	16.28
	4.25-4.49	841	18.95	905	19.21	1000	19.15	983	18.04	943	16	4672	18.17	1130	30.16	1383	30.07	1247	28.96	1353	26.71	1708	32.16	6821	29.62
	4.50-4.74	324	7.3	401	8.51	431	8.26	411	7.54	436	7.4	2003	7.79	1060	28.29	1320	28.7	1318	30.61	1644	32.45	1517	28.56	6859	29.78
	4.75-4.99	266	6	251	5.33	283	5.42	278	5.1	320	5.43	1398	5.44	890	23.75	1026	22.3	1079	25.06	1525	30.1	1080	20.34	5600	24.32
	Missing	0.00	0.00	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	3.00	0.08	3.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.03
Sex: n, %	Female	2168	48.86	2267	48.12	2556	48.96	2675	49.09	2836	48.12	12502	48.63	1821	48.6	2201	47.85	2076	48.21	2411	47.59	2526	47.56	11035	47.92
	Male	2269	51.14	2443	51.86	2665	51.04	2774	50.91	3057	51.88	13208	51.37	1923	51.32	2396	52.09	2230	51.79	2655	52.41	2785	52.44	11989	52.06
	Missing	0.00	0.00	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	3.00	0.08	3.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.03
Total: n, %		4437	100	4711	100	5221	100	5449	100	5893	100	25711	100.00	3747	100	4600	100.01	4306	100	5066	100	5311	100	23030	100.00

4.2 Coverage of B4 School Checks

The proportion of eligible children to have a B4 School Check completed in each region each year cannot be accurately determined due to a lack of population data. However, using available data, the CDHB publish annual estimates of uptake (Table 5). These publications indicate that an increasing proportion of eligible children have the B4 School Check done each year, with uptake at around 70-80% at the time of the earthquakes. Disadvantaged communities (high deprivation and Māori) had a lower uptake than the general population in the Canterbury DHB Group during 2008-2014.

Table 5 CDHB B4 School Check Coverage As reported in CDHB Annual Reports

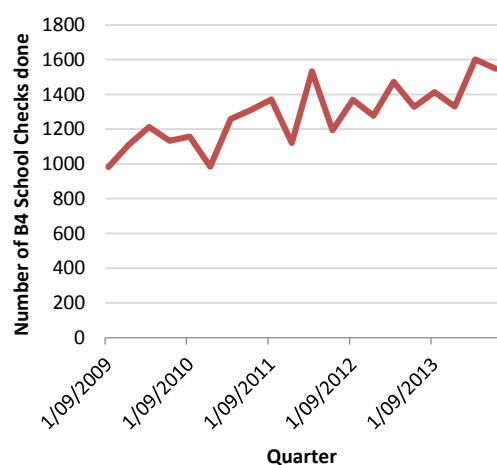
Year	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Total population coverage %	0 (2010 report)	75 (2010 report) 75 (2011 report)	71 (2011 report) 71 (2012 report)	80 (2012 report) 76 (2013 report) 76 (2014 report)	86 (2013 report) 86 (2014 report)	90 (2014 report)
Quintile five and zero coverage %	0 (2010 report)	70 (2010 report)	67 (2012 report)	70 (2012 report)	N/A	N/A
Māori coverage %	N/A	N/A	N/A	68 (2014 report)	84 (2014 report)	90 (2014 report)

Reflecting on the data presented in Table 5, there appears to have been a modest decrease in Canterbury DHB coverage during the 2010/2011 period, which may indicate an effect the earthquakes in Canterbury had on uptake of the B4 School Check by eligible families and their children in the region. There appears to be seasonality in the number of checks done, as can be seen in

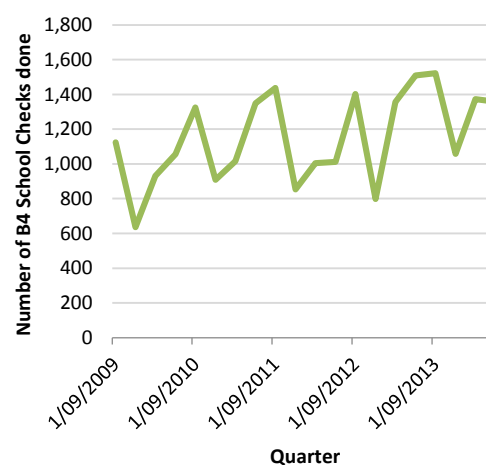
Figure 2 where the quarterly count of completed B4 School Checks is plotted over time and by region of interest. For example, in the Comparison DHB Group, a clear drop in the number of B4 School Checks done can be seen in each summer quarter.

Figure 2 Number of b4 School Checks done by year and region

Canterbury DHB Group



Comparison DHB Group



4.3 Missing Data

4.3.1 Missing SDQ total scores

Table 6 presents the proportion of children in the study population who had B4 School Checks completed but did not have an available SDQ total score for either the parent- or teacher-reported versions. As can be seen in the table, only a small proportion of children who had B4 School Checks done did not have a SDQP total score available, whereas up to a third of children did not have SDQT total scores available.

Table 6 Percentage of sample cases with a missing parent- or teacher-rated SDQ total score by year and region

		Year of B4SC completion				
		01Sep09- 31Aug10	01Sep10- 31Aug11	01Sep11- 31Aug12	01Sep12- 31Aug13	01Sep13- 31Aug14
Parent	Canterbury	0.92	0.98	1.38	1.41	1.27
	DHB Group					
Teacher	Comparison	0.88	2.02	1.42	2.66	3.35
	DHB Group					
Canterbury	DHB Group	27.05	32.67	28.86	27.36	23.82
	Comparison	22.04	25.96	21.27	23.67	19.62
	DHB Group					

Table 7 presents the proportion of children in the study population who had B4 School Checks completed but did not have an available SDQ impact score for either the parent- or teacher-reported versions. As can be seen in the table, the proportion of missing data was very high for teacher-rated scores, particularly within the Comparison DHB Group. Further, for the first two study years of parent-rated scores in the Comparison DHB Group, missing scores were also very high.

Table 7 Percentage of sample cases with a missing parent- or teacher-rated SDQ impact score by year and region

		Year of B4SC completion				
		01Sep09- 31Aug10	01Sep10- 31Aug11	01Sep11- 31Aug12	01Sep12- 31Aug13	01Sep13- 31Aug14
Parent	Canterbury	0.95	0.91	1.28	1.36	1.24
	DHB Group					
Teacher	Comparison	46.98	20.27	1.65	2.98	3.32
	DHB Group					
Canterbury	DHB Group	27.10	32.63	28.90	27.48	23.02
	Comparison	61.04	41.88	21.37	23.72	18.14
	DHB Group					

5 Results Part 2: Main Results

This study had four main outcome variables: SDQ total score, SDQ internalising score, SDQ externalising score and SDQ total impact score. Each outcome variable had both a parent- and a teacher-reported version. Each outcome variable was compared between the Canterbury DHB Group and the Comparison DHB Group. The outcome variables were examined using both mean scores and measures of the prevalence of abnormality.

In this chapter, the findings regarding each of the key outcome variables will be presented in order, one outcome at a time, detailing first the teacher-reported results, followed by the parent-reported results. Firstly, a brief description of the outcome of interest will be provided. Secondly, the descriptive results will be presented, consisting of trends in mean scores over time by region and trends in the proportions of abnormal scores over time by region. Thirdly, analysis of the results regarding the variable of interest will be provided. Logistic regression analysis is only available for the measure ‘proportion of abnormal scores’ and not for ‘mean score’. Consideration of how potential confounders may explain the results will be followed by numerical output of unadjusted and adjusted logistic regression models. These models will then be plotted graphically and a summary briefly interpreted. At the end of this chapter results regarding non-key analyses will be presented.

5.1 *SDQ Total Score*

5.1.1 Descriptive

5.1.1.1 Means

Descriptive means graphs are L-Polynomial graphs showing the trends in moving averages of the relevant SDQ score over time in study regions. Time is represented continuously on the x-axis with the occurrences of major earthquakes (those with a magnitude of 6.0 or above on the Richter scale) marked by vertical lines. This format will be used throughout the chapter.

Mean scores for both parent- and teacher-reported SDQ total scores showed similar slight downward trends for both study regions (Figure 3 and Figure 4). Canterbury DHB Group mean trends did not appear to show any differential changes resulting from the earthquakes in either parent- or teacher-reported measures. The SDQT total score average is consistently lower in the Canterbury DHB Group than in the Comparison DHB Group but shows a similar downward trend. The average SDQP total score is similar for the Canterbury DHB Group and Comparison DHB Group. Average SDQT scores for both regions were lower than the average SDQP scores (~4 cf. ~6.5 respectively).

Figure 3 Mean teacher-reported SDQ total scores over time in the Canterbury DHB Group and the Comparison DHB Group

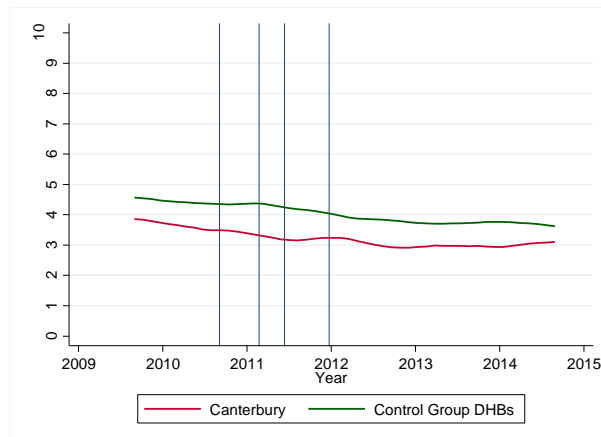
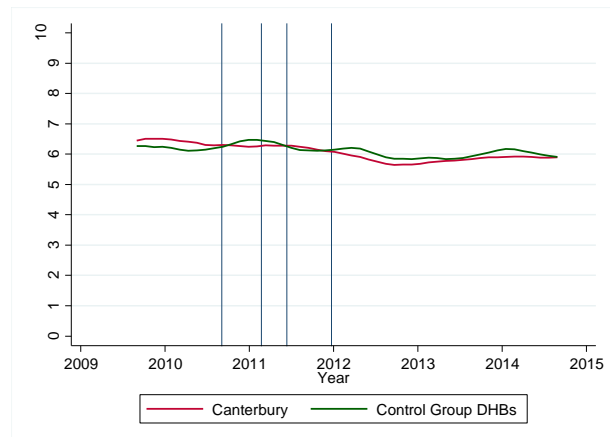


Figure 4 Mean parent-reported SDQ total scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.1.1.2 Proportions

Descriptive proportions graphs are line graphs showing trends in the proportions of abnormal scores identified each year in each study group. To visualise the trends in the proportions of abnormal scores through time, the 5-year study period is split into equal-size blocks of 12 months, starting from September 1, 2009. Due to this discretisation of the temporal axis, the occurrence of the major earthquakes are not displayed. This format is used throughout the chapter.

The proportion of abnormal scores for both parent- and teacher-reported SDQ total scores showed similar, slightly downward trends for both study groups. Canterbury DHB Group proportional trends did not appear to show any changes related to the earthquakes in either parent- or teacher-reported measures. The SDQT proportion of abnormal scores is consistently lower in the Canterbury DHB Group than it is in the Comparison DHB Group but shows a similar trend. The proportion of abnormal SDQP total scores showed similar trends for both regions with Canterbury DHB Group trends closely matching Comparison DHB Group trends. The proportions of abnormal SDQT scores were generally lower than SDQP proportions (~4-9% cf. ~6-10% respectively).

Figure 5 Percentage of abnormal teacher-reported SDQ total scores over time in the Canterbury DHB Group and the Comparison DHB Group

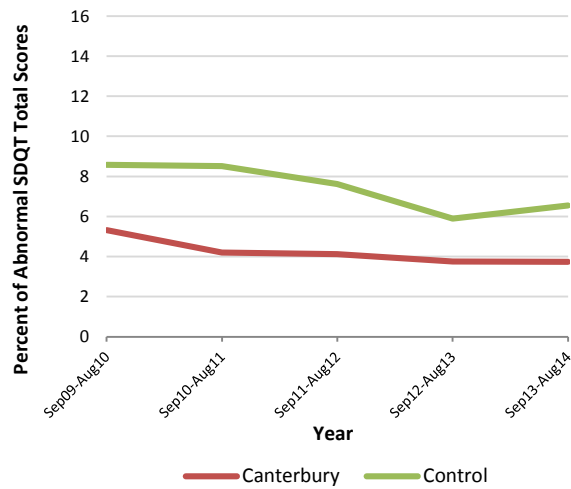
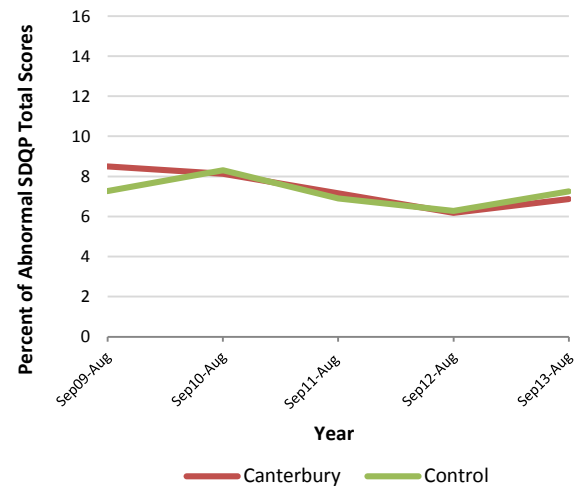


Figure 6 Percentage of abnormal parent-reported SDQ total scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.1.2 Analytical

5.1.2.1 Assessment of Potential Confounders

Tables in this section detail the results of a univariate logistic regression performed to find the contributory effects on outcome of each of a range of potential confounding factors considered. For each potential confounder, the baseline or reference outcome is marked with an asterisk (*). ORs are significant at the 95% confidence interval level unless marked with the note '(NS)'. This format is used throughout the chapter.

All the considered potential confounding variables showed a statistically significant effect on outcome and so were included in the logistic regression models to adjust for their effect on the proportion of abnormal SDQ total scores.

Table 8 SDQ total score confounder characteristics as identified by univariate logistic regression

		SDQT Total			SDQP Total		
		OR	95% CI	P-value of contrasts (ANOVA)	OR	95% CI	P-value of contrasts (ANOVA)
Sex	Female*	1.00		P<0.01	1.00		P<0.01
	Male	2.12	(2.04, 2.21)		1.51	(1.47, 1.55)	
SES	1*	1.00		P<0.01	1.00		P<0.01
	2	1.15	(1.07, 1.24)		1.32	(1.24, 1.4)	
	3	1.34	(1.25, 1.44)		1.77	(1.68, 1.88)	
	4	1.63	(1.52, 1.74)		2.41	(2.29, 2.55)	
	5	1.74	(1.64, 1.86)		3.97	(3.78, 4.17)	
Age	4.00-4.24*	1.00		P<0.01	1.00		P<0.01
	4.25-4.49	1.03 (NS)	(0.98, 1.08)		0.97 (NS)	(0.94, 1.00)	
	4.50-4.74	1.02 (NS)	(0.96, 1.07)		0.92	(0.89, 0.96)	
	4.75-4.99	0.71	(0.67, 0.76)		0.95	(0.91, 0.99)	
Ethnicity	NZ-European*	1.00		P<0.01	1.00		P<0.01
	Māori	1.23	(1.17, 1.29)		2.77	(2.68, 2.86)	
	Pacific Islander	0.89	(0.83, 0.96)		2.21	(2.12, 2.31)	
	Asian	0.77	(0.71, 0.83)		0.96 (NS)	(0.90, 1.02)	
	Other	0.8	(0.74, 0.87)		0.79	(0.74, 0.84)	

5.1.2.2 Models

Tables in this section detail the results of a multivariate logistic regression. Logistic regression model results for teacher- and parent-reported data can be found in Table 9 and Table 10 respectively. For each potential confounder, the baseline or reference outcome is marked with an asterisk (*). ORs are significant at the 95% confidence interval level unless marked with the note '(NS)'. Where adjustment for confounding has changed whether a particular factor is statistically significant, the adjusted model outcome will be marked with a cross (†). This format will be used throughout the chapter. The overall ANOVA p-values for year and year-by-region are presented in the baseline category for each section.

5.1.2.2.1 Teacher

5.1.2.2.1.1 Effect of year

There is evidence for a change in the proportion of abnormal SDQT total scores over time. The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The OR for abnormal SDQT total scores decreases each year, with this reduction reaching statistical significance by the '12-'13 year. This section considers the impact of year only (not DHB).

5.1.2.2.1.2 Effect of region

The model shows that abnormal SDQT total scores are less likely in the Canterbury DHB Group compared with the Comparison DHB Group (adjusted OR=0.60 (95% CI= 0.49-0.72)). The p-value for this OR is < 0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.1.2.2.1.3 The effect of an interaction between year and region

The contrasts of marginal linear predictions test showed that there is insufficient evidence (adjusted $p = 0.19$) to support the hypothesis that the overall change in the proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed no significant effect thus showing that Canterbury DHB Group trends did not change in a way that was significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is non-significant, all individual year by region p-values can be considered non-significant. Adjustments made for potential confounders did not markedly change the resulting models.

5.1.2.2.1.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. The only significant change made by adjustment was that '01 Sep 10-31 Aug 11 in Canterbury' became weakly significant (unadjusted $p = 0.06$ cf. adjusted $p = 0.04$). However, because the contrasts test for this section overall was not significant ($p = 0.19$), this change in significance at the individual year level

can be disregarded. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES, younger and Māori children had higher odds of having an abnormal score in the adjusted model.

5.1.2.2.1.5 Summary

The contrasts interaction of year with region showed no significant effect thus indicating that the Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed no significant effects on the unadjusted model but did show a significant effect in the first year of follow-up in the adjusted model, however, this did not affect the overall outcome. The findings do not provide evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time (adjusted $p=0.19$). The implication of this is that children in the Canterbury DHB Group are not exhibiting an earthquake-related effect on SDQT total scores compared with Comparison DHB Group scores.

Table 9 SDQT total score logistic regression model results

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	0.99	0.85	1.16	0.94 (NS)	0.98	0.84	1.16	0.84 (NS)
	01 Sep 11-31 Aug 12	0.88	0.75	1.03	0.12 (NS)	0.89	0.76	1.06	0.19 (NS)
	01 Sep 12-31 Aug 13	0.67	0.57	0.79	<0.01	0.67	0.56	0.79	<0.01
	01 Sep 13-31 Aug 14	0.75	0.64	0.88	<0.01	0.74	0.63	0.88	<0.01
Region	Comparison DHB Group *	1.00				1.00			
	Canterbury DHB Group	0.60	0.50	0.71	<0.01	0.60	0.49	0.72	<0.01
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.19 (NS)	1.00			0.19 (NS)
	01 Sep 10-31 Aug 11 in Canterbury	0.79	0.61	1.01	0.06 (NS)	0.76	0.58	0.98	0.04 †
	01 Sep 11-31 Aug 12 in Canterbury	0.87	0.68	1.11	0.27 (NS)	0.83	0.64	1.08	0.17 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	1.04	0.81	1.34	0.76 (NS)	0.98	0.76	1.28	0.90 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	0.92	0.72	1.18	0.52 (NS)	0.89	0.69	1.14	0.36 (NS)
Sex	Female*					1.00			
	Male					2.35	2.15	2.56	<0.01
SES	NZ Dep.					1.24	1.20	1.28	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					0.93	0.84	1.04	0.22 (NS)
	4.50-4.74					0.96	0.85	1.08	0.48 (NS)
	4.75-4.99					0.76	0.67	0.88	<0.01
Ethnicity	NZ European*					1.00			
	NZ Maori					1.13	1.01	1.27	0.04
	Pacific Islander					0.95	0.76	1.19	0.65 (NS)
	Asian					0.97	0.80	1.18	0.77 (NS)
	Other					0.94	0.79	1.11	0.45 (NS)
Constant		0.09	0.08	0.11	<0.01	0.03	0.03	0.04	<0.01

5.1.2.2.2 Parent

5.1.2.2.2.1 Effect of year

There is evidence for a change in the proportion of abnormal SDQP total scores over time. The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The OR for abnormal SDQP total scores rose in the year from '09-'10 to '10-'11 and then

decreased during the two subsequent years, before rising again to an OR similar to that of the first year. Despite this finding, p-values for all individual year groups in the model are >0.05 (except for '12-'13 in the adjusted model where $p=0.04$) meaning that there is no significant difference in the OR between the baseline (reference) year (2009-2010 in this case) and each of the follow-up study year groups. This section considers the impact of year only (not DHB).

5.1.2.2.2.2 Effect of region

The model shows that abnormal SDQP total scores are more likely in the Canterbury DHB Group compared with the Comparison DHB Group (adjusted OR=1.21 (95% CI= 1.01-1.44)). The p-value for this OR is <0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.1.2.2.2.3 The effect of an interaction between year and region

The contrasts of marginal linear predictions test showed that there is insufficient evidence (adjusted $p=0.23$) to support the hypothesis that the overall change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed no significant effect thus showing that the Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is non-significant, all individual year by region p-values can be considered non-significant.

5.1.2.2.2.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. The only significant change made by adjustment was that '01 Sep '12-31 Aug '13' became weakly significant (unadjusted $p=0.07$ cf. adjusted $p=0.04$). This change did not, however, alter the evidence for a global change. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES, Māori and Pacific Islander children had higher odds of having an abnormal score in the adjusted model.

5.1.2.2.2.5 Summary

The contrasts interaction of year with region showed no significant effect thus indicating that Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The findings do not provide evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time (adjusted $p=0.23$) for the SDQP total measure. The implication of this is that children in the Canterbury DHB Group are not

exhibiting an earthquake-related effect on SDQP total scores compared with Comparison DHB Group scores.

Table 10 SDQP total score logistic regression model outputs

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	1.16	0.98	1.36	0.08 (NS)	1.14	0.96	1.35	0.13 (NS)
	01 Sep 11-31 Aug 12	0.95	0.80	1.12	0.53 (NS)	0.95	0.80	1.14	0.61 (NS)
	01 Sep 12-31 Aug 13	0.86	0.72	1.01	0.07 (NS)	0.84	0.70	1.00	0.04†
	01 Sep 13-31 Aug 14	1.00	0.85	1.17	0.99 (NS)	0.97	0.82	1.15	0.71 (NS)
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	1.19	1.01	1.40	0.04	1.21	1.01	1.44	0.04
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.28 (NS)	1.00			0.23 (NS)
	01 Sep 10-31 Aug 11 in Canterbury	0.82	0.66	1.03	0.08 (NS)	0.81	0.64	1.02	0.08 (NS)
	01 Sep 11-31 Aug 12 in Canterbury	0.88	0.70	1.10	0.26 (NS)	0.86	0.68	1.09	0.20 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	0.83	0.66	1.04	0.11 (NS)	0.82	0.64	1.03	0.09 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	0.79	0.64	0.99	0.04	0.77	0.62	0.97	0.03
Sex	Female*					1.00			
	Male					1.56	1.45	1.67	<0.01
SES	NZ Dep.					1.33	1.29	1.36	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					0.95	0.87	1.05	0.31 (NS)
	4.50-4.74					0.89	0.80	1.00	0.05 (NS)
	4.75-4.99					0.95	0.85	1.07	0.42 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.53	1.39	1.69	<0.01
	Pacific Islander					1.45	1.22	1.71	<0.01
	Asian					0.94	0.80	1.12	0.50 (NS)
	Other					0.87	0.74	1.02	0.09 (NS)
Constant		0.08	0.07	0.09	<0.01	0.03	0.02	0.03	<0.01

5.2 SDQ Internalising Score

5.2.1 Descriptive

5.2.1.1 Means

Mean scores for both parent- and teacher-reported SDQ internalising scores showed similar slight downward trends for both study groups. Canterbury DHB Group results did not appear to show any differential changes resulting from the earthquakes. The SDQT internalising score average is consistently lower in the Canterbury DHB Group than it is in the Comparison DHB Group but shows a similar trend. The SDQP total score averages are roughly equal for the Canterbury DHB Group and the Comparison DHB Group with both regions showing a similar gradient. Average SDQT scores for both groups were lower than average SDQP scores (~1.5-2 cf. ~2.5 respectively).

Figure 7 Mean teacher-reported SDQ internalising scores over time in the Canterbury DHB Group and the Comparison DHB Group

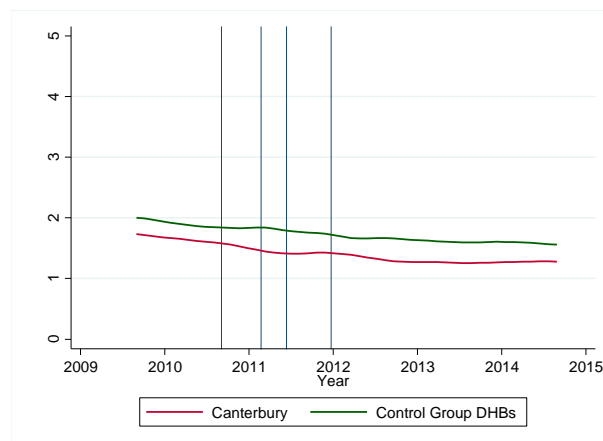
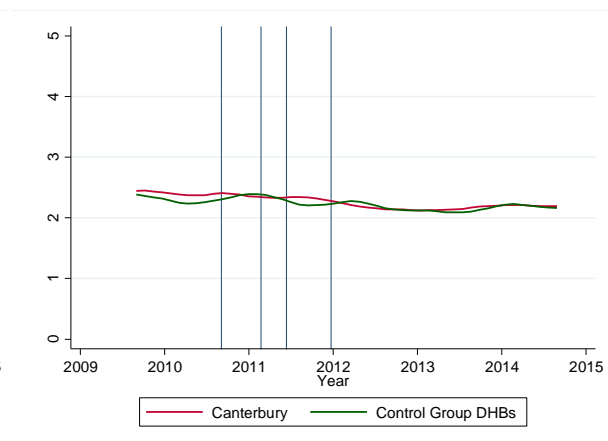


Figure 8 Mean parent-reported SDQ internalising scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.2.1.2 Proportions

The proportions of abnormal scores for both parent- and teacher-reported SDQ internalising scores showed similar slight downward trends for both study regions. Canterbury DHB Group proportional trends did not appear to show any differential changes resulting from the earthquakes. The proportion of abnormal SDQT internalising scores in the Canterbury DHB Group was consistently lower than that of the Comparison DHB Group. The proportion of abnormal SDQP internalising scores showed similar trends for both regions with Canterbury DHB Group trends closely matching Comparison DHB Group trends. The proportions of abnormal SDQT scores were generally similar to SDQP proportions but with a wider range between groups (~4-9% cf. ~5-8% respectively).

Figure 9 Percentage of abnormal teacher-reported SDQ internalising scores over time in the Canterbury DHB Group and the Comparison DHB Group

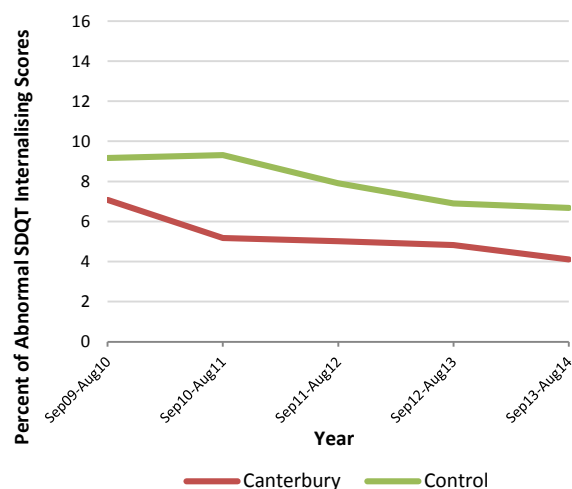
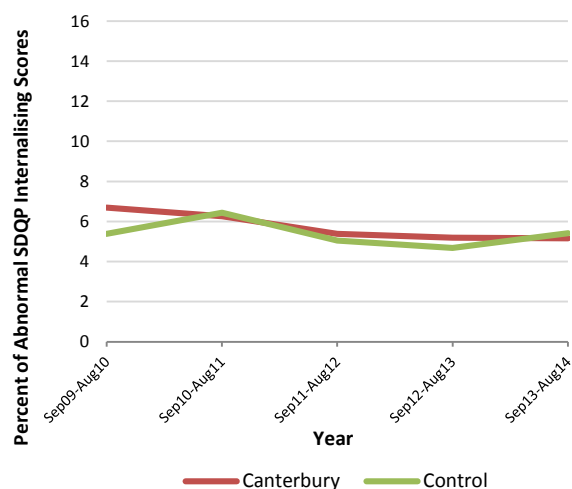


Figure 10 Percentage of abnormal parent-reported SDQ internalising scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.2.2 Analytical

5.2.2.1 Assessment of Potential Confounders

All the considered potential confounding variables except for age in the parent-rated version showed a statistically significant effect on outcome and so were added to the logistic regression models to adjust for their potential effect on the proportion of abnormal SDQ total scores.

Table 11 SDQ internalising score confounder characteristics as identified by univariate logistic regression

		SDQT Internalising			SDQP Internalising		
		OR	95% CI	P-value of contrasts (ANOVA)	OR	95% CI	P-value of contrasts (ANOVA)
Sex	Female*	1.00		P<0.01	1.00		P<0.01
	Male	1.28	(1.22, 1.34)		1.19	(1.15, 1.23)	
SES	1*	1.00		P<0.01	1.00		P<0.01
	2	1.14	(1.05, 1.23)		1.23	(1.15, 1.31)	
	3	1.29	(1.20, 1.39)		1.51	(1.42, 1.61)	
	4	1.57	(1.46, 1.69)		1.98	(1.87, 2.10)	
	5	2.07	(1.93, 2.21)		3.01	(2.86, 3.18)	
Age	4.00-4.24*	1.00		P<0.01	1.00		P=0.17
	4.25-4.49	0.96 (NS)	(0.91, 1.02)		1.00 (NS)	(0.96, 1.04)	
	4.50-4.74	0.89	(0.84, 0.95)		0.96 (NS)	(0.92, 1.00)	
	4.75-4.99	0.82	(0.77, 0.89)		0.97 (NS)	(0.93, 1.02)	
Ethnicity	NZ-European*	1.00		P<0.01	1.00		P<0.01
	Māori	1.47	(1.39, 1.56)		2.42	(2.33, 2.51)	
	Pacific Islander	1.63	(1.50, 1.78)		2.48	(2.36, 2.60)	
	Asian	1.19	(1.09, 1.29)		1.39	(1.31, 1.47)	
	Other	0.96 (NS)	(0.88, 1.05)		0.97 (NS)	(0.90, 1.04)	

5.2.2.2 Models

Tables in this section detail the results of a multivariate logistic regression. Logistic regression model results for teacher and parent reported data can be found in Table 12 and Table 13 respectively.

5.2.2.2.1 Teacher

5.2.2.2.1.1 Effect of year

There is evidence for a change in the proportion of abnormal SDQT internalising scores over time.

The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The OR for abnormal SDQT internalising scores increases slightly in '10-'11 and then decreases each year, with this reduction reaching statistical significance by the '12-'13 year. This section considers the impact of year only (not DHB).

5.2.2.2.1.2 Effect of region

The model shows that abnormal SDQT internalising scores are less likely in the Canterbury DHB Group compared with the Comparison DHB Group (adjusted OR=0.75 (95% CI= 0.61-0.92). The p-value for this OR is < 0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.2.2.2.1.3 The effect of an interaction between year and region

The contrasts of marginal linear predictions test showed that there is insufficient evidence (adjusted $p = 0.17$) to support the hypothesis that the overall change in the proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed no significant effect thus showing that Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is non-significant, all individual year by region p-values can be considered non-significant. Adjustments made for potential confounders did not markedly change the resulting models.

5.2.2.2.1.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. No significant changes resulted from the statistical adjustment of this model. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES, and Māori children had higher odds of having an abnormal score in the adjusted model.

5.2.2.2.1.5 Summary

The contrasts interaction of year with region showed no significant effect thus indicating that Canterbury DHB Group trends did not change in a way that was statistically significantly different to

Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed a significant effect in the first year of follow-up in the both the unadjusted and adjusted model, but this did not affect the overall outcome. The findings do not provide evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time (adjusted $p=0.17$). The implication of this is that children in the Canterbury DHB Group are not exhibiting an earthquake-related effect on SDQT internalising scores compared with Comparison DHB Group scores.

Table 12 Internalising SDQT logistic regression model results

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	1.02	0.86	1.20	0.86 (NS)	1.01	0.84	1.20	0.95 (NS)
	01 Sep 11-31 Aug 12	0.85	0.71	1.01	0.07 (NS)	0.86	0.72	1.04	0.12 (NS)
	01 Sep 12-31 Aug 13	0.73	0.62	0.88	<0.01	0.73	0.60	0.87	<0.01
	01 Sep 13-31 Aug 14	0.71	0.60	0.84	<0.01	0.69	0.58	0.83	<0.01
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	0.70	0.63	0.91	<0.01	0.75	0.61	0.92	0.01
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.11 (NS)	1.00			0.17 (NS)
	01 Sep 10-31 Aug 11 in Canterbury	0.70	0.54	0.92	0.01	0.73	0.55	0.96	0.03
	01 Sep 11-31 Aug 12 in Canterbury	0.81	0.62	1.06	0.13 (NS)	0.78	0.59	1.03	0.08 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	0.91	0.70	1.18	0.47 (NS)	0.90	0.68	1.18	0.45 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	0.79	0.61	1.03	0.09 (NS)	0.79	0.60	1.04	0.09 (NS)
Sex	Female*					1.00			
	Male					1.28	1.17	1.39	<0.01
SES	NZ Dep.					1.17	1.13	1.20	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					0.99	0.88	1.11	0.82 (NS)
	4.50-4.74					1.00	0.88	1.14	0.96 (NS)
	4.75-4.99					0.88	0.76	1.03	0.11 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.18	1.04	1.35	0.01
	Pacific Islander					1.08	0.84	1.38	0.57 (NS)
	Asian					1.12	0.92	1.37	0.24 (NS)
	Other					1.01	0.85	1.22	0.88 (NS)
Constant		0.10	0.09	0.11	<0.01	0.06	0.05	0.07	<0.01

5.2.2.2.2 Parent

5.2.2.2.2.1 Effect of year

There is evidence for a change in the proportion of abnormal SDQP internalising scores over time.

The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The OR for abnormal SDQP internalising scores rose in the year from '09-'10 to '10-'11

and then decreased during the two subsequent years, before rising again to an OR similar to that of the first year. Despite this finding, p-values for all individual year groups in the model are ≥ 0.05 (except for '10-'11 in the adjusted model where $p=0.03$) meaning that there is no significant difference in the OR between the baseline (reference) year (2009-2010 in this case) and each of the follow-up study year groups. This section considers the impact of year only (not DHB).

5.2.2.2.2 Effect of region

The model shows that abnormal SDQP internalising scores are more likely in the Canterbury DHB Group compared with the Comparison DHB Group region (adjusted OR=1.34 (95%CI= 1.10-1.65). The p-value for this OR is ≤ 0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.2.2.2.3 The effect of an interaction between year and region

The contrasts of marginal linear predictions test showed that there is insufficient evidence (adjusted $p=0.08$) to support the hypothesis that the overall change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed no significant effect thus showing that Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is non-significant, all individual year by region p-values can be considered non-significant. Adjustments made for potential confounders did not markedly change the resulting models.

5.2.2.2.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. No significant changes resulted from the statistical adjustment of this model. This suggests that differences between regions were not explained by differences in the demographics of the population.

Male, low SES, Māori, Pacific Islander and Asian children had higher odds of having an abnormal score in the adjusted model.

5.2.2.2.5 Summary

The contrasts interaction of year with region showed no significant effect thus indicating that Canterbury DHB Group results did not change in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed a significant effect in the first and last year of follow-up in the both the unadjusted and adjusted model, but this did not affect the overall outcome. The findings do not provide evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time. The implication of this is that

children in the Canterbury DHB Group are not exhibiting an earthquake-related effect on SDQP internalising scores compared with Comparison DHB Group scores.

Table 13 Internalising SDQP logistic regression model outputs

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	1.21	1.00	1.45	0.05 (NS)	1.25	1.02	1.51	0.03†
	01 Sep 11-31 Aug 12	0.93	0.77	1.14	0.49 (NS)	0.95	0.78	1.17	0.65 (NS)
	01 Sep 12-31 Aug 13	0.86	0.71	1.05	0.14 (NS)	0.87	0.71	1.07	0.18 (NS)
	01 Sep 13-31 Aug 14	1.01	0.83	1.21	0.95 (NS)	1.01	0.83	1.23	0.93 (NS)
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	1.26	1.05	1.52	0.02	1.34	1.10	1.65	<0.01
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.17 (NS)	1.00			0.08 (NS)
	01 Sep 10-31 Aug 11 in Canterbury	0.77	0.60	0.99	0.04	0.73	0.56	0.95	0.02
	01 Sep 11-31 Aug 12 in Canterbury	0.85	0.66	1.10	0.22 (NS)	0.83	0.63	1.09	0.17 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	0.89	0.68	1.14	0.35 (NS)	0.84	0.65	1.10	0.22 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	0.75	0.59	0.97	0.03	0.71	0.55	0.92	0.01
Gender	Female*					1.00			
	Male					1.26	1.16	1.37	<0.01
SES	NZ Dep.					1.23	1.19	1.26	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					1.01	0.90	1.12	0.90 (NS)
	4.50-4.74					1.05	0.93	1.19	0.41 (NS)
	4.75-4.99					1.02	0.89	1.17	0.75 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.47	1.31	1.65	<0.01
	Pacific Islander					1.79	1.49	2.15	<0.01
	Asian					1.57	1.34	1.85	<0.01
	Other					1.09	0.92	1.29	0.30 (NS)
Constant		0.06	0.05	0.07	<0.01	0.02	0.02	0.03	<0.01

5.3 SDQ Externalising Score

5.3.1 Descriptive

5.3.1.1 Means

Mean scores for both parent- and teacher-reported SDQ externalising scores showed similar slight downward trends for both study regions. Canterbury DHB Group mean trends did not appear to show any differential changes resulting from the earthquakes. The SDQT total score average is consistently lower in the Canterbury DHB Group than it is in the Comparison DHB Group region but shows a similar trend. The SDQP total score averages are roughly equal for the Canterbury DHB Group and the Comparison DHB Group with both regions showing a similar gradient. Average SDQT scores for both regions were lower than SDQP scores for both regions (~2 cf. ~4 respectively).

Figure 11 Mean teacher-reported SDQ externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group

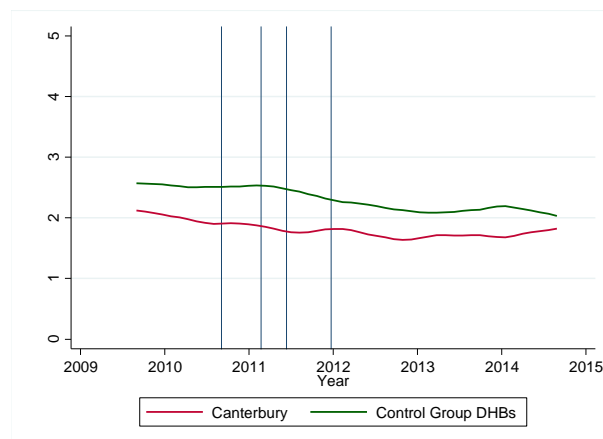
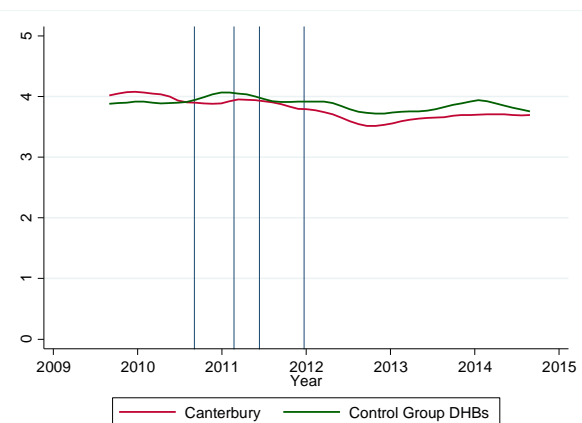


Figure 12 Mean parent-reported SDQ externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.3.1.2 Proportions

The proportion of abnormal scores for teacher-reported SDQ externalising scores showed downward trends for both study regions with the Comparison DHB Group's rate of change being greater than that of the Canterbury DHB Group's. Conversely, the proportion of abnormal scores for parent-reported SDQ externalising scores showed very similar slight downward trends for both study regions. Canterbury DHB Group proportional trends did not appear to show any differential changes resulting from the earthquakes. The proportion of abnormal SDQT total scores in Canterbury DHB Group was consistently lower than for the Comparison DHB Group regions. The proportion of abnormal SDQP total scores showed similar trends for both regions. The proportions of abnormal SDQT scores were generally higher and showed greater variance than SDQP proportions (~5-13% cf. ~5-8% respectively).

Figure 13 Percentage of abnormal teacher-reported SDQ externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group

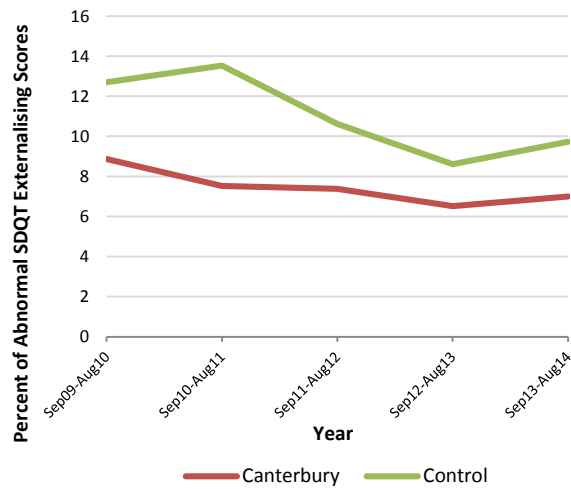
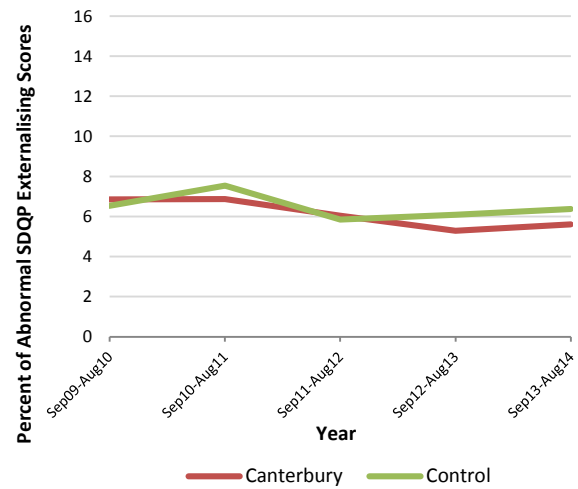


Figure 14 Percentage of abnormal parent-reported SDQ externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.3.2 Analytical

5.3.2.1 Assessment of Potential Confounders

All the considered potential confounding variables except for age in the parent-rated version showed a statistically significant effect on outcome and so were added to the logistic regression models to adjust for their potential effect on the proportion of abnormal SDQ total scores.

Table 14 SDQ externalising score confounder characteristics as identified by univariate logistic regression

		SDQT Externalising			SDQP Externalising		
		OR	95% CI	P-value of contrasts (ANOVA)	OR	95% CI	P-value of contrasts (ANOVA)
Sex	Female*	1.00		P<0.01	1.00		P<0.01
	Male	2.58	(2.47, 2.69)		1.81	(1.75, 1.87)	
SES	1*	1.00		P<0.01	1.00		P<0.01
	2	1.21	(1.13, 1.30)		1.26	(1.19, 1.35)	
	3	1.43	(1.34, 1.53)		1.67	(1.57, 1.77)	
	4	1.89	(1.78, 2.02)		2.21	(2.08, 2.34)	
	5	2.43	(2.29, 2.58)		3.32	(3.14, 3.51)	
Age	4.00-4.24*	1.00		P=0.02	1.00		P=0.03
	4.25-4.49				1.02		
		1.02 (NS)	(0.98, 1.07)		(NS)	(0.98, 1.06)	
	4.50-4.74	0.98 (NS)	(0.93, 1.03)		0.95	(0.91, 0.99)	
	4.75-4.99				1.00		
Ethnicity	NZ-European*	0.92	(0.87, 0.98)		(NS)	(0.95, 1.05)	
		1.00		P<0.01	1.00		P<0.01
	Māori	1.85	(1.77, 1.94)		2.23	(2.15, 2.31)	
	Pacific Islander	1.51	(1.41, 1.63)		1.37	(1.29, 1.44)	
	Asian	0.92	(0.85, 0.99)		0.56	(0.52, 0.60)	
	Other	1.02 (NS)	(0.94, 1.10)		0.74	(0.69, 0.79)	

5.3.2.2 *Models*

Tables in this section detail the results of a multivariate logistic regression. Logistic regression model results for teacher and parent reported data can be found in Table 15 and Table 16 respectively.

5.3.2.2.1 *Teacher*

5.3.2.2.1.1 *Effect of year*

There is evidence for a change in the proportion of abnormal SDQT externalising scores over time. The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The OR for abnormal SDQT externalising scores shows a non-statistically significant increase in '10-'11 and then shows a statistically significant decrease compared with baseline over the next two years, followed by a slight increase in '13-'14. This section considers the impact of year only (not DHB).

5.3.2.2.1.2 *Effect of region*

The model shows that abnormal SDQT externalising scores are less likely in the Canterbury DHB Group compared with the Comparison DHB Group (adjusted OR=0.68 95%CI= 0.56-0.81). The p-value for this OR is <0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.3.2.2.1.3 *The effect of an interaction between year and region*

The contrasts of marginal linear predictions test showed that there is moderate evidence (adjusted $p = 0.04$) to support the hypothesis that the overall change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed a significant effect thus suggesting that Canterbury DHB Group trends changed in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is significant, one can look to see where in the individual year by region p-values this change is happening. The p-value for the year category 10-11 in the Canterbury DHB Group is <0.05 meaning that there is a significant difference in the OR between the baseline (reference) year and region (2009-2010 in the Comparison DHB Group in this case) and the first follow-up study year group in the Canterbury DHB Group. Children who participated in the B4 School Check in Canterbury in the September '10 to August '11 period were significantly less likely to have an abnormal SDQT externalising score than would be expected, based on how the trend in the Comparison DHB Group changed (adjusted OR=0.75 95%CI= 0.59-0.96). Conversely, the interaction of year with region showed no significant effect for the last three study years in the Canterbury DHB Group thus showing that Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends during this period. From this it can be seen that the difference in trends occurred in the two year September '09 to

August '11 period. As this period coincides with the majority of earthquake activity, it is possible that the difference in trends between the Canterbury DHB Group and Comparison DHB Group may be associated with the disaster events. Adjustments made for potential confounders did not markedly change the resulting models.

5.3.2.2.1.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. No significant changes resulted from the statistical adjustment of this model. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES, younger and Māori children had higher odds of having an abnormal score in the adjusted model.

5.3.2.2.1.5 Summary

The contrasts interaction of year with region showed a significant effect thus indicating that the Canterbury DHB Group trends changed in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed a significant effect in the first year of follow-up in the both the unadjusted and adjusted model. The findings give evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time. The implication of this is that children in the Canterbury DHB Group may be exhibiting an earthquake-related effect on SDQT externalising scores compared with Comparison DHB Group scores.

Table 15 SDQT externalising score logistic regression model results

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	1.08	0.93	1.25	0.33 (NS)	1.07	0.92	1.25	0.38 (NS)
	01 Sep 11-31 Aug 12	0.82	0.70	0.95	0.01	0.82	0.69	0.96	0.01
	01 Sep 12-31 Aug 13	0.65	0.55	0.76	<0.01	0.64	0.54	0.75	<0.01
	01 Sep 13-31 Aug 14	0.74	0.64	0.86	<0.01	0.72	0.62	0.85	<0.01
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	0.67	0.57	0.79	<0.01	0.68	0.56	0.81	<0.01
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.04	1.00			0.04
	01 Sep 10-31 Aug 11 in Canterbury	0.78	0.62	0.98	0.03	0.75	0.59	0.96	0.02
	01 Sep 11-31 Aug 12 in Canterbury	1.00	0.80	1.26	0.98 (NS)	1.00	0.78	1.27	0.99 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	1.11	0.88	1.40	0.40 (NS)	1.08	0.85	1.38	0.53 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	1.04	0.84	1.31	0.70 (NS)	1.02	0.80	1.28	0.90 (NS)
Sex	Female*					1.00			
	Male					2.72	2.50	2.95	<0.01
SES	NZ Dep.					1.23	1.20	1.26	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					0.95	0.86	1.05	0.32 (NS)
	4.50-4.74					0.88	0.78	0.99	0.03
	4.75-4.99					0.89	0.78	1.01	0.06 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.31	1.18	1.47	<0.01
	Pacific Islander					1.14	0.93	1.41	0.22 (NS)
	Asian					0.85	0.71	1.02	0.09 (NS)
	Other					0.95	0.81	1.11	0.50 (NS)
Constant		0.15	0.13	0.16	<0.01	0.05	0.04	0.05	<0.01

5.3.2.2.2 Parent

5.3.2.2.2.1 Effect of year

There is evidence for a change in the proportion of abnormal SDQP externalising scores over time.

The contrasts of marginal linear predictions test showed that overall there is strong evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality ($p < 0.01$). The ORs for abnormal SDQP externalising scores fluctuate over the study period but p -values for all individual year groups in the model are ≥ 0.05 meaning that there is no significant

difference in the OR between the baseline (reference) year (2009-2010 in this case) and each of the follow-up study year groups. This section considers the impact of year only (not DHB).

5.3.2.2.2 Effect of region

The model shows that abnormal SDQP internalising scores are more likely in the Canterbury DHB Group compared with the Comparison DHB Group, but that this difference is not statistically significant (adjusted OR=1.12, 95% CI= 0.92-1.35). This section considers the impact of DHB only (not year).

5.3.2.2.3 The effect of an interaction between year and region

The contrasts of marginal linear predictions test showed that there is insufficient evidence (adjusted $p = 0.37$) to support the hypothesis that the overall change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed no significant effect thus showing that the Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is non-significant, all individual year by region p -values can be considered non-significant. Adjustments made for potential confounders did not markedly change the resulting models.

5.3.2.2.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. No significant changes resulted from the statistical adjustment of this model. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES and Māori children had higher odds of having an abnormal score in the adjusted model.

5.3.2.2.5 Summary

The contrasts interaction of year with region showed no significant effect thus indicating that Canterbury DHB Group trends did not change in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed no significant effects on either the unadjusted or adjusted models. The findings do not provide evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time. The implication of this is that children in the Canterbury DHB Group are not exhibiting an earthquake-related effect on SDQP externalising scores compared with Comparison DHB Group scores.

Table 16 SDQP externalising score logistic regression model outputs

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11	1.17	0.98	1.38	0.08 (NS)	1.11	0.93	1.32	0.26 (NS)
	01 Sep 11-31 Aug 12	0.89	0.74	1.06	0.20 (NS)	0.87	0.72	1.05	0.15 (NS)
	01 Sep 12-31 Aug 13	0.93	0.78	1.10	0.38 (NS)	0.89	0.74	1.06	0.20 (NS)
	01 Sep 13-31 Aug 14	0.97	0.82	1.15	0.75 (NS)	0.94	0.79	1.12	0.48 (NS)
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	1.05	0.88	1.25	0.59 (NS)	1.12	0.92	1.35	0.26 (NS)
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.30 (NS)	1.00			0.37 (NS)
	01 Sep 10-31 Aug 11 in Canterbury	0.86	0.68	1.09	0.21 (NS)	0.88	0.69	1.13	0.32 (NS)
	01 Sep 11-31 Aug 12 in Canterbury	0.99	0.77	1.26	0.92 (NS)	0.98	0.76	1.26	0.86 (NS)
	01 Sep 12-31 Aug 13 in Canterbury	0.82	0.64	1.05	0.11 (NS)	0.83	0.64	1.06	0.14 (NS)
	01 Sep 13-31 Aug 14 in Canterbury	0.83	0.66	1.05	0.12 (NS)	0.82	0.65	1.05	0.12 (NS)
Sex	Female*					1.00			
	Male					1.87	1.73	2.02	<0.01
SES	NZ Dep.					1.32	1.28	1.36	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					1.07	0.96	1.18	0.23 (NS)
	4.50-4.74					0.93	0.83	1.05	0.25 (NS)
	4.75-4.99					1.05	0.92	1.19	0.47 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.33	1.20	1.48	<0.01
	Pacific Islander					0.92	0.75	1.14	0.45 (NS)
	Asian					0.49	0.39	0.61	<0.01
	Other					0.76	0.63	0.90	<0.01
Constant		0.07	0.06	0.08	<0.01	0.02	0.02	0.03	<0.01

5.4 SDQ Impact Score

5.4.1 Descriptive

5.4.1.1 Means

Mean scores for both parent- and teacher-reported SDQ impact scores showed relatively stable trends for both study regions with slightly more fluctuation in the parent-reported means. Canterbury DHB Group mean trends showed a slight decline over the earthquake period while slight increases were

seen in the Comparison DHB Group regions over the same period, which may indicate an earthquake effect. The SDQT total score average trend shows similar stability across all study regions. The SDQP total score averages for the Canterbury DHB Group and the Comparison DHB Group show a trend towards convergence over the first two years followed by similarly stable mean scores. Average SDQT scores for all regions were generally lower than SDQP scores for all regions (~0.05-0.1 cf. ~0.1-0.2 respectively).

Figure 15 Mean teacher-reported SDQ impact scores over time in the Canterbury DHB Group and the Comparison DHB Group

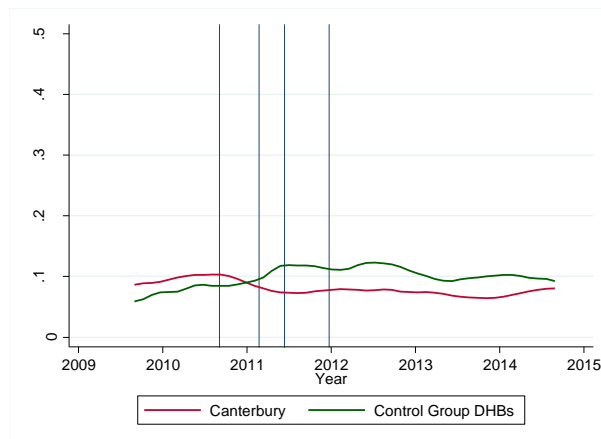
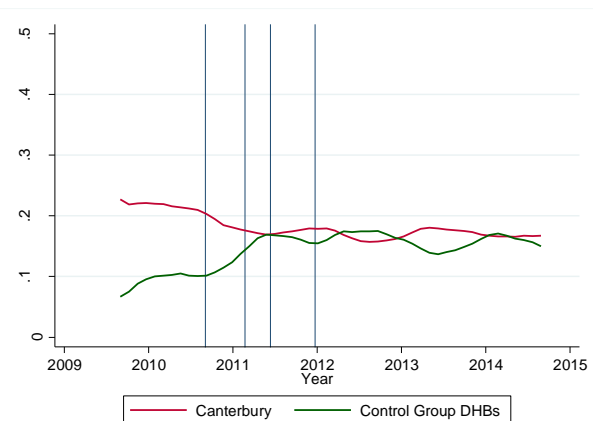


Figure 16 Mean parent-reported SDQ impact scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.4.1.2 Proportions

The proportion of abnormal scores for both parent- and teacher-reported SDQ impact scores showed a similar slight downward trend for the Canterbury DHB Group over time in contrast with a slight upward or stable trend in the Comparison DHB Group. The Canterbury DHB Group proportional trends show some differential change compared with comparison regions, which may suggest that some earthquake effect may be present. The Canterbury DHB Group mostly showed a lower proportion of abnormal SDQT scores than the Comparison DHB Group but a generally higher proportion of abnormal SDQP scores. The proportions of abnormal SDQT scores were generally lower than SDQP proportions (~1-3% cf. ~2-5% respectively).

Figure 17 Percentage of abnormal teacher-reported SDQ impact scores over time in the Canterbury DHB Group and the Comparison DHB Group

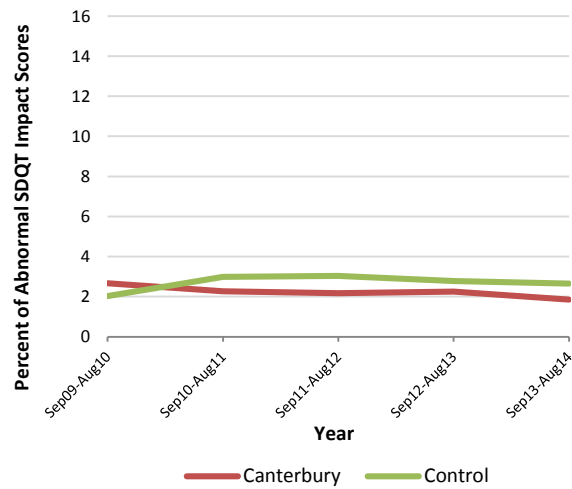
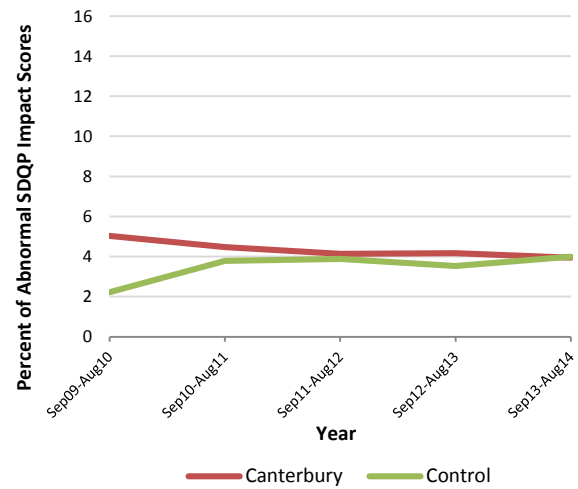


Figure 18 Percentage of abnormal parent-reported SDQ impact scores over time in the Canterbury DHB Group and the Comparison DHB Group



5.4.2 Analytical

5.4.2.1 Assessment of Potential Confounders

All the considered potential confounding variables except for age in the parent-rated version showed a statistically significant effect on outcome and so were added to the logistic regression models to adjust for their potential effect on the proportion of abnormal SDQ total scores.

Table 17 SDQ impact score confounder characteristics as identified by univariate logistic regression

		SDQT Impact			SDQP Impact		
		OR	95% CI	P-value of contrasts (ANOVA)	OR	95% CI	P-value of contrasts (ANOVA)
Sex	Female*	1.00		P<0.01	1.00		P<0.01
	Male	2.49	(2.32, 2.68)		1.88	(1.78, 1.98)	
SES	1*	1.00		P<0.01	1.00		P<0.01
	2	1.35	(1.19, 1.52)		1.26	(1.15, 1.39)	
	3	1.61	(1.43, 1.81)		1.44	(1.31, 1.58)	
	4	1.96	(1.75, 2.19)		1.64	(1.50, 1.79)	
	5	1.83	(1.64, 2.05)		1.88	(1.73, 2.05)	
Age	4.00-4.24*	1.00		P<0.01	1.00		P=0.09
	4.25-4.49				1.01		
		0.96 (NS)	(0.88, 1.04)		(NS)	(0.95, 1.08)	
	4.50-4.74				0.97		
		0.88	(0.80, 0.96)		(NS)	(0.91, 1.05)	
Ethnicity	4.75-4.99	0.69	(0.62, 0.76)		0.92	(0.85, 0.99)	
	NZ-European*	1.00		P<0.01	1.00		P<0.01
	Māori	1.04 (NS)	(0.96, 1.13)		1.33	(1.25, 1.41)	
	Pacific Islander	0.49	(0.42, 0.56)		0.67	(0.60, 0.74)	
	Asian	0.65	(0.57, 0.75)		0.47	(0.41, 0.53)	
	Other	0.63	(0.55, 0.73)		0.67	(0.60, 0.75)	

5.4.2.2 *Models*

Tables in this section detail the results of a multivariate logistic regression. Logistic regression model results for teacher and parent reported data can be found in Table 18 and Table 19 respectively.

5.4.2.2.1 *Teacher*

5.4.2.2.1.1 *Effect of year*

There is a lack of evidence for a change in the proportion of abnormal SDQT impact scores over time. The contrasts of marginal linear predictions test showed that overall there is little evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality (adjusted $p=0.28$). Given that the overall (contrast) test for year by region is non-significant, all individual year by region p -values can be considered non-significant. This section considers the impact of year only (not DHB).

5.4.2.2.1.2 *Effect of region*

The model shows that there is no significant difference in the proportion of abnormal SDQT impact scores OR between the baseline (reference) DHB (the Comparison DHB Group in this case) and the Canterbury DHB Group (the exposed DHB). Abnormal scores are more likely in the Canterbury DHB Group compared with the Comparison DHB Group, but that this difference is not statistically significant (adjusted OR=1.24, 95% CI= 0.90-1.69). This section considers the impact of DHB only (not year).

5.4.2.2.1.3 *The effect of an interaction between year and region*

The contrasts of marginal linear predictions test showed that there is moderate evidence (adjusted $p=0.03$) that the change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed a significant effect thus showing that Canterbury DHB Group trends changed in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is significant, one can look to see where in the individual year by region p -values this change is happening. The p -values for all study year categories in the Canterbury DHB Group are <0.05 meaning that there is a significant difference in the OR between the baseline (reference) year and region (2009-2010 in the Comparison DHB Group in this case) and all subsequent study year groups in the Canterbury DHB Group. Children who participated in the B4 School Check in the Canterbury DHB Group in the September '10 to August '14 period were significantly less likely to have an abnormal SDQT impact score than would be expected based on how the trend in the Comparison DHB Group changed (adjusted OR=0.55-0.63, 95% CI= 0.37-0.93). From this it can be seen that a change in expected trends occurred in the Canterbury DHB Group from about the same time as the onset of the earthquakes, which may indicate some kind of earthquake-

related effect on SDQT impact scores. Adjustments made for potential confounders did not markedly change the resulting models.

5.4.2.2.1.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. The only significant change made by adjustment was that '01 Sep 12-31 Aug 13' went from being moderately significant to weakly significant (unadjusted $p=0.02$ cf. adjusted $p=0.05$). However, because the contrasts test for this section overall was not significant ($p=0.28$), this change in significance at the individual year level can be disregarded. This suggests that differences between regions were not explained by differences in the demographics of the population.

Male, low SES and younger children had higher odds of having an abnormal score in the adjusted model.

5.4.2.2.1.5 Summary

The contrasts interaction of year with region showed a significant effect thus indicating that the Canterbury DHB Group trends changed in a way that was statistically significantly different to the Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed a significant effect in all years of follow-up in the both the unadjusted and adjusted model. The findings give evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time. The implication of this is that children in the Canterbury DHB Group may be exhibiting an earthquake-related effect on SDQT impact scores compared with Comparison DHB Group scores.

Table 18 SDQT impact score logistic regression model results

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			0.32 (NS)	1.00			0.28 (NS)
	01 Sep 10-31 Aug 11	1.48	1.12	1.97	0.01	1.41	1.05	1.89	0.02
	01 Sep 11-31 Aug 12	1.52	1.14	2.02	<0.01	1.48	1.10	1.99	0.01
	01 Sep 12-31 Aug 13	1.38	1.04	1.83	0.02	1.34	1.00	1.80	0.05 (NS)†
	01 Sep 13-31 Aug 14	1.32	0.99	1.75	0.06 (NS)	1.25	0.93	1.67	0.13 (NS)
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	1.32	0.99	1.77	0.06 (NS)	1.24	0.90	1.69	0.18 (NS)
Year by Region	01 Sep 09-31 Aug 10 in Canterbury*	1.00			0.01	1.00			0.03
	01 Sep 10-31 Aug 11 in Canterbury	0.57	0.39	0.85	0.01	0.61	0.40	0.91	0.02
	01 Sep 11-31 Aug 12 in Canterbury	0.54	0.37	0.79	<0.01	0.55	0.37	0.83	<0.01
	01 Sep 12-31 Aug 13 in Canterbury	0.61	0.42	0.89	0.01	0.63	0.42	0.93	0.02
	01 Sep 13-31 Aug 14 in Canterbury	0.52	0.36	0.77	<0.01	0.55	0.37	0.81	<0.01
Sex	Female*					1.00			
	Male					2.47	2.17	2.82	<0.01
SES	NZ Dep.					1.26	1.21	1.32	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					1.00	0.86	1.17	0.98 (NS)
	4.50-4.74					0.91	0.76	1.10	0.34 (NS)
	4.75-4.99					0.75	0.60	0.92	0.01
Ethnicity	NZ European*					1.00			
	NZ Maori					1.11	0.94	1.32	0.22 (NS)
	Pacific Islander					0.78	0.55	1.10	0.16 (NS)
	Asian					1.05	0.80	1.36	0.74 (NS)
	Other					0.80	0.61	1.05	0.12 (NS)
Constant		0.02	0.02	0.03	0	0.01	<0.01	0.01	<0.01

5.4.2.2.2 Parent

5.4.2.2.2.1 Effect of year

There is a lack of evidence for a change in the proportion of abnormal SDQP impact scores over time.

The contrasts of marginal linear predictions test showed that overall there is little evidence that year of interest compared with baseline year is a significant predictor of the likelihood of abnormality (adjusted $p=0.15$). Given that the overall (contrast) test for year by region is non-significant, all

individual year by region p-values can be considered non-significant. This section considers the impact of year only (not DHB).

5.4.2.2.2 Effect of region

The model shows that abnormal SDQP impact scores are more likely in the Canterbury DHB Group compared with the Comparison DHB Group (adjusted OR=2.36 95%, 95%CI=1.80-3.10). The p-value for this OR is <0.05 meaning that this difference is statistically significant. This section considers the impact of DHB only (not year).

5.4.2.2.3 The effect of an interaction between year and region

The p-values for all study year categories in the Canterbury DHB Group are <0.05 meaning that there is a significant difference in the OR between the baseline (reference) year and region (2009-2010 in the Comparison DHB Group in this case) and each of the subsequent study year groups in the Canterbury DHB Group. Adjustments made for potential confounders did not markedly change the resulting models. There is strong evidence ($p < 0.001$) that the change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group.

The contrasts of marginal linear predictions test showed that there is strong evidence (adjusted $p < 0.001$) that the change in proportion of abnormal scores over time was different in the Canterbury DHB Group compared to the Comparison DHB Group. The interaction of year with region showed a significant effect thus showing that Canterbury DHB Group trends changed in a way that was statistically significantly different to Comparison DHB Group trends. Given that the overall (contrast) test for year by region is significant, one can look to see where in the individual year by region p-values this change is happening. The p-values for all study year categories in the Canterbury DHB Group are <0.05 meaning that there is a significant difference in the OR between the baseline (reference) year and region (2009-2010 in the Comparison DHB Group in this case) and all subsequent study year groups in the Canterbury DHB Group. Children who participated in the B4 School Check in the Canterbury DHB Group in the September '10 to August '14 period were significantly less likely to have an abnormal SDQT impact score than would be expected based on how the trend in the Comparison DHB Group changed (adjusted OR=0.44-0.53, 95%CI= 0.31-0.74). From this it can be seen that a change in expected trends occurred in the Canterbury DHB Group from about the same time as the onset of the earthquakes, which may indicate some kind of earthquake effect on SDQP impact scores. Adjustments made for potential confounders did not markedly change the resulting models.

5.4.2.2.2.4 Effect of confounders

Adjustments made for potential confounders did not markedly change the resulting models. No significant changes resulted from the statistical adjustment of this model. This suggests that differences between regions were not explained by differences in the demographic of the population.

Male, low SES, and Māori children had higher odds of having an abnormal score in the adjusted model.

5.4.2.2.2.5 Summary

The contrasts interaction of year with region showed a significant effect thus indicating that Canterbury DHB Group trends changed in a way that was statistically significantly different to Comparison DHB Group trends. Adjustments made for potential confounders did not markedly change the resulting models. The interaction of year with region showed a significant effect in all years of follow-up in both the unadjusted and adjusted models. The findings give evidence to support the hypothesis that the change in likelihood of being abnormal in the Canterbury DHB Group over time differs to the change in likelihood of being abnormal in the Comparison DHB Group over time. The implication of this is that children in the Canterbury DHB Group may be exhibiting an earthquake-related effect on SDQP impact scores compared with Comparison DHB Group scores.

Table 19 SDQP impact score logistic regression model outputs

		<u>Unadjusted Model</u>				<u>Adjusted Model</u>			
		OR	95% CI low	95% CI high	P-value	OR	95% CI low	95% CI high	P-value
Year	01 Sep 09-31 Aug 10*	1.00			0.11 (NS)	1.00			0.15 (NS)
	01 Sep 10-31 Aug 11	1.74	1.33	2.26	<0.01	1.68065	1.28	2.21	0
	01 Sep 11-31 Aug 12	1.78	1.36	2.33	<0.01	1.78	1.35	2.34	<0.01
	01 Sep 12-31 Aug 13	1.62	1.24	2.10	<0.01	1.58	1.20	2.07	<0.01
	01 Sep 13-31 Aug 14	1.84	1.42	2.37	<0.01	1.80	1.38	2.34	<0.01
Region	Comparison DHB Group*	1.00				1.00			
	Canterbury DHB Group	2.34	1.81	3.02	<0.01	2.36	1.80	3.10	<0.01
Year by Region	01 Sep 09-31 Aug 10 in Canterbury	1.00			<0.01	1.00			<0.01
	01 Sep 10-31 Aug 11 in Canterbury	0.51	0.37	0.71	<0.01	0.53	0.38	0.74	<0.01
	01 Sep 11-31 Aug 12 in Canterbury	0.46	0.33	0.64	<0.01	0.47	0.33	0.66	<0.01
	01 Sep 12-31 Aug 13 in Canterbury	0.51	0.37	0.70	<0.01	0.53	0.38	0.74	<0.01
	01 Sep 13-31 Aug 14 in Canterbury	0.42	0.31	0.58	<0.01	0.44	0.31	0.61	<0.01
Gender	Female*					1.00			
	Male					1.86	1.69	2.06	<0.01
SES	NZ Dep.					1.23	1.19	1.27	<0.01
Age	4.00-4.24*					1.00			
	4.25-4.49					1.01	0.89	1.14	0.92 (NS)
	4.50-4.74					0.99	0.85	1.14	0.87 (NS)
	4.75-4.99					0.97	0.82	1.14	0.70 (NS)
Ethnicity	NZ European*					1.00			
	NZ Maori					1.17	1.02	1.34	0.02
	Pacific Islander					0.80	0.61	1.05	0.10 (NS)
	Asian					0.55	0.42	0.72	<0.01
	Other					0.94	0.78	1.15	0.57 (NS)
Constant		0.02	0.02	0.03	<0.01	0.01	0.01	0.01	<0.01

5.5 Summary of Key Findings

In summary, the SDQ total difficulties and internalising scores showed no evidence of an earthquake effect (as evidenced by a statistically significant difference in the five-year trend between the Canterbury DHB Group data and Comparison DHB Group data) in either the teacher or parent reported version (Table 20). The SDQ externalising scores showed some evidence for an earthquake effect (in the teacher-reported version only). The SDQ impact score showed the most evidence for an earthquake effect with a difference found regardless of SDQ-informant. Where a possible effect was

identified, the direction was always towards a reduction in the odds of having an abnormal score in the Canterbury DHB Group compared with what would have been expected had the trend not changed (adjusted OR= 0.37-0.75).

Table 20 ANOVAs of logistic regression results as evidence for an earthquake effect on child wellbeing

		Total Score P-value	Internalising Score P-value	Externalising Score P-value	Impact Score P-value
Teacher-rated	Unadjusted	0.19 (NS)	0.11 (NS)	0.04	0.01
	Adjusted	0.19 (NS)	0.17 (NS)	0.04	0.03
Parent-rated	Unadjusted	0.28 (NS)	0.17 (NS)	0.30 (NS)	≤0.001
	Adjusted	0.23 (NS)	0.08 (NS)	0.37 (NS)	≤0.001

5.5.1 Examination of Significant Results

Three outcome variables exhibited evidence for an effect of earthquake exposure on child emotional and behavioural wellbeing. In all cases, evidence was in the direction of an effect of improvement following exposure. Figure 19, Figure 20, and Figure 21 show the plotted data of outcomes for which evidence for an earthquake effect was found.

Figure 19 Percentage of abnormal teacher-reported SDQT externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group

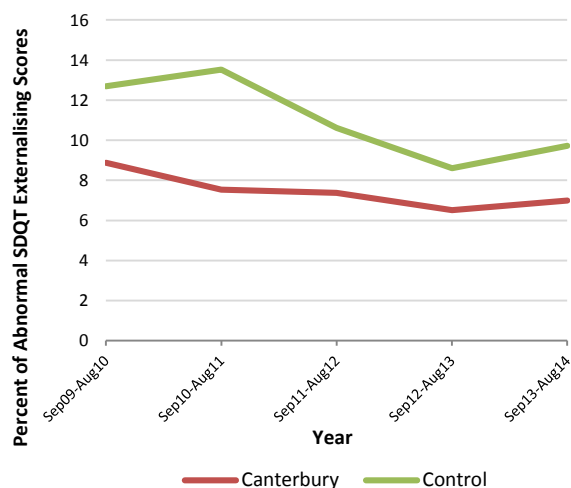
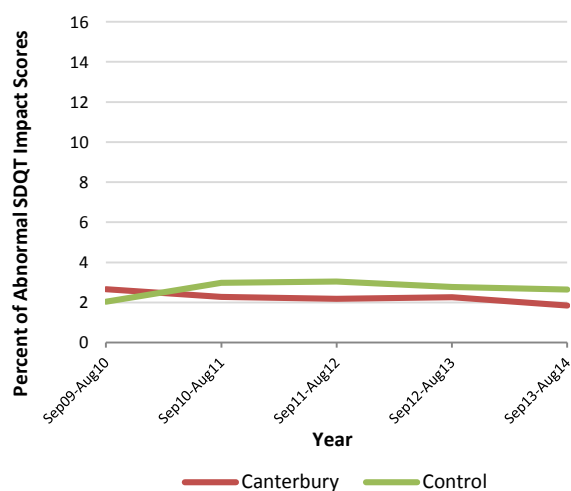


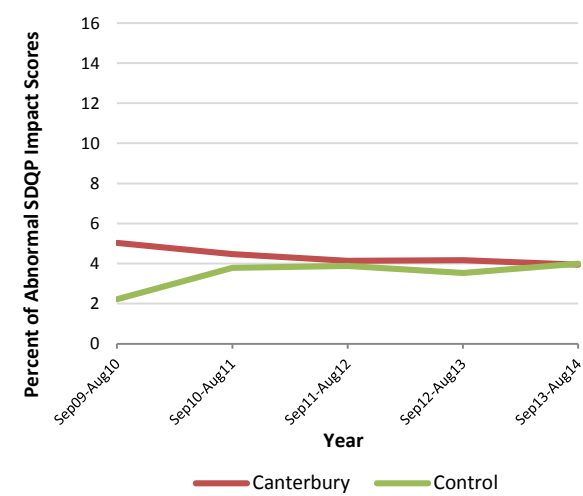
Figure 20 Percentage of abnormal teacher-reported SDQT impact scores over time in the Canterbury DHB Group and the Comparison DHB Group



The percent of abnormal SDQT externalising scores in the Canterbury DHB Group is trending differently to the percent of abnormal externalising scores in the Comparison DHB Group. The proportion of abnormal SDQT externalising scores is reducing over time in the Canterbury DHB Group (8.87% to 6.99% over five years, or approximately -0.38% per year), whereas the proportions of abnormal externalising scores in the Comparison DHB Group have shown an overall decrease during the same time period but with greater fluctuation and to a greater extent (12.70% to 9.72% over five years, or approximately -0.60% per year).

The percent of abnormal SDQT impact scores in the Canterbury DHB Group is trending differently to the percent of abnormal impact scores in the Comparison DHB Group. The proportion of abnormal SDQT impact scores is reducing over time in the Canterbury DHB Group (2.66% to 1.85% over five years, or approximately -0.16% per year), whereas the proportions of abnormal impact scores in the Comparison DHB Group have shown overall increases during the same time period (2.03% to 2.65% over five years, or approximately 0.12% per year).

Figure 21 Percentage of abnormal parent-reported SDQP impact scores over time in the Canterbury DHB Group and the Comparison DHB Group



The percent of abnormal SDQP impact scores in the Canterbury DHB Group is trending differently to the percent of abnormal impact scores in the Comparison DHB Group. The proportion of abnormal SDQP internalising scores is reducing over time in the Canterbury DHB Group (from 5.03% to 3.95% over five years, or approximately -0.22% per year), whereas the proportions of Comparison DHB Group have shown overall increases during the same time period. The Canterbury DHB Group has a higher proportion of abnormal scores over time is only over-taken by the Comparison DHB Group’s proportion in the last year of study (2.22% to 3.99% over five years, or approximately 0.35% per year).

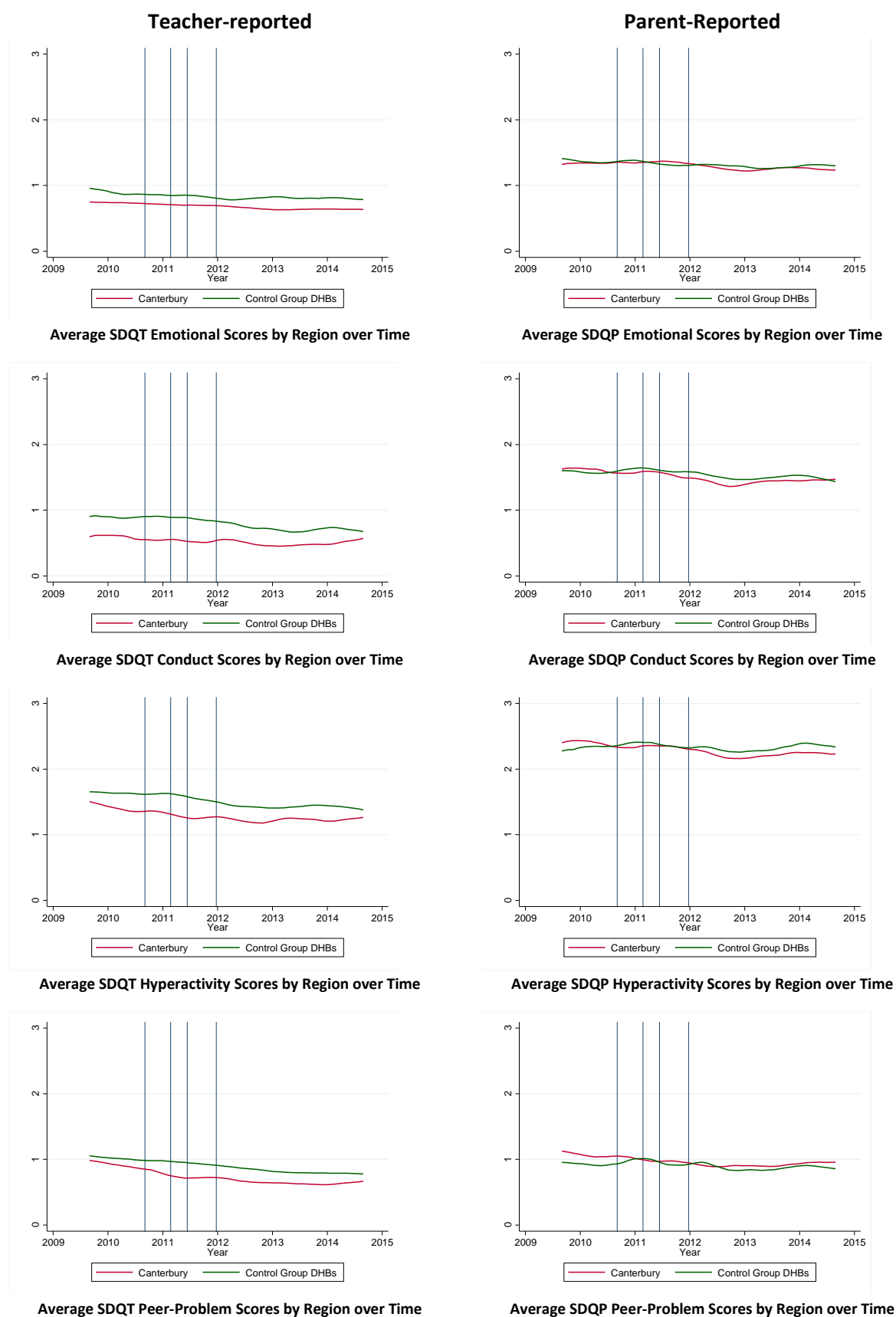
5.6 *Auxiliary Results*

5.6.1 SDQ Subscale Scores

5.6.1.1 *Means*

SDQ subscale score averages in the Canterbury DHB Group and the Comparison DHB Group regions showed similar trends suggesting the absence of an earthquake effect (Figure 22). Mean scores for all SDQ subscale scores across regions showed either slight downwards trends or stability over time. Average SDQT scores for each subscale were generally lower and more regionally variant than their respective SDQP scores.

Figure 22 Mean emotional, conduct, hyperactivity and peer problem scores by informant, region and time.

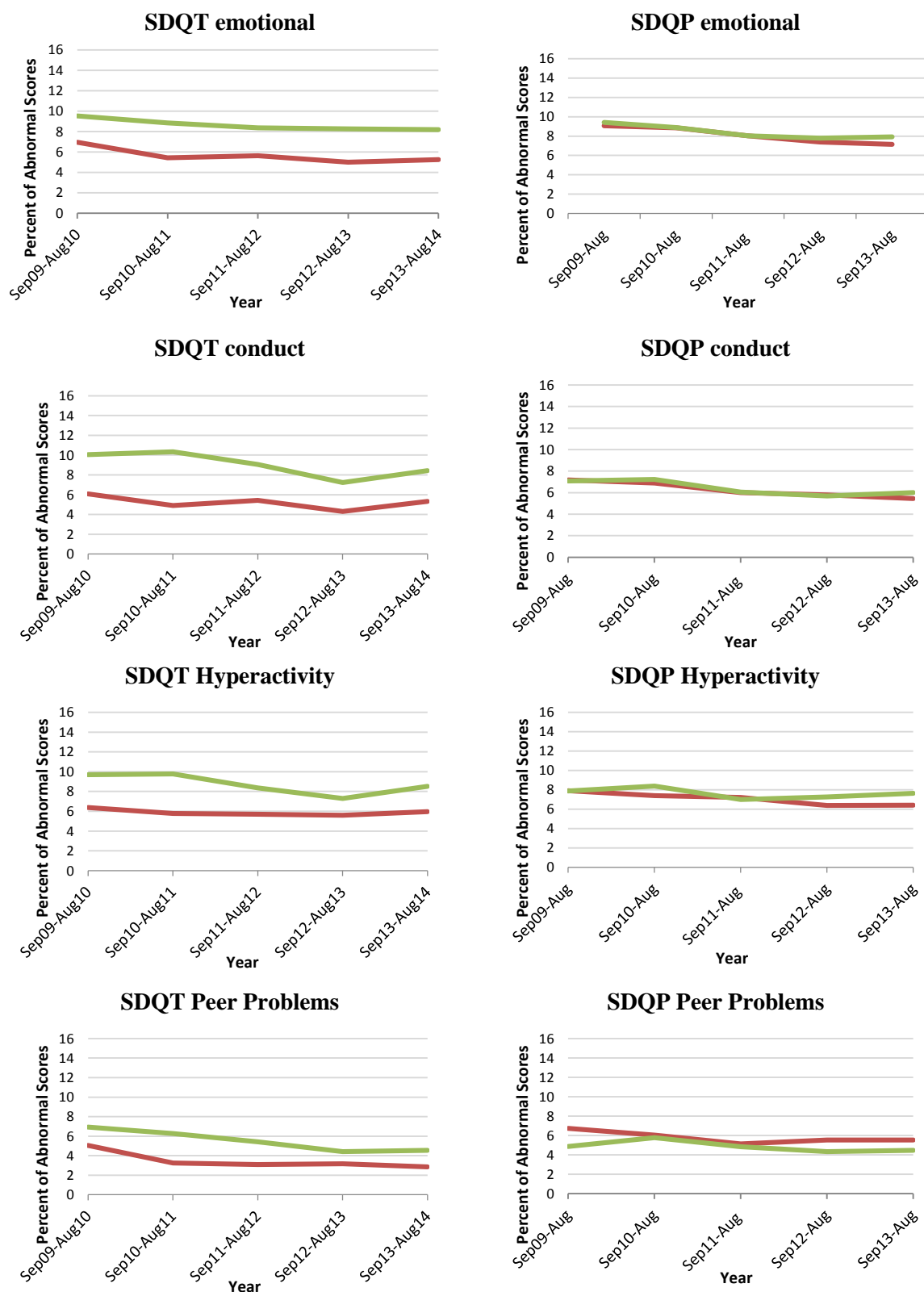


5.6.1.2 Proportions

The proportions of abnormal subtest scores that make up the total difficulties scores did not appear to show any important earthquake effects but rather all followed similar trends to the total score trends (Figure 23). Both regions showed generally similar downward or static trends for each subscale. The proportions of abnormal SDQT scores for each subscale generally showed greater variability by region than did their respective SDQP scores.

Figure 23 Percent of abnormal teacher- and parent-reported sub-scale SDQ scores by region and year. The X axis shows time broken into study years each beginning on 01 September and ending 31 August. The Y axis shows the percentage of children who received an abnormal score for each time period.

● = Canterbury DHB Group ● = Comparison DHB Group



5.6.1.3 Summary

Neither mean nor proportion of abnormal subtest scores appeared to show any important earthquake effects but rather all followed similar trends to the total score trends.

5.6.2 Trends in abnormal and borderline scores

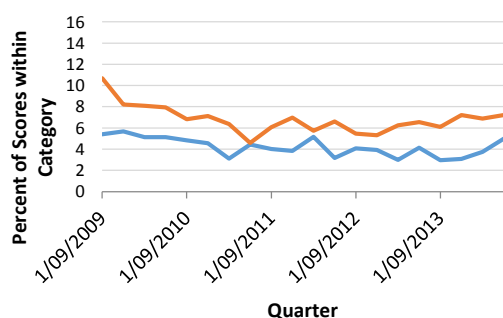
In the main analysis, scores were dichotomised into ‘abnormal’ and ‘not abnormal’ categories. This was done to simplify analysis; however, this is a slight misrepresentation of how the SDQ is used in practice. In their use in the B4 School Check, SDQ scores can be categorised as ‘normal’ ‘borderline’ or ‘abnormal’. In order to check that an important change in trends had not been missed by omitting the ‘borderline’ category from descriptions, the percent of scores within each of the increased risk categories for the SDQ total scale were plotted (see any acute effect was not lost.

Figure 24). In doing this, it was found that the prevalence of abnormal and borderline scores in the Canterbury DHB Group showed similar trends over time compared with other studied regions, suggesting a lack of evidence for an earthquake effect on ‘borderline’ scores. For this analysis, data were divided by quarter years rather than full years to ensure that any acute effect was not lost.

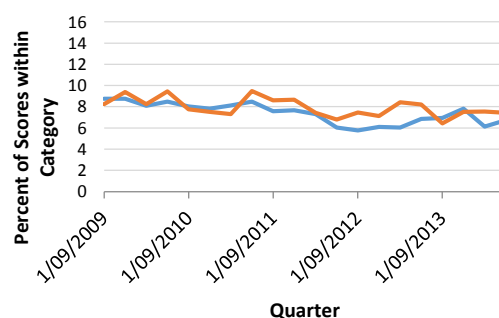
Figure 24 Proportions of borderline and abnormal scores over time by region and informant. X axis shows time as quarter years with quarter 1 being 01 September 2009- 01 December 2009. Y axis shows the percentage of children who received each category of score for each time period.

● = Abnormal ● = Borderline

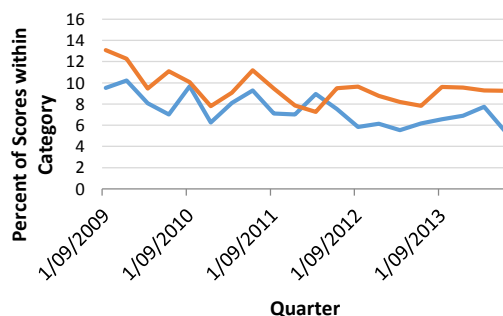
Canterbury DHB Group SDQT Total Scores



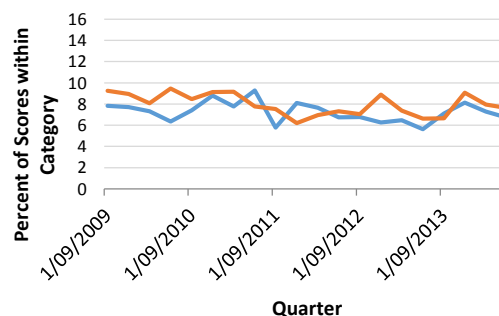
Canterbury DHB Group SDQP Total Scores



Comparison DHB Group SDQT Total Scores



Comparison DHB Group SDQP Total Scores



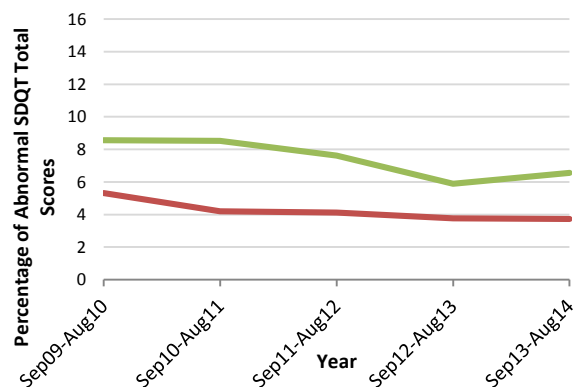
5.6.3 Trends in Scores within at-risk populations

Considering the disproportionate effect disasters can have on more vulnerable populations as noted in the literature, there was a need to investigate whether an earthquake effect could be found in some of these groups within our sample. It was found that although children of high deprivation status and non-NZ European ethnicity showed slightly different prevalence trends in abnormal scores, trends in the Canterbury DHB Group did not notably differ from corresponding trends in other studied regions suggesting the absence of any earthquake effect here too. Only total scores have been presented here but all other outcome variables supported this finding also.

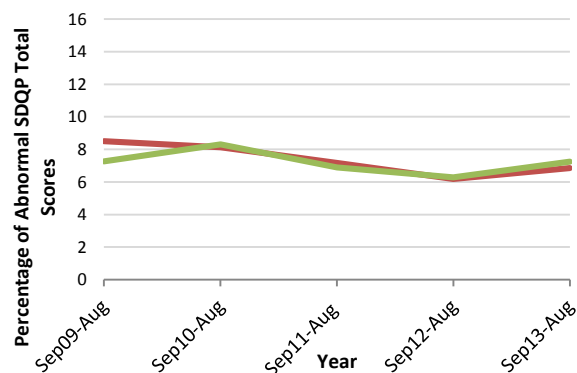
Figure 25. Proportions of abnormal scores over time by region and informant for higher-risk sub-populations. The X axis shows time broken into study years each beginning on 01 and ending 31 August. Y axis shows the percentage of children who received an abnormal score for each time period.

● = Canterbury DHB Group ● = Comparison DHB Group

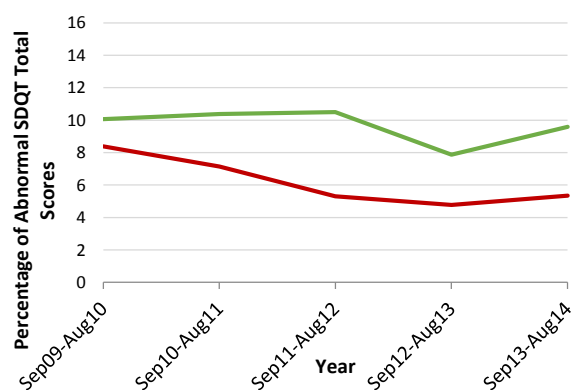
Percentage of Abnormal SDQT Total Scores by Year



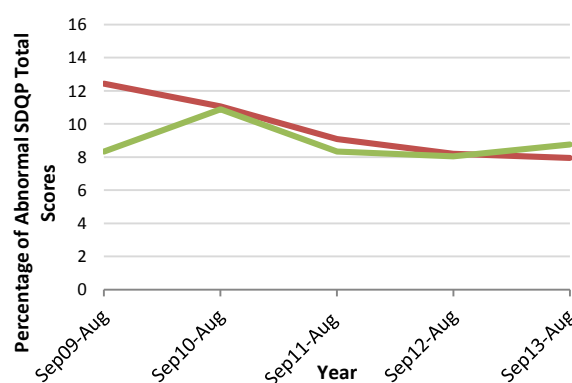
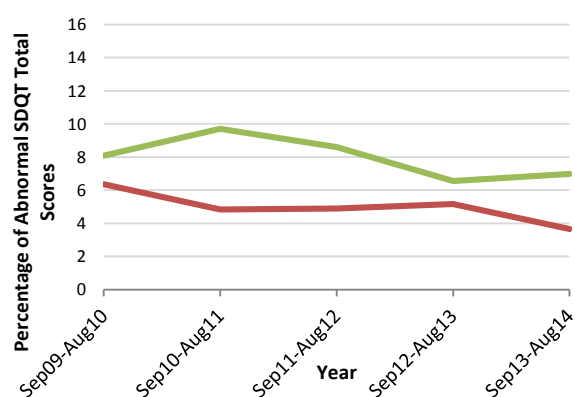
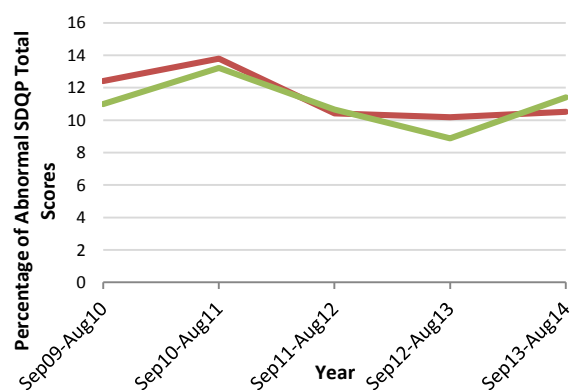
Percentage of Abnormal SDQP Total Scores by Year



High Deprivation Participants' Percentage of Abnormal SDQT Total Scores by Year



High Deprivation Participants' Percentage of Abnormal SDQP Total Scores by Year



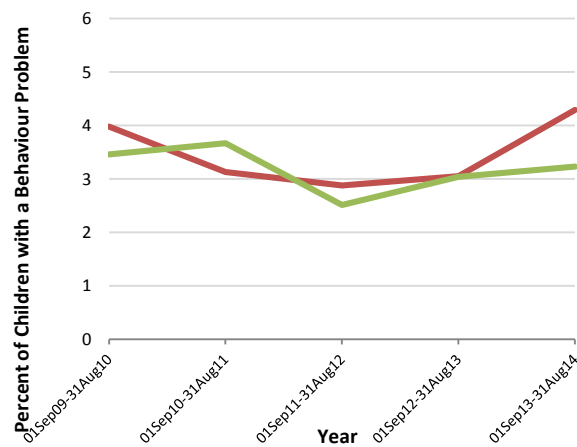
5.6.4 PEDS results

The proportions of children with reported behaviour and relationship problems as reported in the PEDS form were low (~3-4% and ~1-2% respectively). Further, there was no clear earthquake effect that could be seen for either measure.

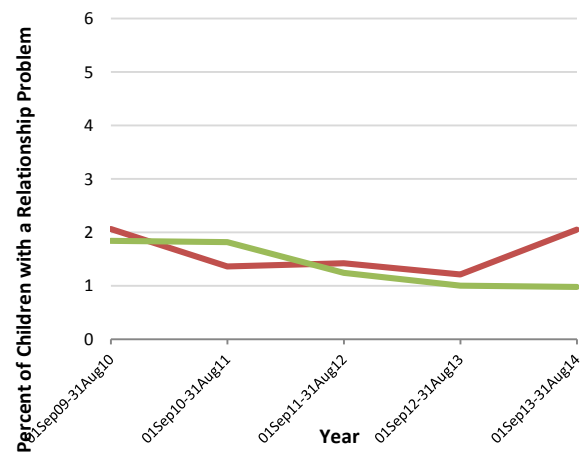
Figure 26 Selected results from PEDS graphed over time

● = Canterbury DHB Group ● = Comparison DHB Group

Percent of Children with a Reported Behaviour Problem by Year



Percent of Children with a Reported Relationship Problem by Year

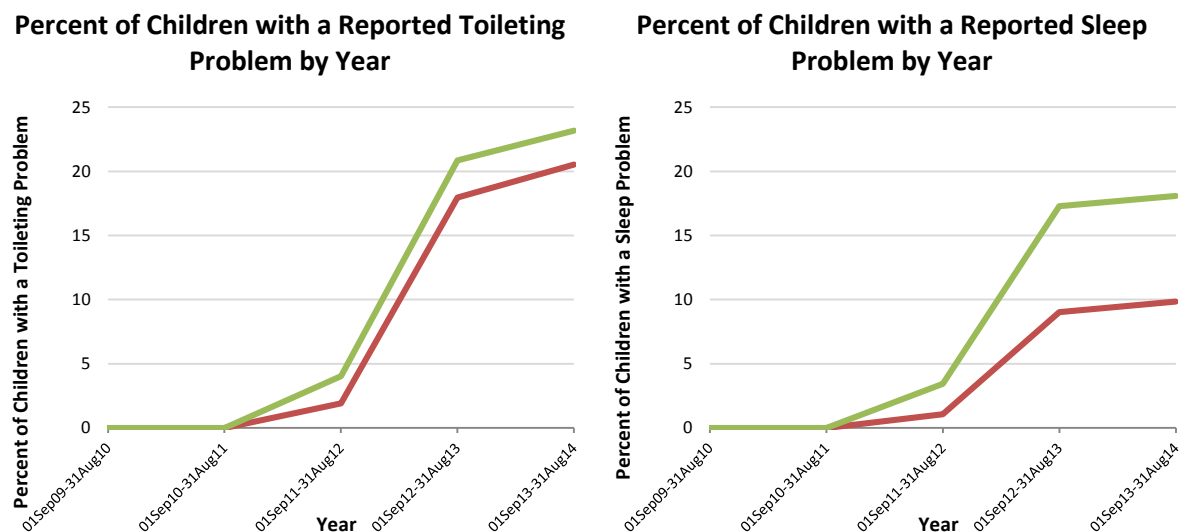


5.6.5 CHQ Results

Responses to the Child Health Questionnaire (does the child have a toileting, sleep problem) are coded as either yes or no: there is no "missing" option. It appears that this measure was introduced partway through our study period as no positive results are recorded in the first study year. As such it is impossible to make any inference about any possible earthquake effect.

Figure 27 Selected results from CHQ graphed over time

● = Canterbury DHB Group ● = Comparison DHB Group



6 Discussion

The purpose of this study was to examine whether any effect on psychosocial wellbeing as a possible reaction to the Canterbury earthquakes could be evidenced among successive cohorts of 4-year-olds living in the region by using data collected as part of the B4 School Check programme.

6.1 Summary of key results

Overall, no evidence of a negative earthquake effect on child SDQ scores was found. Mean population scores and the proportion of abnormal scores in the population over time both decreased on all measures over the study period. This indicates that since September 2009 the prevalence of emotional and behavioural problems in 4-year-olds in Canterbury has decreased.

In order to investigate whether changes over time were specific to this region, or were in fact representative of a general downwards trend in emotional and behavioural problem prevalence more generally, we compared Canterbury trends with those of a control group. Five of the eight outcome variable trends were not statistically significantly different compared to control group trends, indicating that this decrease in morbidity is not specific to the Canterbury context. For the three outcomes where a significant difference was found, it did not appear that the occurrence of the earthquakes had caused a negative impact on trends compared with the control group.

Table 21 Summary of key results

	SDQT	SDQP
SDQ Total Score	No difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Mean scores and the proportion of abnormal scores are declining in Canterbury.	No difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Mean scores and the proportion of abnormal scores are declining in Canterbury.
SDQ Internalising Score	No difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Mean scores and the proportion of abnormal scores are declining in Canterbury.	No difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Mean scores and the proportion of abnormal scores are declining in Canterbury.
SDQ Externalising Score	Difference found between the Canterbury DHB Group trend	No difference found between the Canterbury DHB Group

	and the Comparison DHB Group trend. Canterbury is trending downwards over time at a slower rate than the control group. Mean scores and the proportion of abnormal scores are declining in Canterbury.	trend and the Comparison DHB Group trend. Mean scores and the proportion of abnormal scores are declining in Canterbury.
SDQ Impact Score	Difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Canterbury is trending slightly downwards over time whereas the control group goes slightly up. Mean scores and the proportion of abnormal scores are declining in Canterbury.	Difference found between the Canterbury DHB Group trend and the Comparison DHB Group trend. Canterbury is trending slightly downwards over time whereas the proportion of abnormal score in the control group goes up. Mean scores and the proportion of abnormal scores are declining in Canterbury.

The statistical analysis identified that the following outcome variables are trending differently in the Canterbury DHB Group compared with the Comparison DHB Group:

- SDQT proportion of abnormal externalising scores ($p=0.04$)
- SDQT proportion of abnormal impact scores ($p=0.01$)
- SDQP proportion of abnormal impact scores ($p<0.001$)

The other five outcome variables which were statistically analysed showed no significant evidence of any potential earthquake effect. Analyses of supplementary outcomes supported the main findings.

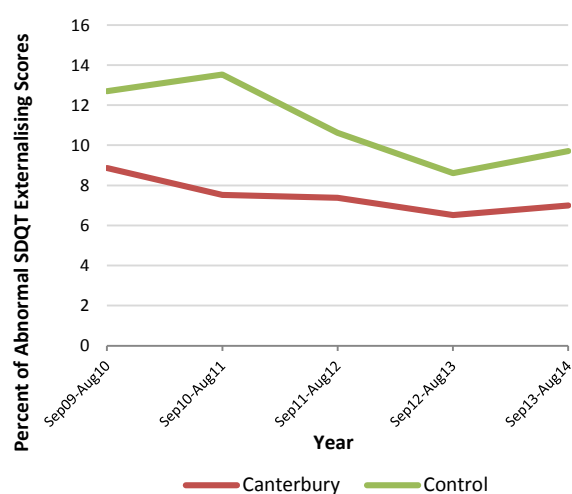
By examining whether trends in the exposed group differed from trends in a control group, we could gather evidence for or against the hypothesis that the Canterbury earthquakes have altered the psychosocial wellbeing of resident children.

By using the Comparison DHB Group as a control for the Canterbury DHB Group trend, we are inferring that had the earthquakes not occurred in Canterbury, we would have expected the trends in the Canterbury DHB Group to not be statistically significantly different to those in the Comparison DHB Group. The implication of this in light of our results is that the occurrence of the Canterbury

earthquakes caused children in Canterbury to become less likely to have an abnormal SDQT externalising, SDQT impact, or SDQP impact score than if the earthquakes had not occurred. Further, the trends in the other five major outcomes were not statistically significantly impacted by the occurrence of the earthquakes. Stated another way, at the population level, the earthquakes either had no effect, or had a positive effect on how exposed children scored on the SDQ section of the B4 School Check.

Let us examine the plotted data of the variables which evidenced an effect:

Figure 28 Percentage of abnormal teacher-reported SDQT externalising scores over time in the Canterbury DHB Group and the Comparison DHB Group



The percent of abnormal SDQT externalising scores in the Canterbury DHB Group is trending differently to the percent of abnormal externalising scores in the Comparison DHB Group. The proportion of abnormal SDQT externalising scores is reducing over time in the Canterbury DHB Group (8.87% to 6.99% over five years, or approximately -0.38% per year), whereas the proportions of abnormal externalising scores in the Comparison DHB Group have shown an overall decrease during the same time period but with greater fluctuation and to a greater extent (12.70% to 9.72% over five years, or approximately -0.60% per year).

Figure 29 Percentage of abnormal teacher-reported SDQT impact scores over time in the Canterbury DHB Group and the Comparison DHB Group

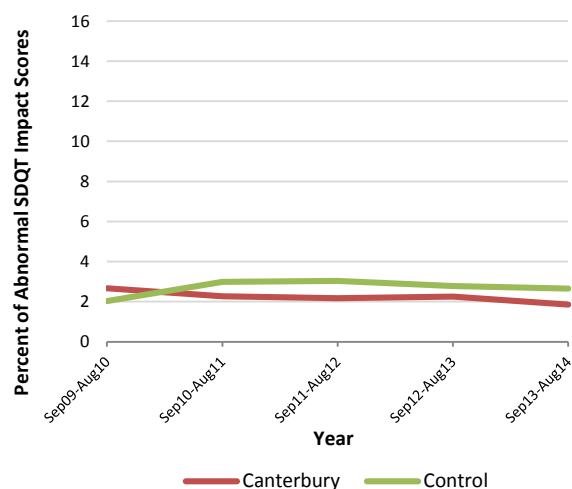
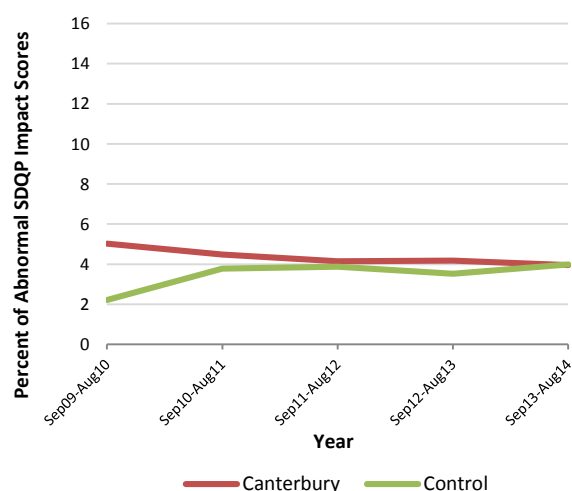


Figure 30 Percentage of abnormal parent-reported SDQP impact scores over time in the Canterbury DHB Group and the Comparison DHB Group



The percent of abnormal SDQT impact scores in the Canterbury DHB Group is trending differently to the percent of abnormal impact scores in the Comparison DHB Group. The proportion of abnormal SDQT impact scores is reducing over time in the Canterbury DHB Group (2.66% to 1.85% over five years, or approximately - 0.16% per year), whereas the proportions of abnormal impact scores the Comparison DHB Group have shown overall increases during the same time period (2.03% to 2.65% over five years, or approximately 0.12% per year).

The percent of abnormal SDQP impact scores in the Canterbury DHB Group is trending differently to the percent of abnormal impact scores in the Comparison DHB Group. The proportion of abnormal SDQP internalising scores is reducing over time in the Canterbury DHB Group (from 5.03% to 3.95% over five years, or approximately -0.22% per year), whereas the proportions of the Comparison DHB Group have shown overall increases during the same time period. The Canterbury DHB Group has a higher proportion of abnormal scores over time, which is only over-taken by the Comparison DHB Group's proportion in the last year of study (2.22% to 3.99% over five years, or approximately 0.35% per year).

Across each of the outcomes that showed statistically different trending in Canterbury compared with the Comparison DHB Group, a major commonality is that between the first and second year, the proportion of abnormal scores in Canterbury DHB Group is decreasing, while in the Comparison

DHB Group it is increasing. This factor may explain the statistically significant difference in trends found in each of the outcomes. This time period coincides with the onset of the Canterbury earthquakes, suggesting that the disaster situation in Canterbury may have contributed to this change in trends.

In summary, the findings from the current study suggest that the experience of the Canterbury earthquakes among young resident children had no negative, and possibly a slight positive effect on how these children scored across a range of emotional and behavioural wellbeing measures.

6.2 Possible explanations for the findings

6.2.1 True result

Optimistically, it may be that our findings of no negative impact from the Canterbury earthquakes on the local child population's measure of psychosocial wellbeing reflect a true situation. In other words, we have found no evidence for a negative effect because there was no net negative effect on the population for the variables that we studied.

6.2.1.1 Resilience

A possible explanation for the maintenance of wellbeing in the child population following the Canterbury earthquakes is resilience. Resilience has been defined as “the capacity of a dynamic system to withstand or recover from significant challenges that threaten its stability, viability, or development” (Ann S. Masten, 2011). Let us explore some of the mechanisms by which the process of resilience may have led to our findings.

6.2.1.1.1 Community wellbeing was promoted

Some evidence suggests that in the wake of the disasters, residents found support from one-another through community. A study of six affected communities in Canterbury found that “social connectedness and a sense of community clearly supported community resilience” in the wake of the disasters (Thornley et al., 2015). A range of support systems were quickly made available within the community to promote wellbeing and recovery. Although these were not necessarily targeted at young children, they may have benefitted them indirectly by supporting the people who support them (Terranova et al., 2015). An example of how this may have worked is social network theory, that is, post-traumatic resilience may spread person-to-person through social ties within the family and community (Alisic et al., 2011). In other words, resilience may be ‘contagious’ and our results reflect a community-wide infection of resilience.

6.2.1.1.2 Cultural explanations

While many international studies have found that disaster exposure can cause a detrimental effect on child wellbeing, there is no available literature specific to children of the New Zealand culture. It may be that no negative effect from the disaster was found on local children because young New

Zealanders show particularly high resilience. It has been demonstrated that perceptions of traumatic events and how they are processed differs by culture (Thabet et al., 2006). The New Zealand parenting style may be particularly promotive of child resilience. A non-disaster-related study of behavioural disorders in New Zealanders aged 2-5 years has revealed that a lower threshold on the CBCL tool is required for New Zealanders compared to other countries in order to capture the true prevalence of behavioural disorders. This is despite the prevalence of disorder being similar across comparison regions (Pavuluri et al., 1995). The authors suggest that this may be because “parental perception, based on the cultural expectations of New Zealand society, is more permissive, or that parents are better educated and therefore either more tolerant or able to manage better, with fewer problems.” This may be an indication of cultural resilience which may in turn partially explain the results of the current study.

6.2.1.1.3 The nature of the earthquake series

One study considering psychological measures of youth exposed to two separate hurricane events suggests that experiencing a lower-impact disaster sometime after experiencing a similar higher impact disaster may change the way the initial disaster is remembered, helping to prevent negative outcomes by re-programming the memory of how bad the worst event was to make it seem not as bad (Weems et al., 2014). This idea is analogous to exposure-based fear therapy, and may help to explain how children in Canterbury may have showed resilience. Because Cantabrians were exposed to many thousands of earthquakes, the majority of which did little or no damage, the reactions to memories of the worst earthquakes may have been dulled. By being exposed to many ‘safe’ earthquakes, children may have processed and conceptualised their experiences of the ‘unsafe’ earthquakes in a less extreme manner than they would have had they only experienced the worst events.

6.2.1.2 The studied children may have been too young or the exposure not severe enough to cause problems

While effects on psychosocial wellbeing from trauma exposure among very young children have been demonstrated, there may be a certain qualitative or quantitative value to the traumatic exposure that must be reached in order for negative impact to arise. The children in the current study were 4 years old or younger at the time of the earthquakes, with the youngest being new-borns. The developmental capacity to have a lasting traumatic response to earthquakes at these ages may not be present. If this were true, one would expect to see effects in older children only, or in cases of very extreme exposure only.

6.2.1.3 Effect on non-studied measures only

Previous disaster studies have found that measurements of broad psychopathology (such as were examined in the current study) may show less pronounced effects than measurements on specific symptomatology, such as that which is rated in the diagnosis of PTSD (Ayub et al., 2012). Although a useful tool for investigating general mental wellbeing of children, the SDQ is not designed to identify

specific psychopathology. It may be that the results produced in the current study regarding the mental health impact of the earthquakes are due to which questions were asked, rather than whether or not earthquake-related problems were present.

6.2.2 Other explanations

While it is possible that the current results are fully explained by the above interpretation, it is important also to consider other explanations as partial or full reasons for having found these results.

6.2.2.1 Chance

By creating statistical models based on available data and then comparing them with the plotted data, it was possible to assess what role chance may have played in producing the current findings. As the statistical models closely match the plotted data, one can be largely confident that chance is not a likely explanation for the patterns found in the data. Further, the large population sample size reduces the likelihood that chance alone would explain our findings.

6.2.2.2 Bias

Bias occurs when there is a systematic difference between study measurements and the true population values. Biases that could possibly contribute to explaining the results of the current study are discussed.

6.2.2.2.1 Problems with SDQ that may have caused bias

6.2.2.2.1.1 Lack of norms

New Zealand-specific norms for the SDQ are not used in the B4 School Check. However, the current study was able to use the results from a recently conducted normative study of the SDQ in New Zealand to determine nationally-relevant cut-off points for the SDQ scales. Unfortunately, these cut-off points were determined by attempting to split population data so that the ratio of normal: borderline: abnormal would be 80:10:10 as per Goodman's recommendation. While this is a useful guide, it assumes that there will always be a roughly 10% prevalence of emotional and behavioural psychopathology amongst the local child population. It would be more correct to gain a population-specific average prevalence using a gold-standard screening tool (perhaps a diagnostic interview) and then determine cut-off scores based on this. Previous research, (Usami et al., 2014), has been able to consider post-disaster measures in the context of well-established national norms. This allows for comparison of the rates of abnormal scores amongst the exposed population to a baseline norm distribution. As a result of the lack of high-quality national norm and baseline data in New Zealand, bias may have arisen in the current study whereby outcome was systematically misclassified. This would be a particularly important problem if norms and baselines are differential by region.

6.2.2.2.2 Problems with B4 School Check that may have caused bias

6.2.2.2.2.1 Performance bias

At the beginning of the study, the B4 School Check had only recently been introduced. As a result, the nurses who administer the check had only recently been trained, and had little practice in administering the check. As nurses became more experienced at administering the test, they may have altered subtle aspects of their technique, potentially altering some trends in outcomes. This would particularly be an issue if the turn-over rate of administrators was significantly different in different regions.

6.2.2.2.2.2 Procedural bias

A number of procedural biases may have impacted the results of the current study. Firstly, time pressure put on nurses and/or parents during the administration of the check may differ by region, affecting how outcome questions are responded to. Secondly, in regions where there is a feeling of drudgery or mistrust about doing the check, nurses and parents may not put in the same effort in answering as in other regions. Thirdly, since its inception in 2008 the B4 School Check has been contracted out to different providers within each region and, as a consequence, is delivered by nurses with varying degrees of paediatric experience and training. Each of these issues may systematically alter outcome measurements from their true values, and thus are potential biases.

6.2.2.2.2.3 Missing data

Due to the use of a pre-collected database in this study, there is little that could be done about the high level of missing data. In particular, the teacher-reported measures were deficient, with up to a third of data points missing. Further, it appears that the control group had issues with ensuring completion of the impact section of the SDQ during the first two study years as these also have very high proportions of missing data. It is interesting to note that the outcomes for which a significant difference in trend was found were also all outcomes with a great deal of missing data. This presents a significant potential for bias and error to be contributing to the possible explanation of results. If the reason for SDQ incompleteness was also linked with either severity of disaster exposure, or the presence of emotional and/or behavioural symptoms, then the missing data may have contributed to producing results differing from the ones found in the current study, had they been available. Indeed, if the missing data represented information about children at higher-than-average risk for emotional and behavioural problems, then this may explain why evidence was found of a positive earthquake effect in the difference between trends. If this is true then in fact the positive earthquake effect found in the sample was due to having a non-representative sample, not due to a positive impact that disaster exposure had on children.

6.2.2.2.2.4 Lack of teacher forms

Having both the parent- and teacher-rated SDQ forms is important for the sensitivity of the tool because psychosocial problems may be highly situational (Stone et al., 2010). Inquiry has been made into why the SDQT is so frequently incomplete (S. J. Williams, 2013). Williams (2013) found that B4 School Check providers reported a number of issues explaining why the teacher response was so low. Firstly, some children do not attend a formal early childhood education centre, making it impossible for these children to have a teacher answer questions about them. Secondly, not all early childhood education centres were supportive of the B4 School Check and declined to fill in the SDQ form. Thirdly, one participant deemed the use of the SDQT unnecessary and did not actively encourage parents to have it completed. Given that the psychometrics of the SDQ are based on high quality, complete data, and that the database used in the current study lacked a significant amount and possibly a diminished quality of data, one must accept that the SDQ is unlikely to have functioned optimally in the current study, thus introducing a substantial risk for bias.

6.2.2.2.2.5 Change in SDQT impact measurement

Since the introduction of the B4 School Check, the MoH has changed the way that they record impact data for the teacher version of the SDQ. Originally, all four impact questions were asked of both the parents and teachers. However, at some point, two of the questions were dropped from the teacher version. All SDQT impact scores were analysed based on a two-question scoring system so that there was consistency across time. However, it is necessary to consider how dropping those two questions may have affected the way teachers respond to the impact supplement. It may be that the trends in SDQT impact score are partly explained by the change in procedure.

6.2.2.2.2.6 Inadequate training

There is some evidence to suggest that training for B4 School Check providers is inadequate in some cases (S. J. Williams, 2013). If training is provided differently by region then this introduces a possible source of bias to the current study.

6.2.2.2.2.7 Interviewer bias

Interviewer bias occurs when knowledge of the participants' exposure or outcome status affects the data collected. In this case, the B4 School Check provider is likely privy to the child's exposure status, that is, they know whether the child was in Canterbury during the earthquakes. Having this knowledge may cause them to be more likely to encourage particular answers from parents and teachers, thus creating a bias. Ideally assessors would be blinded to the exposure status of a participant.

6.2.2.2.2.8 Response bias

Similarly to interviewer bias, response bias occurs when the informant provides a slightly more positive or negative view of the child because of motivations linked to their exposure status. Although

good evidence suggests that parents generally underreport children's symptoms, the factors that play a role in influencing this underreporting are unknown (Alisic et al., 2011). Examples of how underreporting may come about include informants giving responses that they think the interviewer wants to hear, or a disinclination to give socially unacceptable answers. These issues can be symptoms of wider community prejudice or discrimination. If exposure status affects how response biases occur in the current study, then it is possible that a bias towards underreporting may partially explain the results found in the current study.

6.2.2.2.3 Problems with study design that may have caused bias

6.2.2.2.3.1 Misclassification of exposure

While the current study design permitted for a particularly high rate of uptake compared with most other disaster studies, there remain a number of limitations to our sampling strategy that may have resulted in bias.

Ultimately the intention had been to assess how earthquake exposure impacted measures of wellbeing, but as data on the exposure status of children was not available, the proxy measure of having a B4 School Check done in the Canterbury DHB was used to indicate that a child was exposed. This is clearly a very coarse classification system. Many other studies on disaster populations categorise exposure continuously by using measurement tools to assess level of exposure to disaster-related events. Much has been written about which specific exposure characteristics may increase or decrease the likelihood of resultant problems (Furr et al., 2010). It is possible that there are specific disaster-related factors that are not experienced by everyone in a disaster that moderate the coping pathway. For example, if it were feasible to divide the exposed group into those who had high levels of exposure (e.g. had a building collapse around them, or saw a dead body) and those without high levels of exposure, different trends might have been observed between these groups. Whilst this is an interesting angle on the topic, it would not address the study aim of the current study, which was to assess whole-of-population effects.

Not only was the classification system coarse, it was also error-prone. Just because a child had a B4 School Check done in Canterbury, does not mean that they were present in Canterbury during the earthquakes. They may have been present for all, some or none of the disaster sequence. And just because a child had their B4 School Check done in one of the control group DHBs, does not mean that they were not present in Canterbury during the earthquakes. If this source of error was random then it does not introduce a significant threat to the validity of the study. However, it is plausible that children who were most affected by the earthquakes may be less likely to be in the exposure group of the study. This may be because they didn't have their check done or because they moved away from Canterbury, possibly to one of the control regions, thus further biasing the sample.

6.2.2.3.2 Misclassification of outcome

Aside from limitations specific to the SDQ, misclassification of outcome in our sample may have been introduced due to the difficulties inherent in assessing 4-year-olds due to the variable nature of ‘normal’ behaviour in their developmental stage. In the lack of strict criteria to inform what should be reported on or not, if exposure status or location affects how ‘lenient’ a reporter is on what is ‘acceptable’ behaviour at age 4, then a result due partially due to bias may be seen. Williams’ 2013 study corroborates this point as she reports that nurses who administer the B4 School Check often found that there was “a difference in what one parent would consider ‘normal’ and acceptable behaviour for their child compared to another parent with a similar age child” (S. J. Williams, 2013)

6.2.2.3 Confounding

Confounding occurs when a spurious association is made at the analysis stage between outcome and exposure which, in reality, results from a secondary exposure that was not included in the analysis. An attempt to control for confounding in the design and analysis stages was made by matching the control group as closely as possible to the exposed group and also by adjusting for child demographic features (age, sex, ethnicity and SES). Despite these efforts, it is possible that there may be residual confounding.

6.2.2.3.1 Problems with SDQ that may have caused confounding

6.2.2.3.1.1 SDQ not designed for use in a disaster situation

The SDQ was not designed for use in a disaster situation, however, the choice of measurement tool plays an important role in determining the findings of a youth disaster mental health study (Furr et al., 2010).

6.2.2.3.1.2 Scores are reliant on the subjective opinions of external, untrained raters

While potential confounders were controlled for where possible, there are no data available regarding the demographic characteristics of the parents and teachers who rated the children in the study. Due to this, it was not possible to investigate whether informant age, race, sex, level of education or any other characteristic may explain a portion of how they perceive the children in their care. To address this, an attempt was made to match as closely as possible the gross-level population characteristics in the exposed and control groups using census data. It is however highly possible that residual confounding remains.

Similarly, parents and teachers may base their views and reports on the wellbeing of children within the context of their experiences. If this is the case, then it may be that negative outcomes are underreported in the exposed population because informants believe these problems to be ‘understandable’ considering the child’s exposure and thus unnecessary to report.

Lastly, the exposure status of parents and teachers may affect how they perceive the wellbeing of the children they rate. Since exposed children are likely to be rated by exposed adults, the effect that is

seen may actually reflect how adult exposure affects perception of child problems, rather than an objective measure of child problems. A meta-analysis of post-disaster youth PTS studies found that: “a small-to-moderate effect of disasters was found among studies relying on child-report data ($r = .20$, $p < .0001$), whereas studies relying on parent-data did not collectively find a significant effect of disasters” (Furr et al., 2010). It is possible that child emotional and behavioural problems in the wake of a disaster may manifest largely without parents’ and teachers’ awareness. Amongst older age groups where self-rating is possible (children answer SDQ questions about themselves), a consistent finding has been that children identify greater difficulties in themselves than do parents or teachers (Stone et al., 2010). This may indicate that a substantial portion of morbidity has not been identified because the measurement of outcome was based on the reports of external, untrained raters.

6.2.2.3.1.3 Cultural issues

Williams’ 2013 study of the use of the SDQ as part of the B4 School Check in New Zealand reported that “The participants readily identified that there appeared to be differences in the perceptions of the cultural norms of behaviour for children aged 4 years” (S. J. Williams, 2013). She supports this argument by pointing to a review study by Woerner, Fleitlich-Bilyk, Martinussen, Fletcher and Cucchario (2004) who found that cultural tolerance for certain behaviours likely introduced important difficulties for the international use of the SDQ in the absence of culturally specific validation. As culture varies by region, the differences and similarities seen between the trends in the exposed and control groups of the current study may be partially explained by cultural issues and how these may impact perceptions.

Williams (2013) also points out that the SDQ is not available in Mandarin, Samoan, Tongan, or Māori translations, all of which are languages of particular relevance to New Zealand (S. J. Williams, 2013). This language barrier may impose a small confounding effect on our results, although it is not likely to be substantial because the prevalence of English competency in the regions studied is very high.

6.2.2.3.2 *Problems with B4 School Check that may have caused confounding*

6.2.2.3.2.1 Administration problems

A qualitative study investigating seven nurses’ experiences in delivering the B4 School Check in New Zealand found that many participants “admitted to rephrasing questions” or “resorted to changing the terminology and miming in order to explain what certain words or phrases meant” to clarify meaning. Further, it was reported that “without exception new tools had been developed by the participants themselves or their employers that allowed for closer interaction and observation of the child” (S. J. Williams, 2013). These are noteworthy problems that indicate that the reporting of a child on in their B4 School Check is dependent on who administered the check.

6.2.2.3.3 *Problems with study design the may have caused confounding*

6.2.2.3.3.1 Correlational design

Due to the correlational design of the current study, confounding is an unavoidable possibility that must be considered as a causative explanation for results found.

6.2.2.3.3.2 Not comparing the same children over time, possible generational effect

It is possible that trends found in the current study were the result of a generational effect, rather than an effect of disaster exposure. It can be seen in both the exposed and control groups that the distribution of emotional and behavioural problems is changing over time with subsequent cohorts of 4-year-olds. It is beyond the scope of this study to speculate on why this might be occurring, but it is relevant to consider that because the current study compares consecutive cohorts of children, there may be an effect of some aspects in relation to the child's year of birth as a possible contribution to the trends seen.

6.2.2.3.3.3 Between subjects design

The current study employed a between-subjects design as this matched the availability of data (one measurement per child at a single cross-sectional point). However, one meta-analysis of post-disaster youth mental health studies found that: "effect sizes were lower across studies that used between-subjects comparisons ($r = .19$, $SDr = .18$, $p < .001$) than across studies that used within-subjects comparisons ($r = .31$, $SDr = .15$, $p < .001$)" (Furr et al., 2010). Had multiple measurements from each child been taken over time instead and compared the trends of exposed children with unexposed children, differing results may have been found.

6.2.2.3.3.4 Time effects

For the purposes of the current study, it was most practical to group time into one year blocks, rather than treating it as a consecutive measure. It may be that this grouping is too coarse and that there is an effect present which is only visible at a less than one-year-follow-up. Furr's (2010) meta-analysis found that "small-to-moderate effects were found among studies conducted <3 months post-disaster ($r = .17$, $SDr = .11$), 3–6 months post-disaster ($r = .19$, $SDr = .16$), and 6–12 months post-disaster ($r = .27$, $SDr = .15$), whereas studies conducted beyond 1 year post-disaster did not collectively find a significant effect. Studies conducted in the first year post-disaster found a stronger effect of disasters on youth PTS than studies conducted beyond one year post-disaster" (Furr et al., 2010). If this is the case, an effect on child psychosocial wellbeing may have been present in Canterbury during and following the earthquakes, but this effect may have resolved quickly and was therefore undetected by the current research.

6.2.2.3.3.5 Categorical outcome

For the purposes of such a large-scale study, it was practical to have a binary outcome. In reality, emotional and behavioural problems exist along a scale; but for simplicity's sake scores were

dichotomised into either the ‘normal’ or ‘abnormal’ score group. As a conservative measure, participants whose score fell within the ‘borderline’ range were classed as ‘normal’. It is possible that through this design decision, some evidence of an effect may have been missed. However, had substantial evidence of an earthquake effect been found, a more nuanced analysis would have been considered; but given the results found, this gross categorisation was satisfactory.

6.2.2.3.4 Other possible confounders

Various studies have researched how individual factors may influence a child’s likelihood of having an adverse psychosocial reaction to a disaster experience. Pre-existing psychopathology, prior traumatisation and parental psychopathology may all play important roles in determining a child’s likelihood of developing emotional and behavioural problems in the wake of a disaster, but could also have been affecting the Comparison DHB Group. However, it is unlikely that these individual-level factors would be likely to have a significant effect on the overall population trends as they would need to be differentially distributed between the exposure groups to act as confounders.

Similarly, evidence exists for a number of positive factors which may help children to better cope with challenging situations such as social support and availability of mental health services. If the presence of any of these positive factors is more common in one of the exposure groups than the other, it is possible that protective confounding has contributed to our findings. Considering that rurality may play an important role in the availability of social support and/or mental health services, and that the rurality profiles of our two exposure groups differ somewhat (despite an attempt to match them), this may be a mechanism for partially explaining the results of the current study.

Furthermore, consideration must be given to whether any intervention action taken in Canterbury following the earthquakes is partially responsible for the findings of the current study. Myriad actions were taken across many sectors with the intention of helping people to cope after the earthquakes. Of course, it is not possible to separate out any effects these programmes may have had. Accordingly, these interventions are an important source of potential confounding in the current study.

Finally, the definition of exposure used in the current study does not take into account how exposure may have occurred in the Comparison DHB Group. Comparison DHB Group trends may be an artefact of other traumatic events. Alternatively, the heavy media coverage of the disaster may have affected children in the Comparison DHB Group. Some disasters did occur within the control region during the study period, such as a coal mining accident which killed 29 men. Traumatic experiences such as these in the Comparison DHB Group may have contributed to deviations within the “unexposed” population. It is possible also that seeing repetitive footage of the devastation caused by the earthquakes may have had a negative impact on children who were not in Canterbury at the time. The limitation of this is that it would suggest that exposure to traumatic events is extremely widespread as most house-holds engage to some degree with the news media.

6.2.2.4 Error

6.2.2.4.1 Mis-coding

Throughout the B4 School Check process there are a number of chances for error by way of mis-recording or mis-coding. Parents, teachers, the administering nurse or the data entry person may all make mistakes in recording or coding responses. Practical limitations such as time- or funding-pressures may exacerbate these errors. Provided that this error does not differentiate by exposure status, it should not introduce a major problem.

6.2.2.4.2 Prosocial scale

The prosocial scale is marked in an opposite direction to the other four scales. It appears that many people administering the SDQ have not realised this and have thus marked a child with no problems as a zero score, which corresponds to major social problems, rather than lack of social problems. Over 50% of children have an abnormal prosocial score, suggesting that this marking is incorrectly completed a significant proportion of the time. This made the prosocial data unworkable as it could not be determined how children had been marked.

6.2.2.4.3 Inverse questions in the SDQ

Similarly with the prosocial scale, some questions are asked inversely and are thus scored inversely, so that rather than assessing a difficulty, the question is posed as a strength. In this case, the marking scale is reversed for the question. The obvious issue with this is that the reversal may not be accounted for when assigning a score for the question, with the administrator marking the question as if it were a difficulty like the rest and thus giving the wrong score. As scores are not available for each individual question, there is not much that can be done about this, however, it ought to be recognised that this phenomena may have added to the noise, dampening extremes and thus obfuscating any signal. This shouldn't be affected by the earthquake (although it is possible that administrators living in the earthquake environment may have been more stressed and thus more likely to make this mistake) and so it is probably more of a source of error than of systematic bias.

6.3 Comparison with expected results from other studies

6.3.1 Findings of similar studies

A full list of related studies with brief descriptive information can be found in the introductory section. Here a selection of the literature containing features of interest are discussed in more detail.

6.3.1.1 Exposed children exhibited greater emotional and behavioural problems than non-exposed children

Most commonly, studies on the psychosocial effects of disaster-exposure on children report that a range of emotional and behavioural problems are commonly seen in disaster-exposed children. Less frequently, studies compare the prevalence of these problems with baseline measures. Four studies with baseline data are summarised below.

1. Swenson et al. (1996) found that 14 months after a hurricane, exposed 2- to 6-year-old children showed significantly greater problems with the following behaviours compared with a non-exposed control group: whining, wanting things immediately, refusing to sleep alone, having trouble going to bed or falling asleep, being fearful without good reason, clinging to adults, hyperactivity, acting younger than formerly for age and being easily startled (Swenson et al., 1996).
2. Burke et al. (1982) studied the parent-rated behaviour problems of preschool children six months before and five months after a major storm and found that problem-behaviour scores for aggressive conduct, externalising, and antisocial measures had worsened over that time period. The sample used in this study limits how generalizable the findings are, however, because the group for which both pre- and post- disaster data were available was made up of only 21 children who were “repeating” a “Head Start” programme.
3. Parental reports of pre-schoolers’ reactions to a hurricane 6 to 8 weeks after the disaster found an increase in both the number and severity of behaviour problems in preschool children, although the severity of these problems did not extend into the clinical range (Sullivan et al., 1991). A major limitation of this study, however, was that measure of both pre- and post- disaster functioning were taken after the disaster had occurred. The implication of this is that a recall bias could potentially explain findings.
4. The study that had the most similar design to the current study that was found within this field was performed by Stuber et al. (2005) who used cross sectional random-digit-dial telephone surveys conducted 11 months before, 4 months after and 6 months after World Trade Centre attacks to assess behavioural problems of 6-17 year old children living in the region. Four months after the disaster, parents reported significantly fewer behavioural problems in their children than they had 11 months prior to the disaster. Pre-disaster levels were re-attained by the 6 month follow-up. For 6- to 11-year-olds, the prevalence of behavioural problems went from 32.0% to 18.7% to 33.1%. A major limitation of this study was that pre-attack data was collected differently from post-disaster data, which may have biased the results (Stuber et al., 2005).

The large quantity of studies reporting emotional and behavioural children following disaster exposure seems persuasive at face-value of the hypothesis that children suffer emotional and behavioural problems as a result of disaster exposure. Upon closer examination, however, the availability of high-quality data implicating a causative effect is low.

6.3.1.2 *Exposed children did not exhibit greater emotional and behavioural problems than non-exposed children*

Occasionally, studies are published in which the findings reveal an absence of evidence to indicate the deterioration in emotional and behavioural wellbeing amongst children exposed to a potentially traumatic disaster. Five such studies are summarised below:

1. Eighteen months after an earthquake in Pakistan, Ayub et al. (2012) used the SDQ to measure emotional and behavioural problems, as well as a PTSD diagnostic instrument amongst 7- to 16-year-old children (Ayub et al., 2012). The proportion of children suffering from emotional and behaviour difficulties was 34.6%, which was not significantly different from the prevalence found in previously conducted studies of non-affected children in the region. Emotional symptoms were more common in girls, compared with hyperactivity symptoms in boys. The rate of psychiatric morbidity due to PTSD was found to be twice as high as the rate of SDQ-measured morbidity. The authors suggest that these findings may indicate that that trauma specifically affects symptoms of PTSD and not emotional and behavioural symptoms as assessed by SDQ. They further propose that community resilience may have explained why broader psychopathology measures in this study did not supersede the normal “non-trauma” level.
2. Langley et al. (2013) studied 4th to 8th grade children in the USA who had been exposed to a hurricane 15 months prior for self-reported depression and PTSD symptoms as well as teacher-reported SDQ measures of emotional and behavioural problems (Langley et al., 2013). A high prevalence of PTSD and depression symptoms were found, but hurricane exposure was not found to be a predictor of these symptoms. Previous trauma experience was the main predictor of psychopathological symptoms. Teacher-rated SDQ data identified a much lower prevalence of difficulties than child-rated PTSD and depression data had. No comparisons were made with a control group, meaning that no evidence of temporality to support causation could be provided.
3. A similar finding resulted from a study by Chemtob et al. (2008) who studied the behavioural problem of children who were under 5 years of age when they were exposed to the World Trade Centre attacks. Eighteen to 54 months after the exposure, parents reported that significant increases in behavioural problems following the disaster were only exhibited the group of children with previous traumatic experience exposure. Children without a prior history of other trauma did not differ in their prevalence of behavioural problems from non-exposed children.
4. Galante and Foa (1986) surveyed approximately 300 1st to 4th grade Italian children who had been exposed to an earthquake to test the hypothesis that the number of children at risk for

developing neurotic or antisocial problems would be positively correlated with the amount of destruction in a region (Galante & Foa, 1986). The hypothesis was not supported: children in differently affected regions showed no significant difference in measures of their risk for developing neurotic or antisocial problems. A treatment intervention was carried out in one region for a year, which resulted in a significant decrease of at-risk scores. Although treatment had a positive effect, the authors concluded that risk was likely more closely related to the length of time each community needed for recovery.

5. Following a hurricane in the USA, Shaw (1993) investigated a range of psychosocial effects on 6- to 11-year-old school children from a highly exposed region compared with children from a school with low exposure in the same county. Pre- and post-disaster data were available for teacher-reported behaviour problems for both schools. Interestingly, disruptive school behaviour showed a significant decrease in prevalence in the grading period immediately following the hurricane in the high-exposure school; but a marked increase in the low exposure school compared with prevalence measures from the school year preceding the hurricane. In the article it is posited that this pattern is “due to a generic shock-like, numbing effect in the immediate aftermath of the hurricane which dampened the behavioural responses to the disaster”. Shaw (1993), however, also investigated PTSD symptomatology and found that endorsement of severe to very severe post-traumatic symptomatology was twice as likely at the high-impact school eight weeks after the disaster. This indicates that the decrease in disruptive behaviours was not necessarily indicative of healthy coping amongst the more highly-exposed children. By 32 weeks post disaster, the levels of post-traumatic symptomatology had significantly reduced from the eight-week measure but still remained high (Shaw, 1993).

While effects of disasters on diagnosable psychopathology symptoms are frequently cited in studies in this field, authors who have attempted to investigate effects on broader emotional and behavioural wellbeing have commonly reported on null results.

6.3.2 Possible explanations for conflicting findings between this study and other studies

6.3.2.1 Unique study design

The current study is unique in its field: no other study that the author knows of has used a repeated cross-section design to analyse pre- and post-disaster, systematically collected screening data to compare trends in the prevalence of emotional and behavioural problems over time in an exposed child population with a non-exposed child population. A major limitation found in most studies in this sector is the absence of a baseline measurement. Studies often aim to describe the prevalence of mental health measures after a disaster, with no reference to what the pre-exposure measures were in

the population. This may be useful in quantifying need in the population, but it does not allow one to draw any inferences about whether disaster exposure is causative. Other studies investigate how risk or preventive factors such as objective measurements of the severity of exposure are associated with outcomes. This is useful in informing how high-risk children might be identified after a disaster, however, it does not necessarily say much about what can be expected at a population level.

6.3.2.2 The differences may be explained by funding and reporting biases

Funding, reporting and publishing biases may be contributing factors explaining why few studies have reported findings similar to the current study. Local governing bodies may fund studies in order to access additional funding to cover post-disaster mental health costs. Researchers will generally favour studies that are likely to show an effect. Disaster-affected populations may call for attention from researchers; however this is only in cases where additional help is needed and scientific evidence could be a political tool. Publishing biases exist: studies with null findings are less frequently published than those with positive findings. Together, these possible biases may have contributed to the dominance of literature that supports the hypothesis that disaster exposure has a negative impact on child psychosocial health.

6.3.2.3 Factors unique to the Canterbury earthquakes may explain why no negative effect was found

As noted by Soeteman et al. (2007) “The problem with research about health problems after disasters is that every disaster is unique and occurs in specific communities in a specific period” (Soeteman et al., 2007). Findings from studies of different disasters seldom report precise consistencies across the range. The variance in the current study’s findings from findings of previous studies may simply be an artefact of the variance between disaster events.

6.3.2.4 Bias and confounding both in the current study and in other studies may explain the findings

Above, an extensive list of possible biases and confounders for the current study are detailed. Similarly, lengthy inventories could be created for all of the other studies in this field. With so many variable factors at play, one simply cannot deduce which findings are most “correct” in terms of their external validity. The only way of addressing this problem is to champion higher quality research with consistency throughout the field.

6.3.2.5 Previous research is reporting on normal, non-pathological reactions to a highly stressful experience

Measurement tools for outcomes in this field vary greatly. Partly this is because of interest in slightly different outcomes (such as diagnosable psychopathology prevalence, or measures of the impact on broader psychosocial wellbeing, such as in the current study). However, even across studies researching the impact of disasters on specific, clearly defined outcomes, the use of multiple different measuring tools can be seen. Consistent use of the best-available tools would greatly reduce this

problem. Nonetheless, a deeper academic question arises: are the disaster-responses seen ones that are causing significant harm and need corrective intervention for best practice, or are they disaster responses that are normal considering the experience and generally non-pathological? What is a meaningful finding in terms of clinical implications? The current study did not find evidence of population-level psychosocial decompensation amongst children. Perhaps the measures used to indicate problems in conflicting studies are in fact reflecting the normal human response to extreme stress. This is a response that in most cases will not cause long-term damage; but is instead a necessary adaptive response for surviving, coping and learning in our unpredictable world.

6.4 Implications

The aim of this study was to expand on the evidence that currently informs our understanding of how natural disasters affect child mental health by investigating the long-term effects of the Canterbury earthquakes and their sequelae on the emotional and behavioural wellbeing of consecutive cohorts of resident children as they turned 4-years-old.

The primary objective was to gain a better insight into the needs of Cantabrian children in the wake of the earthquakes. Speculation regarding the level and severity of the mental health needs of children in the area needed to be addressed as the anecdotal and proxy evidence that had surfaced following the earthquakes was insufficient to adequately inform policy and practice. The current study described the trends in population-level child mental health measures and compared these with a comparison group. In doing so, no significant evidence of an adverse earthquake effect could be seen, and indeed, some evidence pointed to an improvement in child population mental health following the earthquakes.

The secondary objective of the current study was to investigate how the Canterbury experience may be useful to illustrate the child mental health changes that may be expected to be seen in a population of young children exposed to a major natural disaster. The current study was particularly well posed to explore this issue due to the opportunity to compare post-disaster trends with data from the pre-exposure period. The setting of the current study allowed for the comparison of consecutive cohorts of children to be assessed. This allowed for the determination of the course of population-level psychosocial wellbeing in children in the wake of a natural disaster. The current findings conflicted somewhat with the findings of previous research, which may help to open the dialogue around normal patterns of coping and recovery. The hope of the author is that this knowledge may prove useful terms of supporting future disaster victims.

6.4.1 Theoretical

The current study does not support the majority of literature currently available regarding the impacts of natural disaster experience on child mental wellbeing. Whilst most studies have found evidence for a link between disaster exposure and negative mental health outcomes, the current study did not.

The current study posed a research question that is not often addressed, perhaps a foregone conclusion may have arisen that a negative impact on mental health will always occur at some level in the child population due to a disaster. Hence, the focus of most studies revolves around deciphering what the risk and protective factors are for this. However, the current study questioned whether at a population level there was any evidence for an effect on the mental health of children resulting from disaster exposure.

There are four key theoretical possibilities that could explain if our findings have described a true result:

1. The vast majority of children in the current study had the right protective factors available to them or the absence of risk factors. The proportion of children who had sufficient risk factors or insufficient protective factors made up such a small proportion of the population that no significant negative trend was found.
2. Natural disasters do not cause child emotional and behavioural problems in the vast majority of exposed individuals
3. In all previous literature that found a negative effect of disaster exposure on children's psychosocial wellbeing, the findings were not due to a real effect but due to error, confounding and bias.
4. No evidence for a deleterious effect of the Canterbury disaster on child wellbeing was found because the data used to investigate this effect was not fit for purpose. The SDQ and its application through the B4 School Check were not intended to be used as they have been in the current study.

A significant difference in trend between the exposed and unexposed groups was present for three of the studied scales: SDQT externalising, SDQT impact and SDQP impact. Although one cannot say for certain, it does not appear that these differences are explained by the earthquakes as no major fluctuations around the time of the events can be seen in the exposed sample. Even if the differences are explained by the earthquakes, they do not pose a cause for concern as they suggest that measures of Canterbury child population wellbeing are improving over time. This is not the first time that a study has found improvement in measures of child population mental wellbeing after a disaster. The theoretical implications of such an improvement need to be explored, however this is beyond the scope of the current study.

6.4.2 Practical applications

Understanding the population-level effects of a disaster on child mental health is important for informing policy regarding planning and funding. However, an understanding of descriptive measures alone is insufficient for the implementation of best practice. Ultimately there is a need to understand

how clinically meaningful effects are, and what the intra- and inter-personal impacts of an effect are. Qualitative research is required to examine these issues and gain better insight into what the consequences are.

Some children will likely develop post-traumatic stress reactions after a disaster- this is undisputed. However, what is as yet not understood is whether this extreme is indicative of a wider, population level decompensation (a shift of the bell-curve) or is simply an extreme reaction amongst a small minority of children, as would be implicated by the current study. These two possibilities need to be differentiated between because the implications from each are very different. If a population-level decompensation typically occurs amongst disaster-exposed children, then the logical step would be to provide population level support for these children. However, if the broad majority of children do not experience emotional and behavioural problems of a burdensome level after disaster exposure then it would be imprudent to channel additional resources into a population-level intervention. However, evidence used to inform practical applications needs to meet high standards of quality. Evidential data used to draw conclusions in the current study were of inadequate quality and, as such, practical applications should not be derived based on the current findings.

6.4.3 Generalizability

To reiterate, there is very limited generalizability of any research into the child psychosocial effects of disasters. The conclusions drawn from the current study are best restricted to the studied population due the high degree of variability at play. The descriptive statistics show that successive cohorts of Cantabrian children are generally scoring better on SDQ measures than their predecessors. The analytic statistics show us that in five out of the eight measurements, the trend for scores in Canterbury is not significantly different from the trend in a control region which has a similar demographic profile, but where damage from the Canterbury earthquakes was minimal. Within the studied populations this is useful information, but how this might generalise to external population is unclear. Extrapolations of the findings of the current study to different contexts should be cautiously regarded.

The current study was of population health, not of individual health. Consequently, the findings of the current study are not applicable at the individual level. The interplay between population health and individual health is dynamic: each affects the other. However, it is impossible to draw clinical conclusions about individual health based on the findings of this study.

6.5 Further study

The scope for further study in this area is broad. Specifically, in order to further advance the current knowledge, a strong focus on methodology will be key. Studies similar to the current one could clarify uncertainties by:

- Using tools with well established, culturally-specific norms
- Comparing populations exposed to different disasters using the same methodology
- Measuring informant characteristics
- Measuring exposure more precisely
- Using a longitudinal design to study the individual-level processes involved
- Assessing more closely what impact missing data may have
- Considering aspects of positive psychology

Ultimately the progress of knowledge in this field will rely largely on the availability of screening and surveillance data as the current study did. Programmes such as the B4 School Check which made this research possible ought to be supported wherever possible, as only through careful analysis of quality data can balanced and constructive conclusions be drawn.

As highlighted by the current findings, the collective scientific understanding on this topic is modest at best. Considering the importance of protecting and promoting child mental wellbeing, and the vulnerability of children in a world full of potentially traumatic experiences, it is imperative that this comprehension of how natural disasters may play a role in emotional and behavioural wellbeing be further developed. It is not possible to address what is not understood.

6.6 Conclusions

The Canterbury earthquakes provided a rare opportunity to further the existing knowledge regarding the impact of exposure to a major natural disaster on the psychosocial health of children. Cantabrians have suffered ongoing adversity for years as a result of the earthquake, and the author was curious as to whether this experience might have led to an increase in the prevalence or severity of emotional and behavioural problems of 4-year-olds; as reported by their parents and teachers. This would align with the anecdotal concerns expressed by community members as well as with the majority of the available scientific literature.

With one full year's worth of pre-disaster data available from the SDQ section of the B4 School Check, as well as 4 years' worth of disaster and post-disaster data, the author set out to compare how Canterbury data trended over time with how a comparison region trended. The main method in doing this was plotting the proportions of 'abnormal' SDQ score results in each population per year for both regions.

Overall, no evidence of an adverse effect from being in the exposed group were found. Generally, the proportions of abnormal scores decreased slightly over time for children in Canterbury. In five out of eight measures, the trends in the Canterbury DHB Group were not significantly different from the

Comparison DHB Group trends. For the three measures where a significant difference in trends between regions was found, it did not appear that the difference was likely to be due to the Canterbury earthquakes.

By comparing SDQ scores of consecutive cohorts of 4-year-olds participating in the B4 School Check programmes, evidence of a deleterious effect of the Canterbury earthquakes on local children was not found. Whether this reflects a reality in which Cantabrian children did not significantly decompensate at the population level following the earthquakes, or whether the findings are attributable to other explanations is not clear. The findings of the current study are not un-precedented, although they are unexpected based on available literature. Both theoretical and practical implications arise from the findings of this study, but ultimately further study is required to better understand how disaster exposure affects the psychosocial health of children.

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8 Appendix

SDQ parent and teacher forms are attached.

Strengths and Difficulties Questionnaire

T 2-4

For each item, please mark the box for Not True, Somewhat True or Certainly True. It would help us if you answered all items as best you can even if you are not absolutely certain or the item seems daft! Please give your answers on the basis of the child's behaviour over the last six months or this school year.

Child's Name

MaleFemale

Date of Birth

	Not True	Somewhat True	Certainly True
Considerate of other people's feelings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Restless, overactive, cannot stay still for long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often complains of headaches, stomach-aches or sickness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shares readily with other children (treats, toys, pencils etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often has temper tantrums or hot tempers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rather solitary, tends to play alone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally obedient, usually does what adults request	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Many worries, often seems worried	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Helpful if someone is hurt, upset or feeling ill	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Constantly fidgeting or squirming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Has at least one good friend	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often fights with other children or bullies them	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often unhappy, down-hearted or tearful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally liked by other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Easily distracted, concentration wanders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nervous or clingy in new situations, easily loses confidence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Kind to younger children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often argumentative with adults	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Picked on or bullied by other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often volunteers to help others (parents, teachers, other children)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Can stop and think things out before acting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Can be spiteful to others	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gets on better with adults than with other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Many fears, easily scared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sees tasks through to the end, good attention span	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Do you have any other comments or concerns?

Overall, do you think that this child has difficulties in one or more of the following areas: emotions, concentration, behaviour or being able to get on with other people?

No

Yes-minor difficulties

Yes-definite difficulties

Yes-severe difficulties

☐

☐

☐

☐

If you have answered "Yes", please answer the following questions about these difficulties:

• How long have these difficulties been present?

Less than a month

1-5 months

6-12 months

Over a year

☐

☐

☐

☐

• Do the difficulties upset or distress the child?

Not at all

Only a little

Quite a lot

A great deal

☐

☐

☐

☐

• Do the difficulties interfere with the child's everyday life in the following areas?

Not at all

Only a little

Quite a lot

A great deal

PEER RELATIONSHIPS

LEARNING

☐

☐

☐

☐

☐

☐

☐

☐

• Do the difficulties put a burden on you or the class or group as a whole?

Not at all

Only a little

Quite a lot

A great deal

☐

☐

☐

☐

Signature

Date

Playgroup leader/Nursery teacher/Other (please specify):

Please turn over - there are a few more questions on the other side

Thank you very much for your help

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Strengths and Difficulties Questionnaire

P 2-4

For each item, please mark the box for Not True, Somewhat True or Certainly True. It would help us if you answered all items as best you can even if you are not absolutely certain or the item seems daft! Please give your answers on the basis of the child's behaviour over the last six months.

Child's Name

MaleFemale

Date of Birth

	Not True	Somewhat True	Certainly True
Considerate of other people's feelings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Restless, overactive, cannot stay still for long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often complains of headaches, stomach-aches or sickness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shares readily with other children (treats, toys, pencils etc.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often has temper tantrums or hot tempers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rather solitary, tends to play alone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally obedient, usually does what adults request	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Many worries, often seems worried	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Helpful if someone is hurt, upset or feeling ill	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Constantly fidgeting or squirming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Has at least one good friend	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often fights with other children or bullies them	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often unhappy, down-hearted or tearful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Generally liked by other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Easily distracted, concentration wanders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nervous or clingy in new situations, easily loses confidence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Kind to younger children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often argumentative with adults	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Picked on or bullied by other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Often volunteers to help others (parents, teachers, other children)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Can stop and think things out before acting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Can be spiteful to others	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gets on better with adults than with other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Many fears, easily scared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sees tasks through to the end, good attention span	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Do you have any other comments or concerns?

Overall, do you think that your child has difficulties in one or more of the following areas: emotions, concentration, behaviour or being able to get on with other people?

No

Yes-minor difficulties

Yes-definite difficulties

Yes-severe difficulties

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☐

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If you have answered "Yes", please answer the following questions about these difficulties:

• How long have these difficulties been present?

Less than a month

1-5 months

6-12 months

Over a year

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☐

• Do the difficulties upset or distress your child?

Not at all

Only a little

Quite a lot

A great deal

☐

☐

☐

☐

• Do the difficulties interfere with your child's everyday life in the following areas?

Not at all

Only a little

Quite a lot

A great deal

HOME LIFE

FRIENDSHIPS

LEARNING

LEISURE ACTIVITIES

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• Do the difficulties put a burden on you or the family as a whole?

Not at all

Only a little

Quite a lot

A great deal

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☐

☐

☐

Signature

Date

Mother/Father/Other (please specify):

Please turn over - there are a few more questions on the other side

Thank you very much for your help

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