Neighbourhood level impact of crime on community health outcomes

A thesis submitted in partial fulfilment of the
requirements for the Degree of Master of Science
in Geography at the University of Canterbury

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University of Canterbury
2012

Matt Willoughby – Master of Science Thesis
'Neighbourhood level impact of crime on community health outcomes'

Abstract

Objectives: Previous research has demonstrated an association between crime, the fear of crime and negative mental and physical health outcomes. The aim of this thesis is to investigate whether there is statistically significant association between recorded crime and stress-related health outcomes at a census area unit (CAU) level in Christchurch, New Zealand. **Methods:** Using multivariate linear regression and crime and health data from 2008-2010 (Calendar Years) this relationship was analysed. **Results:** Violent crime (assault) in a neighbourhood was significantly associated with poorer physical and mental health outcomes. Coefficient values indicate a strong statistical association between higher violent crime and higher heart attack [0.513 (0.161)**] and anxiety [0.474 (0.145)**] rates at a 95% confidence interval [CI]. Two confounding variables were found to have a positive association with positive health outcomes. 'Median Income' [-0.359 (0.166)**] was associated with reduced heart attack admissions and 'Community Resources' [-0.213 (0.078)**] was associated with reduced anxiety admissions. **Conclusions**: Crime reduction and community support initiatives should be encouraged. The results from this study demonstrate that there is a statistically significant association between crime and health at a neighbourhood level (CAU) and is reflective of findings from previous literature and add credence to crime as an environmental stressor.

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Acknowledgements

I would like to acknowledge the support, help and encouragement that I have received from my supervisors Dr Greg Breetzke and Dr Simon Kingham over a tough year enduring earthquakes; they have provided timely advice and feedback that has been invaluable in helping me develop my research skills and complete this thesis

Thanks also to the staff and students in the GeoHealth Laboratory for putting up with my questions and for the frequent discussions and loads of laughs that we've shared over the past year. Working at home and working in the lab has been a challenge, but the way we all work together and help each other out where we can has been a great source of encouragement and a great environment to work in.

I would like to acknowledge the assistance and provision of data from the Ministry of Health, New Zealand Police, Statistics New Zealand and the GeoHealth Laboratory. The ability to conduct this research would not have been possible without the help and provision of data.

Thanks to all my friends for the friendly banter, celebrating achievements and forming closer bonds through extremely challenging situations in post-earthquake Christchurch. Thanks for all the experiences we've shared over the years.

To my awesome family! I want to extend a HUGE thank you to for your amazing support and encouragement throughout my life and their support of me undertaking this Master of Science thesis. To my mum, Lesley, and dad, Neil, thank you so much for encouraging me to pursue my dreams and encouraging me to work hard to achieve them. Your passion and interest in Geography must have rubbed off on me. To my sister, Olivia, thanks for being a great sister; not many people have siblings that they can always have a laugh with and get along with so well. To my beautiful wife, Jo, thank you so much for your love and support that you continually give me and the encouragement you gave me to complete my masters' degree. And lastly, to my grandpa, 'Poppa', and my grandma, 'Nan', thank you for setting aside funds to cover some of my university fees and encouraging me to achieve my goals; your loving and caring nature has been a blessing to me throughout the years and your constant words of support when you were here have inspired me to complete this thesis. I wish you were both here to see the results. I dedicate this thesis to you both.

1. Introduction

Background Information

This research examines the association between patterns of crime and health after controlling for confounding compositional and contextual variables. This research was undertaken in Christchurch, New Zealand. The Christchurch Urban Area (Christchurch City) is made up of 113 census area units (CAU's) and represents 343,281 people (2006 Census). The main urban area is bounded by the Waimakariri River to the north, the Pacific Ocean to the east and Banks Peninsula to the south. This study is the first of this kind to be undertaken in a New Zealand context and is important in providing a case study for further research. Prior literature demonstrates that the presence of acute and chronic stress have been highlighted as a precursor for negative health outcomes - Fink (2010); Krieger (2011); with stress impacting the body through the presentation of physical and mental illnesses.

The field of environmental health empirically demonstrates that influences external to an individual's control can impact upon their health and wellbeing - Dahlgren *et al.* (1991); Rochford (2004). Recorded crime and the fear of crime have been identified as potential environmental hazards that can externally influence an individual's health; crime has been classified as an environmental stressor - B. Chaix (2009); Riger (1985). This study seeks to investigate whether the presence of crime at a census area unit (CAU) is associated with poorer stress-related health outcomes. Similar research throughout the world has been conducted using either recorded crime or residents' fear of crime with a mixture of objective and subjective health outcomes - Chandola (2001); Stafford *et al.* (2007); Sundquist *et al.* (2006). These studies and others found that the presence of crime or the perceived fear of crime was linked with both objective and subjective indicators of poor health.

This study uses objective crime and health measures to test this hypothesis in a New Zealand context. Limited research has been conducted in a New Zealand context regarding crime and health. Pawson et al. (2003) examined the spatiality of rape in Christchurch and Thornley (2004) examined the temporal and spatial trends of burglary in Christchurch - Pawson *et al.* (1993); Thornley (2004). Additionally, Day et al. (2012) examined the spatial association between proximity to alcohol outlets and recorded violent crime - Day *et al.* (2012). Whilst the results of these studies have allowed researchers to gain some insight into the spatial distribution of crime in New Zealand, they have not investigated the association between recorded crime and health outcomes. This study provides research examining that association and adds value and depth to the growing interest in the crime and health association both in New Zealand and internationally.
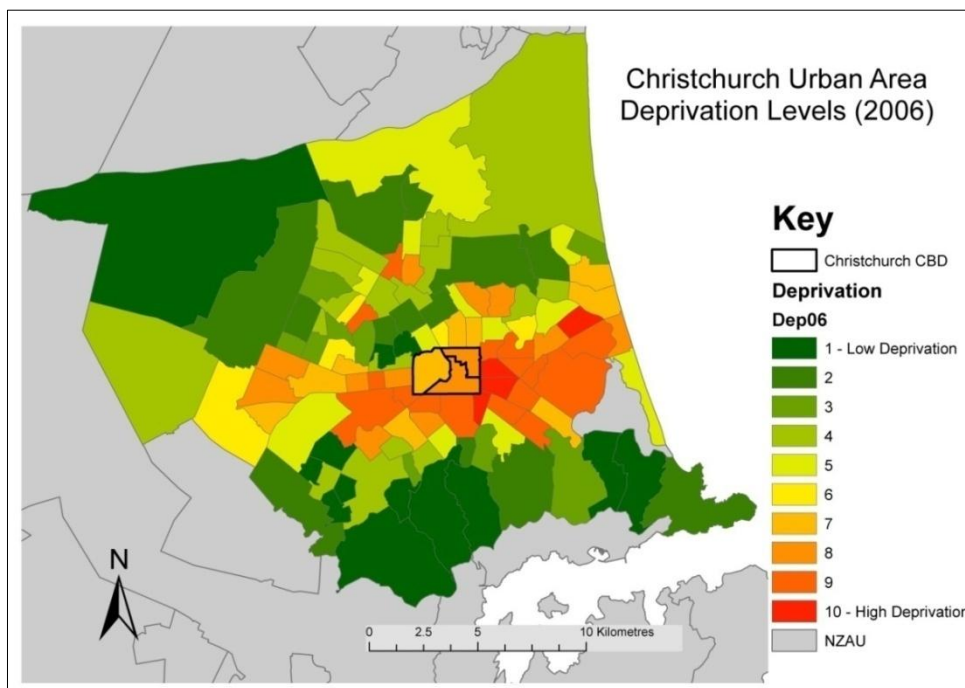
Figure 1.1 – Study Site: Christchurch City (Christchurch Urban Area) – showing socioeconomic deprivation levels (2006)

Geographies of Health

The Geography of Health is an area of geography influenced by medical and social perspectives on geography. The earliest example of 'Health Geography' can be linked back to John Snow in 1854 as a cholera outbreak struck London - Rothman *et al.* (2008); Snow (1855). High levels of morbidity and mortality followed, with public worry being directed toward vapours coming from the ground. Dr. John Snow constructed maps identifying the homes of people who had died of cholera, as well as the locations of water pumps. Dr Snow found that a significant number of cholera related deaths were clustered around a public pump on Broad Street. Later, tests indicated that it was infected water emanating from the pump that contained the disease. The handle was removed from the pump and the incidence of cholera was greatly reduced. The complex nature of human interaction and behaviour increases the capacity for disease transfer through multiple spatial and temporal vector and interactive points. As a discipline, health geography fuses together the spatial and temporal influence of social and biological influences on human attitudes, behaviour and wellbeing - Frumkin (2010); Krieger (2011); Rothman*, et al.* (2008); Walmsley*, et al.* (1993). The investigation of geographical impact on health outcomes is broad and encompasses many physical and biological influences including; temperature, vegetation, water, insect and animal vectors, as well as many physical and social influences including; access to green space, crowding, social and cultural amenity provision and theories around social capital and connectedness.

In most cases the risk of exposure is based on the prevalence of the element that is exposed to a human population. Increased spatial and temporal prevalence of an element increases the likelihood that a human

will be exposed to and influenced by that element. Health Geographers help to explain the methods through which physical diseases and social harms are spread by examining vector influence and possible methods of modification to reduce the incidence of negative health outcomes and reduce the prevalence of ill-health and injury - Frumkin (2010); Krieger (2011); Rothman, *et al.* (2008); Walmsley, *et al.* (1993)

Crime and Health

Crime by nature is invasive. This invasive nature has the potential to impact negatively upon the physical and psychological health of individuals and communities. Exposure to crime happens directly and indirectly. It is well established that crime has the potential to impact upon individual and community cohesion and wellbeing through direct and indirect exposure - Matthews *et al.* (2010). Direct exposure occurs acutely when injuries are sustained during the course of a criminal event. This exposure results in a direct negative health outcome. In the most serious cases, this negative health outcome results in mortality. In cases where serious morbidity occurs, victims are usually able to be supported and treated back to good health by resources provided by primary and secondary healthcare providers. Direct exposure to crime results in acute presentation of negative health outcomes, especially with invasive physical violence, in this sense the link between cause and effect can be easily identified. Indirect exposure occurs chronically with illness onset at a point in time after a criminal event(s). Chronic onset of physical and psychological disease and illness can vary in length from days to weeks to years - Freedman *et al.* (2010). Chronic onset of illness can occur from elevated levels of stress and anxiety related to indirect exposure to crime. People living in neighbourhoods that experience higher levels of crime are more likely to be exposed to stress and anxiety relating to safety perception, than people living in neighbourhood that experience lower levels of crime. It is important to quantify the connections between exposure to criminal activity and both acute and chronic health outcomes so as to ascertain the extent to which crime directly and indirectly influences health outcomes. Research investigating the geographic moderating mechanisms on stress and anxiety is a new and emerging area. Limited study has been conducted investigating links between crime and health - Sundquist, *et al.* (2006). Research is emerging examining links between the fear of crime and health. No research has been conducted in a New Zealand context investigating links between crime and health. This study aims to investigate links between crime and health in a New Zealand setting.

The issue or problem to be investigated

The study will firstly analyse geographic patterns of crime in Christchurch in order to identify communities at risk. The study will then analyse the patterns of stress related health outcomes in Christchurch. The study will then evaluate the relationship between the identified patterns of crime and selected health

outcomes at a census area unit (CAU) level of aggregation. Overall the study aims to identify the extent to which living in a neighbourhood with high crime levels impacts upon the health outcomes of individuals living in those neighbourhoods.

The significance of the study

This study is significant to furthering the research examining the association between the impact of crime on the health and wellbeing of communities. This study is aligned with the New Zealand Police 2011/12 – 2013/14 - Statement of Intent's strategic direction. The study aims to examine the absolute safety and wellbeing of communities by measuring levels of crime in a geographically defined area to identify both confident, safe and secure communities and vulnerable communities. The study aims to identify geographical links between rates of invasive property and violent crime and levels of stress/anxiety-related health outcomes including cardiovascular disease and depression. In addition the study provides analysis in a New Zealand context of a key environmental stressor (crime) on physical and psychological ill-health, and helps to provide more information about indicators of environmental health - B. Chaix (2009); Riger (1985).

Aim

To investigate the association between recorded crime rates and objective measures of stress-related health outcomes

Objectives

- To analyse the spatial and temporal patterns of crime in Christchurch City (Christchurch Urban Area)
- To analyse the spatial and temporal patterns of stress-related health outcomes in Christchurch City
- To examine the association between the spatial and temporal patterns of crime in Christchurch City with recorded health data, to determine whether there is a statistically significant relationship.
- To examine what neighbourhoods (areas) are more vulnerable to detrimental health outcomes based on the level of crime in their neighbourhood.

Research Questions

- What are the spatial and temporal patterns of crime in Christchurch City?
- What are the spatial and temporal patterns of heart attack admission rates and anxiety admission rates in Christchurch City?
- Are patterns of crime independently associated with stress-related health outcomes (heart attacks and anxiety) at a neighbourhood (CAU) level?

2. Literature Review

2.1 - Introduction to Literature Review Chapter

The link between Health Geography and Criminology is an emerging and strengthening field of study - Riger (1985); Sundquist*, et al.* (2006). Acute (direct) outcomes from a crime are easily identifiable and measurable. Chronic (indirect) outcomes are more difficult to measure - Freedman*, et al.* (2010). Criminal Epidemiology searches for underlying causes within individuals, communities, regions and nations to help identify and prevent negative outcomes from occurring. The first section (Section 2.2) explores the discipline of Environmental Health investigating the history and theories of environmental determinants of health. Chemical, biological, physical and social determinants of health are examined to consider how factors external to an individual can impact upon their health. The second section (Section 2.3) examines criminal epidemiology and how crime impacts upon health through the exploration into the role of measurable crime on health, the fear of crime on health, the role of geography, and interventions for risk reduction and crime prevention on physical and mental health outcomes. The third section (Section 2.4) examines the role of crime and health in a New Zealand context; this section examines existing literature regarding crime research and health research and explains how this research will fill a gap in New Zealand literature regarding crime and health.

2.2 – Environmental Health

History, theory and rationale of Environmental Health

Environmental Health seeks to examine the association between aspects of the elements from the physical and social environments on human health. Dr. John Snow in Soho, London provides the earliest example of modern health geography - Rothman*, et al.* (2008); Snow (1855). The field of Environmental health exists alongside several other approaches to determining the influences on human health. The biomedical approach to health geography has been acknowledged since the mid-nineteenth century as the main model used for disease prevention, diagnosis and response - Dahlgren*, et al.* (1991); Schneider (2011). The biomedical approach is constituted as the freedom from disease, pain, or defect. The approach focuses on the physical processes including; pathology, biochemistry and the physiology of a disease. The biomedical approach was advocated by psychiatrist Ronald D. Laing. Laing was critical of the traditional medical psychiatry approach which based diagnosis of a mental illness on patient behaviour and not on the physical pathology of the illness - Boyers (1971). Ronald D. Laing's views on the biomedical approach supported the theorization by Karl Jaspers that mental illness in particular could not be determined by non medical means alone. Jaspers theorized that paranoia and delusions were most likely the result of chemical change

in the brain. The biomedical approach seeks to find the physical causes of an illness or disease through a physical vector point through causation analysis and physical remediation - Jaspers (1959); McHugh (1997). The human body is viewed mechanically, with many parts that can be treated as individual components - Dahlgren, *et al.* (1991); Durie (1994); Schneider (2011). The physical mechanics of the body can reduce in functionality from exposure to a negative outside force, usually seen by the biomedical approach as a purely physical, biological and chemical reaction that can be treated and prevented in a biophysical way. The biomedical approach has significant strengths in its ability to examine vector borne and communicable diseases in great detail through physical biological and chemical analysis - Gatrell (2002). Vector borne and communicable diseases can be supplied from both natural and man-made sources. The biomedical approach has empirically reduced the incidence and prevalence of many vector borne and communicable diseases to minimal levels and has allowed many diseases to be treated and eradicated - Gatrell (2002). In addition to the biomedical approach, there are various approaches to health and wellbeing. Structuration is a sociological concept that constructs the view that all human action is at least partly predetermined based on the varying contextual rules under which it occurs; it sees structure as fluid and subject to reflexive feedback. Structuralism is a sociological concept that constructs the view that a specific domain of culture may be understood by means of a structure – modelled on language – that is distinct from both the organisations of reality and ideas of imagination.

The holistic approach is a concept that constructs the view that all aspects of an individual should be incorporated into the understanding of that individual. The approach believes that peoples' psychological, physical and social needs should be incorporated to view the person as a whole being. The holistic approach incorporates the biomedical approach and additionally incorporates parts of structuration theory, structuralism and social interactionism. Sir Mason Durie constructed a Māori based health model incorporating and expanding on aspects of the holistic approach - Te Whare Tapa Whā - Rochford (2004) (see Figure 2.1). Te Whare Tapa Whā incorporates an individual's Taha Tinana (physical
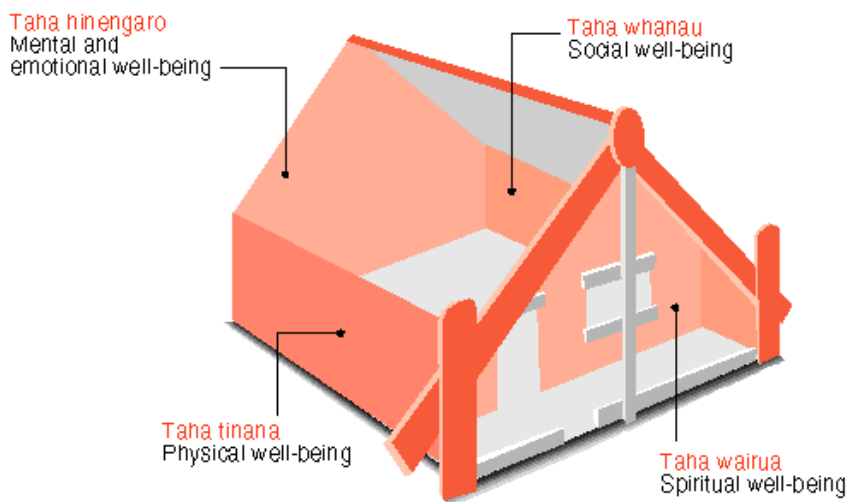
Figure 2.1 - Te Whare Tapa Wha (Source: Te Kete Ipurangi - - Durie (1994); MoH (2011))

health), Taha Wairua (spiritual health), Taha Whānau (family health) and Taha Hinengaro (mental health) - Rochford (2004). Te Whare Tapa Whā seeks to examine the importance of viewing the whole person in analysing determinants of individual health and wellbeing. Taha Tinana (physical health) refers to the capacity for physical growth and development. Our physical being supports our essence and shelters us from the external environment. Māori see good physical health as a requirement for optimal development - Durie (1994); Rochford (2004). Taha Wairua (spiritual health) refers to the capacity for faith and wider communication and the relationship of health to unseen and unspoken energies. Māori view the spiritual essence of an individual as their life force; it determines us as individuals, as a collective, who and what we are, where we have come from and where we are going. Māori analysis of physical manifestations of illness will focus on the wairua (spirit) to determine whether spiritual damage could be a contributing factor to physical illness. Taha Whānau (family health) refers to the capacity to belong, to care and to share where individuals are part of wider social systems. Māori view Whānau as a provider of strength to be who we are, link us with our ancestors and tie us our past, present and future. Taha Hinengaro (mental health) refers to the capacity to communicate, to think and to feel. Māori view the mind and body as inseparable; thoughts, feelings and emotions are important components of the body and soul. Māori see these four concepts of health to be distinctively interlinked and inseparable. The concept of Te Whare Tapa Whā is based on a traditional Marae with four equal sides of strength (Taha Tinana, Taha Wairua, Taha Whānau and Taha Hinengaro). Weakening or damage to any of these sides in a Marae leads to an unbalanced building - Durie (1994). In the same way, the weakening of any of these concepts of health may lead to an unbalanced person and subsequently a person may become unwell. Māori believe that there is too much emphasis on Taha Tinana and not enough emphasis on Taha Wairua, Taha Whānau and Taha Hinengaro; in this regard the Māori perspective on health is largely reflective of the holistic health model which views a person as a whole - Rochford (2004).
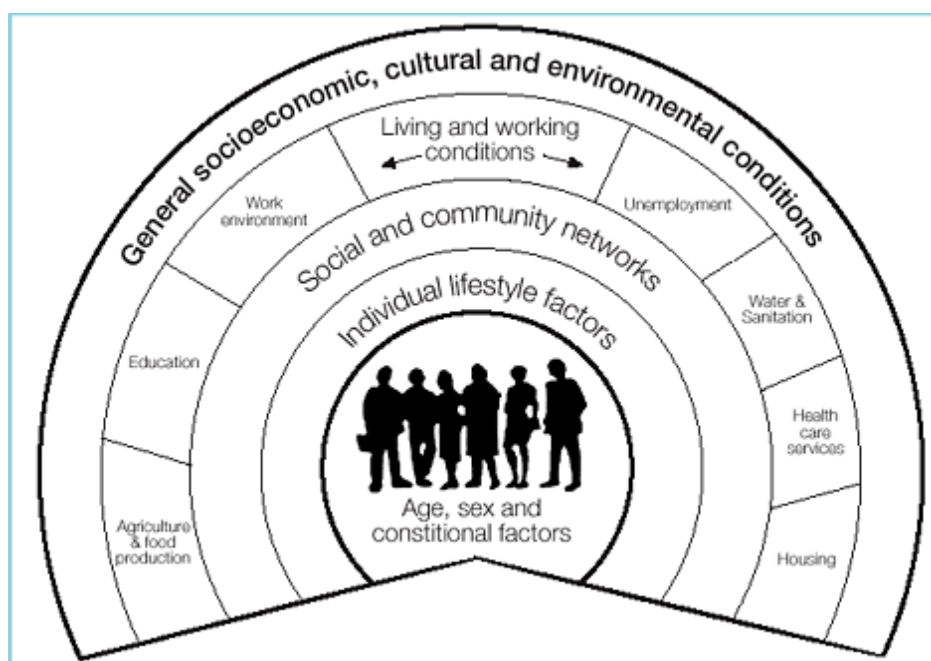
Figure 2.2 - Determinants of Health (Source: Dahlgren et al. 1991)

The holistic approach has been highlighted in wider literature. Theorisation around determinants of health similar to those explored in Te Whare Tapa Whā led to the conceptualisation of intrinsic and extrinsic determinants of health. Goran Dahlgren and Margaret Whitehead theorized that health and wellbeing of communities and individuals is influenced by both intrinsic and extrinsic variables - Dahlgren*, et al.* (1991) (see Figure 2.2). Intrinsic variables refer to attributes of an individual that are not able to be modified, such as; age, gender, ethnicity and genetics. Extrinsic variables refer to attributes of an individual that are able to be modified including; individual lifestyle factors, social and community influences, living and working conditions, general socio-economic and environmental conditions - Dahlgren*, et al.* (1991). Intrinsic variables can predispose individuals to illness and disease with little or no possibility for active changes to modify the outcome aside from bio-medical interventions which are often reactive measures of treatment. Individual lifestyle factors are the easiest of the extrinsic variables for an individual to modify. General socio-economic, cultural and environmental conditions are the most difficult extrinsic variable for an individual to modify. Socio-economic conditions for example, are influenced by numerous macro-level variables including economic and political conditions which are often very rigid - Dahlgren*, et al.* (1991). Cultural conditions rarely change and can greatly influence the perception of resources and attributes that are deemed beneficial or detrimental to an individual's health and wellbeing. Lastly, environmental conditions – which refer to the broader scale physical and social environments including; spatial geophysical and geomorphologic conditions, land use and zoning, spatial amenity provision and spatial-social interaction between individuals and communities have great potential to impact upon individuals' health and wellbeing - Dahlgren*, et al.* (1991). This exploration into intrinsic and extrinsic variables expands upon the holistic approach to health. The exploration into social and community networks, living and working conditions and general socio-economic, cultural and environmental conditions expands upon the biomedical model to include non physical determinants of health. Dahlgren and Whitehead - Whitehead (1991) provide an important representation of the holistic approach to health by including many social determinants that the biomedical model does not encompass. Te Whare Tapa Whā expands further on Dahlgren and Whitehead to include Taha Wairua, Taha Whānau and Taha Hinengaro as important indicators of health and wellbeing.

Environmental Influence on Health Outcomes

Individual choice and exposure to biological agents in addition to genetic predisposition has long been associated with the incidence of poor health outcomes - Perdue *et al.* (2003). However connections have been made between the influence of environmental conditions on the health and wellbeing of individuals and communities; this has largely become a focus for the academic community in recent times - Perdue*, et al.* (2003)

The compositional and contextual construct of physical and social environments has been increasingly linked with variations in health outcomes - Boardman (2004); Wandersman *et al.* (1998). Massey (1993) explores the concepts of space (where something is) and place (what something is). This concept can be used to identify the potential methods through which the physical and social aspects of an area have the potential to impact upon or mediate individual and community health outcomes. The concept of 'space' and 'place' are an integral part of how physical and social environmental conditions are formed - Massey *et al.* (1993). Bernard 2007 develops on how the concepts of space and place influence on health by suggesting that the complex construction of neighbourhoods can be conceived through the availability of and access to relevant resources in a geographically defined area - Bernard *et al.* (2007). The utilisation of space plays an important role in impacting upon the resources that are available to individuals and communities through the complex processes occurring within a neighbourhood setting (see Figure 2.3) - Bernard*, et al.* (2007); Briggs *et al.* (1999). 1) The Physical Domain; the physical is defined by the nature of its components. The first component is natural; this includes air quality, climate, soil composition, rivers, lakes, beaches, hills and mountains. The natural conditions determine where neighbourhoods can be constructed and the likely physical hazards a defined geographical location may be exposed to. The second component is built; this includes construction and quality of buildings, construction and quality of infrastructure (including transport, sewerage, power and stormwater) and the provision of green-space (parks and forests) and blue-space (rivers, beaches and lakes) - Gatrell (2002); Perdue*, et al.* (2003). 2) The Economic Domain; the economic domain is defined by the characteristics of places and the supply and demand for the products and services that these places provide. The flow of money and resources within neighbourhoods plays an important role in ensuring the financial growth of that geographical area. 3) The Community Organisations Domain; the community domain can be defined by the level of community resource provision. This can include religious based
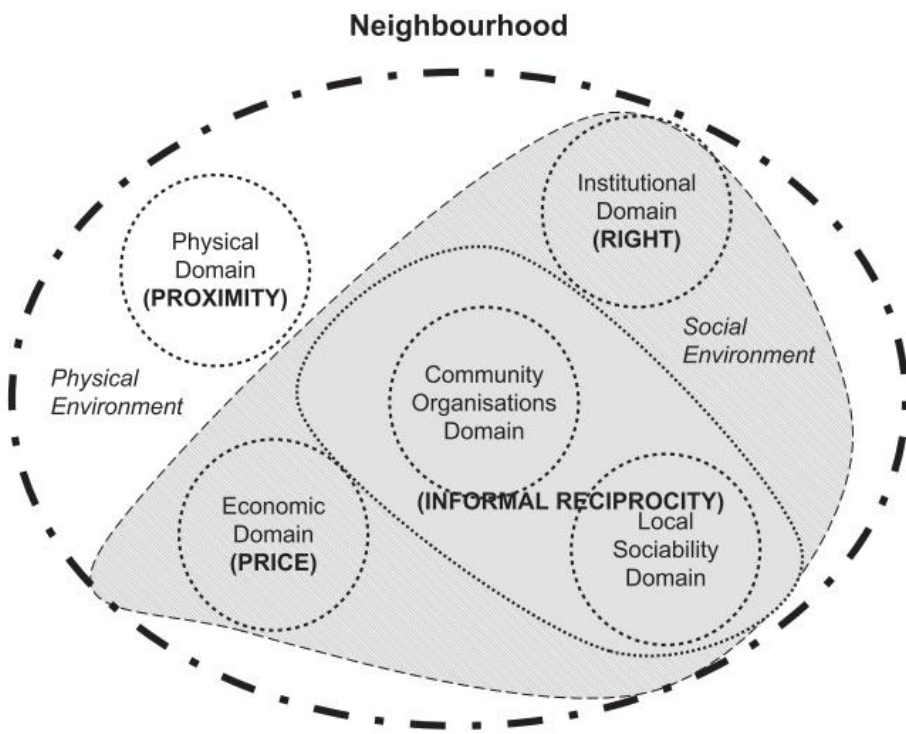
Figure 2.3 - Neighbourhood environments and rules of access (Source - Bernard et al. 2007)

groups providing social services, youth resources and food. Additionally, community organisations can include sports groups, music groups and other extra-curricular activities. 4) The Institutional Domain; the institutional domain includes educational facilities, health facilities, police and other public services.

These public services help to provide resources to neighbourhoods to allow educational and health opportunities amongst other services. 5) Local Sociability Domain; the local sociability domain can be understood as the social interaction within a neighbourhood. This can be measured by the level of social connections that individuals have or the extent to which people are able to interact - Bernard*, et al.* (2007). The interaction between these domains creates a complex network of factors that can influence the extent to which an individual has the chance to engage with a particular neighbourhood. Bernard explores this further by examining the potential impact that these domains can have on an individual's ability to interact positively or negatively with the resources that are available to them within a geographically defined area.

Bernard *et al.* (2007) suggests that health inequalities arise through differing levels of access to the resources provided by the physical, economic, community, institutional and social domains within their local neighbourhood. They highlight that differences between the resources that neighbourhoods offer significantly affects the ability of individuals to seek out resources that will be beneficial to their development - Bernard*, et al.* (2007); McCulloch (2001). The distinction in inequality of access can be made between a neighbourhood that has positive resources such as high quality parks, wholesome food stores, high quality education and health facilities and active community organisations, compared with a neighbourhood that has negative resources such as high levels of pollution, graffiti, high density housing, clustering of liquor stores and limited education and health facilities - Bernard*, et al.* (2007); Gindroz *et al.* (2005); J. Pearce *et al.* (2006). Exposure to either positive or negative resources impacts upon an individual's ability to maintain physical and mental wellbeing. The role of city planning, zoning and broader economic law plays an important role in defining the use of spaces and the defined roles that places may represent - Massey*, et al.* (1993).

Gindroz 2005 highlights the importance that city planning and zoning makes to the ability of a neighbourhood to be as beneficial to the individuals and communities within that neighbourhood. Gindroz suggests that places should be used to their maximum potential and where possible multi-use should be sought after to provide positive place attributes. The sentiments of Gindroz are supported by Kawakimi 2011 through the outlining of the significance of health promoting or health damaging neighbourhood resources - Gindroz*, et al.* (2005); Kawakami *et al.* (2011). Gindroz demonstrates key planning variables that can help define neighbourhoods and encourage the positive use of that space. 1) Planning for organised structure through land use zoning; clear defined zones for specific land use. 2) Boundary

lineation; clear defined boundaries between neighbourhoods, preferably natural barriers such as waterways or trees/forests. 3) Functional elements, provision of infrastructure to allow for mobility of information and people, additionally the provision of adequate educational, health and recreational facilities including schools, doctors, parks and playgrounds - Gindroz*, et al.* (2005); Kawakami*, et al.* (2011).

Gindroz 2005 and Bernard 2007 have highlighted the influence that environmental conditions can have on neighbourhood outcomes. Significant imbalances in these environmental conditions lead to inequality of opportunity and inequality of outcome across space. These imbalances can be measured through the exposure to negative resources from neighbourhood environmental domains. Pearce (2006) showed that there were significant differences in health outcomes linked to neighbourhood resource accessibility. Pearce 2006 found that socially advantaged neighbourhoods had greater access to healthy food compared to socially disadvantaged neighbourhoods.

Additionally Pearce 2006 found that socially advantaged neighbourhoods also had greater access to recreational facilities including parks and playgrounds. Access to educational facilities including primary schools, intermediates and secondary schools differed significantly across all of these categories with more socially disadvantaged communities less likely to have ease of access to the facilities. Access to health facilities varied significantly with people living in socially disadvantaged meshblocks having to travel approximately 7 times further to get to a general practitioner and 5 times further to accident and emergency - J. Pearce*, et al.* (2006). Witten *et al.* (2003) supports of Pearce's findings, showing that access to resources differed across space and socio-economically disadvantaged neighbourhoods were less likely to have access to community resources.

Witten expands on this further by suggesting that contextual approaches to examining and modifying resource accessibility have been limited. Witten continues by illustrating that the quality of resources available is an important factor when examining contextual influence in addition to resource availability - Witten *et al.* (2003). Witten and Pearce have demonstrated the influence that the quality and quantity of resource availability allocated through the physical, economic, community, institutional and social domains significantly influence the health and wellbeing of communities based on their access to and interaction with each of these environmental domains. The use of space and the characteristics of places have been highlighted as significant contributors to the difference in resource availability across space - Kawakami*, et al.* (2011).

Environmental Influence on Health Outcomes

Imbalance in the physical, economic, community, institutional and social domains of a neighbourhood create the potential for environmental influences to act as stressors - Matthews*, et al.* (2010). Disruption to the normal ecological nature and balance of a neighbourhood can create tension and stress through the added risk factor that an individual or community faces. Matthews 2010 demonstrated that the presence of hazardous facilities in the built environment including, substandard housing/building quality, poor transport infrastructure and negative places (liquor stores, fast food outlets) in an area were positively associated with higher stress levels.

Congruently, it was also found that perception of neighbourhood disorder through the lack of community, institutional and social stability was positively associated with higher stress levels - Matthews*, et al.* (2010). These aspects from the built and social environments highlight the influence that environmental or ecological conditions can have on an individual's health outcomes - Matthews*, et al.* (2010). The external nature of environmental stressors means that individuals and communities find it difficult to remedy the symptoms or fix the cause of environmental stressor. This is particularly apparent when there is a contextual change in the built environment; for example the clustering of liquor stores and fast food outlets in a geographically specific location may encourage delinquent behaviour and corresponding criminal activity - Evans (2003); Freedman*, et al.* (2010).

Congruently, extreme and acute changes to the physical environment; for example a river flooding, high speed wind or an earthquake alter the balance in the neighbourhood ecosystem and correspondingly elevate stress levels - Evans (2003); Freedman*, et al.* (2010). The key methods for reducing the impact that imbalance are; firstly, attempt to avoid the impact if at all possible through preventative measures put in place before the imbalance
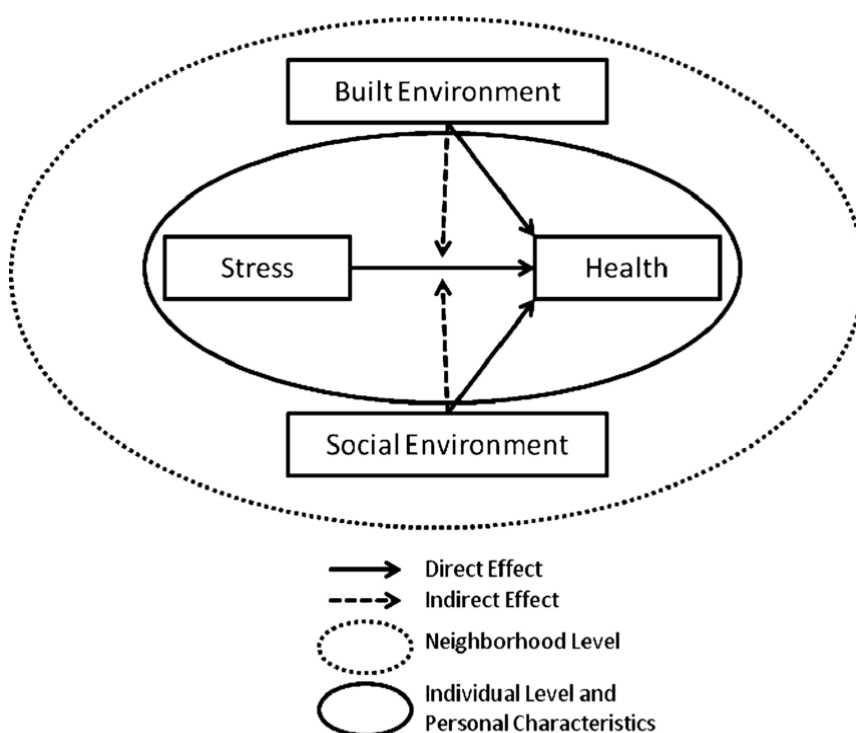
Figure 2.4 – Direct and Indirect influence of the built and social environments in the health of individuals and communities

occurs; secondly, mediate/mitigate the impact through responsive measures that aid in reducing the negative impact as a result of the imbalance; and thirdly, remedy the impact after the imbalance occurs to attempt to return the ecosystem/environment to a balanced state.

2.3 – Crime and Health

Previous literature highlights increased stress levels as a detrimental outcome as a result of indirect exposure to criminal activity - Foster *et al.* (2008). Stress is one of the precursors of illness and has been linked to a wide range of health and social outcomes, such as cardiovascular disease, anti-social behaviours and biological responses - Matthews*, et al.* (2010); Middleton (1998). Matthews (2010) identified "stress" as having four dimensions; 1) an environmental exposure or experience; 2) an appraisal of an environmental condition; 3) a response to environmental exposure; and 4) an interactive association between environmental demands and personal capability to fulfil these demands.

Theoretical evidence suggests that the formation of stress levels may be associated with both individual and neighbourhood environment factors. Much neighbourhood research has focused on the social dimension, examining socioeconomic conditions, deprivation, and individual covariates. Research regarding the influence of modifiable physical and social environmental influences has seen limited attention in regard to stress related illnesses.- Matthews*, et al.* (2010) examined the link between stress levels and health outcomes at a neighbourhood level. A positive association between stress and poor health was evidently found. Respondents with average, above average, and high stress were less healthy than those with no stress (the reference group). The strength of the association increased with the level of stress. (Matthews 2010) highlighted that the association between high stress and health was roughly 1.6 and 2.2 times higher than those for above average stress and average stress, respectively; they also found that the association between high stress and poor health was larger after controlling for individual demographic and socioeconomic variables. The observation of acute or chronic stress has been demonstrated to be associated with reduced physical and mental functioning and shown through the presentation of physical and mental illnesses in the body in biomedical and environmental health studies - Fink (2010); Krieger (2011)

The potential for criminal activity to impact upon an individual's health and wellbeing is dependent upon many variables. These variables can be described as aspects of the physical and social environments - Matthews*, et al.* (2010). Aspects of these physical and social variables contribute to the enhancement or detraction of ecological potential of criminal activity to occur. Congruently, these aspects of physical and

social variables also have the potential to enhance or detract the degree to which individuals and communities are protected from or harmed by criminal activity - Matthews*, et al.* (2010); Middleton (1998). Physical and social neighbourhood ecological variables can act as moderating mechanisms that determine the extent to which criminal activity can impact upon individuals and communities within neighbourhood settings - Boardman (2004). The outcomes that are moderated through these variables can be measured as direct and indirect. Direct outcomes from criminal activity are often seen as an acute result of violent crime. Injuries sustained during the crime occurring are a direct negative physical health outcome. In the most serious cases this negative physical health outcome results in mortality. In cases where serious morbidity occurs, victims are usually able to be supported and treated back to good health by resources provided by primary and secondary healthcare providers. Indirect outcomes from criminal activity are often seen as a chronic result of criminal activity. Heightened stress levels have been linked with higher levels of criminal activity at neighbourhood levels. Chronic onset of physical and psychological disease can vary in length from days to weeks to years - Freedman*, et al.* (2010). It is important to quantify connections between the exposure of criminal activity and both acute and chronic health outcomes so as to ascertain the extent to which crime directly and indirectly influences the health outcomes.

Stress as the result of exposure to detrimental environmental conditions (including exposure to crime) has been demonstrated to be associated with higher levels of poor health outcomes over a variety of health outcomes. (Matthews 2010) highlighted the increased risk between those individuals living in high stress environments with significantly increased risk of detrimental health outcomes.

Crime as an Environmental Stressor

It is important then to examine the links between levels of crime and levels of stress to determine the extent to which crime impacts upon stress levels and corresponding negative health outcomes - Boardman (2004). The presence or perception of crime in an area can reduce individual and community confidence in the safety of that area. Unsafe areas can be described as areas that experience higher levels of crime compared to other areas and areas where there is a perception that the area is unsafe. An indirect or chronic response to an unsafe situation or an unsafe area is stress - Boardman (2004); Matthews*, et al.* (2010); Riger (1985). Boardman 2004 examines the role that neighbourhood level influences have at mediating and moderating stress levels. They found that a significant proportion of stress levels were correlated to variables classified in the built, physical and social environment in addition to individual level variables such as age, gender, ethnicity and socio-economic status - Boardman (2004). They identified that areas with perceived detrimental features in their built, physical and social environments were more likely to experience and perceive ambient risks including crime, violence, failing infrastructure, graffiti and

destruction of property. Individuals in these high risk areas are more likely to experience negative health outcomes and the impact of increased levels of neighbourhood risks is likely to amplify the effect on individual and community stress levels. In addition to the absolute levels of crime is the perception of risk from crime or 'the fear of crime' - Elo *et al.* (2009); Koskela (2009); Pantazis (2000). In most research it is found that the fear of crime patterns often follow the same trend as recorded crime but an elevated level - Stafford*, et al.* (2007). Stafford *et al.* (2007) investigated the impact that fear of crime had on mental health and physical functioning. They highlight that the fear of crime acts as an environmental stressor by restricting individuals choices through an increased perception of risk. Individuals may modify their behavioural responses to situations based on a perceived increase in risk. This can restrict their interactions within their local communities and reduce opportunities that are available to them. The reduction in engagement and perception of increased risk has the potential to elevate the stress levels and decision making abilities of individuals. Stafford found that individuals reporting high levels of fear were 50% more likely to exhibit symptoms of common mental disorders and more than 90% more likely to exhibit symptoms of depression compared to individuals reporting low levels of fear. As has been highlighted; recorded crime rates and the fear of crime potential have been linked with higher rates of stress and stress related illnesses - Boardman (2004); Stafford*, et al.* (2007). In order to examine crime and the fear of crime impact on individuals' health it is important to look closer at the processes contributing to elevated stress levels - Riger (1985).

Measurable Crime and Health

Real and measurable crime is an important indicator of neighbourhood disorganisation and an important indicator on the potential risk to individual and community physical and psychological wellbeing - Middleton (1998). The quantifiable risk to an individual and to a wider community of criminal activity increases the incidence of negative health outcomes occurring; that is, areas with higher rates of crime generally have poorer health outcomes - Middleton (1998). Violent crime and property crime are invasive by nature increasing the risk of negative physical and psychological outcomes for the victims of these crimes. Property and personal crime including robbery and theft have the potential to increase the stress and anxiety levels of victims that are directly affected by the crime - Boardman (2004). Violent crime including domestic violence, rape, murder and assault are acknowledged as major risk factors to health - Robinson *et al.* (2000) with resulting physical trauma to victims along with ongoing psychological impacts after the fact.

Reporting pertaining to domestic violence and rape are notoriously underreported - Robinson*, et al.* (2000), reducing the full extent of the prevalence of these crimes. Interpersonal violence including

domestic violence, rape and assault have been linked with the misuse alcohol by the perpetrator of the crime associated with the physical and social environments from which the perpetrator has been influenced by. The most serious consequence of interpersonal violence is murder, resulting in the mortality of the victim. In addition to direct impact of measurable crime on health outcomes, indirect impacts are just as serious. Acute and chronic physical and psychological trauma can occur to the victims of the crime and additionally to individuals and communities with strong connections to the victim of the crime - Boardman (2004); Freedman, *et al.* (2010); Robinson, *et al.* (2000).

Measurable crime allows for the objective analysis of patterns over defined temporal scales. This can help with analysis of contextual and compositional variable association with crime levels - Breetzke (2010b); Brown (2004). These associations can be used to alter approaches to reducing levels of crime through altering aspects of the built, social or physical environment. Analysis of measurable crime over a temporal and spatial scale can help to provide insights into the relative success or failure of prior approaches to reduce crime levels.

Fear of Crime and Health

The fear of crime in a neighbourhood is an important perspective on neighbourhood safety and risk. The perception of crime in an area is as important as the actual level of crime. The perceived risks of safety have the potential to negatively influence the physical and psychological health of individuals and communities - Chandola (2001). Fear of crime in an area can restrict the extent to which individuals interact with their environment because of perceived risks to their personal safety. Widespread reduction in interactions with local environments has the potential to lead to reduce community connection and reduced factors of influence protecting a community; in this way crime can be seen as an environmental stressor. Perceived negative aspects of the physical and social environments have been linked with increased anxiety, stress and fear of crime. These can be linked to aspects of the local ecology from the physical environment including: rundown buildings and parks, detrimental retail space, lack of community amenities and lack of community infrastructure; and the social environment including: socio-economic deprivation, social signs of incivility, lack of community connection and support and negative perceptions of image - Taylor *et al.* (1993).

Perceived levels of crime are often above the actual level of crime in an area - Chandola (2001); Stafford, *et al.* (2007). This increases the impact of the presence of crime to a base wider than those that are directly affected by crime. Fear of crime is driven by an individual's understanding of their environment. The ecological impact of the fear of crime is sourced from the individual's perception of the factors within their environment that they see as being beneficial and detrimental to them. Individuals have choice as to how

they interact with their environment to the extent to which they can control factors that may influence them. Their choice is limited by the structural components of both the physical and social environments in which they reside. Ecological differences between areas influence the extent to which the fear of crime impacts upon the choices, decisions and health outcomes of individuals and the overall feeling of safety in an area - Chandola (2001); Stafford, *et al.* (2007).

The Role of Geography

Geographical differences in aspects of physical/built and social environments influence the extent to which levels of crime and fear of crime differ across spatial areas. Figure 2.5 illustrates the practical application of anchor point theory to both the physical and social environments. Nodes of influence in both the physical and social environments impact upon individuals and communities based upon the extent to which individuals and communities interact with these nodes.

The spatial location of these nodes determines where and what other nodes the node of influence is able to influence the strongest. In the physical environment these nodes might be retail shops including: supermarkets, fast food, outlets, alcohol outlets, malls, clothing stores, bakeries and other retail stores. In the social environment these nodes might be people with influence including: community leaders, school or work leaders, sports team leaders, leaders of gangs and community group leaders. The strength of these nodes of influence is partially based on their spatial strength of association based on the geographical characteristics. Relative clustering of negative or positive nodes in a physically or socially defined area will increase the level of influence that these nodes can have. Similarly, the level of recorded crimes and the perceived spatial variation in the distribution of criminal activity will increase the level of influence that criminal activity and perceived levels of crime have on individuals and communities. Geographical characteristics of the physical and social environments have the potential
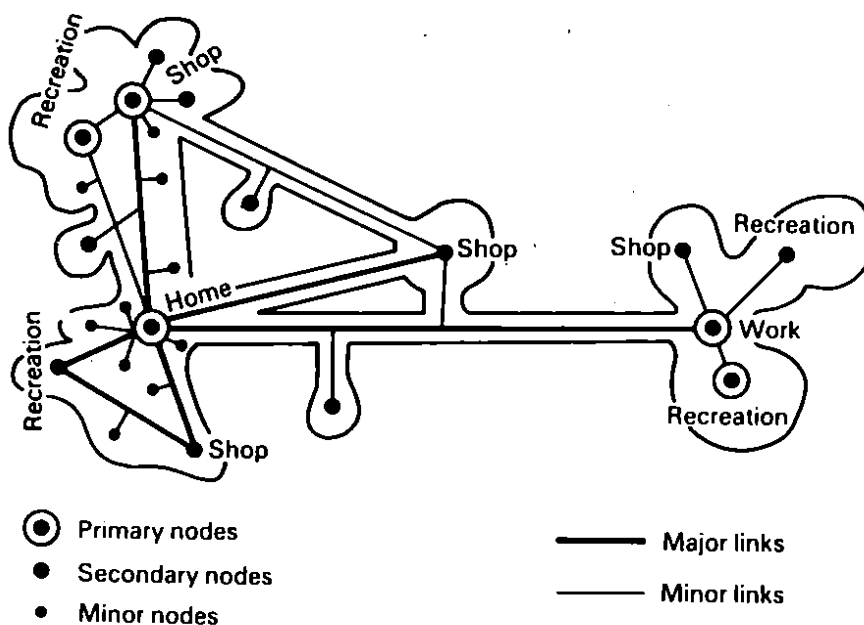
Figure 2.5 - Anchor Point Theory of Environmental Learning.
Source: - Walmsley *et al.* (1993)

to influence the spatial variation of crime and the spatial variation in health outcomes relating to exposure to crime.

Neighbourhood Influence of Crime on Health Outcomes

The extent to which neighbourhood level crime has the potential to impact upon the health of individuals and communities is dependent on the risk and protective factors available to them. If there is an imbalance between the risk and protective factors surrounding individuals, this will result in either a positive outcome of increased protection or a negative outcome of increased risk - Chandola (2001).

Diez Rouz 2001, describe these risk or protective factors as individual-level confounders, mediators or modifiers of the area effect. Diez Rouz also highlights the need to examine both neighbourhood context (area properties including aspects from the social, built and physical environments) and neighbourhood composition (characteristics of individuals within an area) - Diez Rouz (2001).

The relative impact that contextual variables such as crime can have on the outcomes of individuals including health is significantly mediated or amplified by compositional neighbourhood variables - Bernard, *et al.* (2007). Elo 2009 highlights the role of individual characteristics as significant mediators of neighbourhood disorder. They highlight that across many studies that there are key compositional variables including social deprivation, social isolation, minority ethnicity, young males' population and poor education levels. These compositional variables have been linked to varying degrees across different study contexts to higher than expected levels of neighbourhood disorder in comparison to the general public - Brown (2004); Elo, *et al.* (2009). Bernard 2007 investigates the notion that neighbourhoods are not static, as their context and composition change temporally.

Even given the significant mediating influence of compositional variables, the role of contextual neighbourhood variables provide the methods through which neighbourhood disorder and crime can occur. Neighbourhoods that have limited access to resources and limited methods of social control providing opportunities for change are less likely to be able to resist the incidence and reduce the prevalence of anti-social behaviour and crime. In addition, these neighbourhoods are also less likely to have the community resources to be able to support the people at risk of developing negative physical and mental health outcomes through acute and chronic exposure to antisocial and criminal behaviour - Brown (2004); Elo, *et al.* (2009); Robinson, *et al.* (2000).

Neighbourhood Influence of Crime on Health Outcomes – Physical Health

Exposure to and perception of crime has been linked to physical health outcomes of individuals - Stafford, *et al.* (2007); Sundquist, *et al.* (2006). The influence of crime on the physical health of individuals can be understood in two ways; 1) the presence of crime in an area in which an individual interacts elevates the stress level of that individual with accompanying health consequences including: high blood pressure, breathing difficulties and sleep deprivation - Whitley *et al.* (2005); 2) the presence of crime in an area in which an individual interacts reduces the capacity for an individual to engage in physical activity - Whitley, *et al.* (2005). Physical health consequences as a result of exposure to increase crime levels include: slowing of metabolic rate, build up of fat on the body and increased cholesterol rate - Stafford, *et al.* (2007); Sundquist, *et al.* (2006). These accompanying health consequences elevate the risk factor for the development of cardiovascular disease to occur. The physical health consequences of suffering cardiovascular disease reduce the capacity for individuals to engage in activities that they would have been able to engage in prior to suffering from cardiovascular disease - Kawakami, *et al.* (2011). Variations in neighbourhood level criminal activity influence risk or protective extent to which individuals will suffer from cardiovascular disease - Augustin *et al.* (2008).

Cardiovascular disease has the potential to occur in any person regardless of their intrinsic characteristics including age, gender, ethnicity and genetics. Extrinsic influences on cardiovascular disease are preventable within an individual's sphere of influence as individuals have the ability to choose how to interact with their environment. Extrinsic variables beyond an individual's sphere of influence including exposure to criminal activity can only be modified by factors external to the individual. Spatial variation in the incidence and prevalence of cardiovascular disease is dependent on aspects from the physical and social environments which mediate the influence of crime on individuals' health and wellbeing - Sundquist, *et al.* (2006).

Sundquist 2006 found that in neighbourhoods with the highest rates of violent crime were 1.75 times for men and 1.39 times for women more likely to experience coronary heart disease after adjusting for confounding variables. In addition, Augustin 2008 found that individuals living in neighbourhoods with the highest levels of neighbourhood psychosocial hazards including crime were 4 times more likely to have experienced a history of heart disease and 3 times more likely to experience numerous other negative health outcomes including myocardial infarction, stroke and transient ischemic attacks after adjustment for individual lifestyle risk factors. This highlights the potential risk to individual and community health from neighbourhood disorder and crime. Even after adjustment for confounding variables it can be demonstrated that contextual risk factors from the social, physical and built environment can restrict the

ability of individuals to be able to function normally with increased risk of stress and blood pressure with significant risk for other negative health outcomes to develop.

Neighbourhood Influence of Crime on Health Outcomes – Mental Health

Exposure to and perception of crime has been linked to mental health outcomes of individuals - B. Chaix *et al.* (2006); Chandola (2001); Stafford*, et al.* (2007); Whitley*, et al.* (2005). The influence of crime on the mental health of individuals can be understood in two ways; 1) the presence of crime in an area in which an individual interacts elevates the stress level of that individual with accompanying health consequences including: anxiety, depression and sleep related illnesses - B. Chaix*, et al.* (2006); Chandola (2001); Stafford*, et al.* (2007); Whitley*, et al.* (2005); 2) first hand exposure to criminal activity in an area in which an individual interacts insights fear, anger, sadness, social anxiety and feelings of guilt and self loathing. Mental health outcomes associated with exposure to criminal activity can be acute and chronic. Outcomes may occur directly as a result of exposure or presence in an area of elevated stress levels or indirectly as an individual experiences a situation that may highlight memories of their exposure to criminal activity.

The extent to which there is potential for mental illness to occur as a result of the presence of and exposure to criminal activity depend upon the risk and protective factors available to an individual in both the physical and social environments. Beyond intrinsic determinant of mental health including genetic disposition and chemical imbalance; the development of mental health outcomes can be linked with environmental influences. Undiagnosed mental health conditions and external source influence can be detrimental to the establishment of supportive environments for individuals that have been affected by mental illness. The health consequences of suffering from mental illnesses reduce the capacity for individuals to engage in activities that they would have been able to engage in prior to suffering from mental illnesses.

The most common form of mental illness associated with exposure to criminal activity is depression. Some forms of depressive disorders of individuals are able to be treated with changing the environment in which the individual interacts; however some forms of depressive disorders are caused by chemical imbalances. Supportive social structures are essential in assisting individuals and communities cope with the mental health consequences of exposure to and the presence of criminal activity at a neighbourhood level - B. Chaix*, et al.* (2006); Chandola (2001); Stafford*, et al.* (2007); Whitley*, et al.* (2005).

Evans 2003 investigates the impact the contextual role of the physical environment can have on mental health outcomes. This links with the restriction of activity that may occur as a result of perception or experience of criminal activity an area. Evans suggests that individuals living in areas that have low-quality physical environmental features both in terms of the natural and built environments are less likely to be

able to cope with significant stress. Literature that Evans and others cite highlights the potential risk to the mental health of individuals living in these areas to be able to cope with significant stress on their personal situations. This is significant as low-quality physical and built environmental features have been linked with higher rates of crime. This poses a potential double negative impact on people living in these areas that they; 1) have increased potential to experience higher levels of crime and; 2) they are less likely to have resources available to them to be able to mentally cope with increased stress levels - Evans (2003). Given this potential for increased risk it is important to examine methods through which both crime can be reduced to help change the incidence and prevalence of stress related illness and to help make structural changes to allow more resources to those in need.

Interventions for Risk Reduction

Crime impact risk reduction can be achieved through two methods; reducing the levels of crime and increasing support to direct and indirect victims of crime. These two methods provide processes through which modification of the physical and social environments can occur. These modifications can reduce the risk factors from the physical and social environments and/or increase the protective factors from the physical and social environments - Diez Rouz (2001); Elo, *et al.* (2009); Stafford, *et al.* (2007)

Interventions for Risk Reduction – Crime Prevention

Crime prevention through environment design (CPTED) is a concept that promotes planning and construction of neighbourhoods in a way that discourages crime potential - Crowe *et al.* (1994). Theory behind CPTED described in Cozens 2005 is 'the proper design and effective use of the built environment can lead to a reduction in the fear and incidence of crime and an improvement in the quality of life' - Cozens *et al.* (2005). Brantingham and Brantingham (1991) describe four key dimensions to crime occurrence as; 1) the law; 2) the offender; 3) the target and; 4) the location. Cozens 2005 explores this notion around location theory further through noting that if the spatial distribution of offences was random then environmental influence on crime and the prevalence of crime hotspots would not occur. Cozens 2005, highlights several authors that have agreed with this notion around environmental influence on criminal activity. Literature suggests that there are criticisms of CPTED in that it is only limited to physical attributes of space and lacks the capacity to mediate place features and other social factors; this means that CPTED has the capacity to create zoned and defined spaces for industrial, commercial, residential, public and private spaces but lacks the ability to completely decided whether commercial land for example is used in a beneficial or detrimental way - Casteel *et al.* (2000); Cozens, *et al.* (2005); Herbert *et al.* (1985).

CPTED has numerous benefits in that it allows for the creation of defined spaces. Defined spaces help influence the perception of an environment/area/neighbourhood. The clear definition allows for these spaces to be utilized in a way that encourages positive perception about an area and allows for strategic modification to defined spaces to alter the use of those spaces. Brown 1993 explored this concept of defined spaces further by demonstrating that some burglars used perceptions of territory to evaluate the risk of committing a crime. In addition Brown 1993 also found that by eliminating any unassigned/defined spaces and ensuring all spaces have a clearly defined and designated purpose this reduce the risk of negative perception of spaces, congruently reducing the likelihood for crime to occur. Linked with the definition of defined spaces is the theory of access control. CPTED addresses the issue of access control in two ways; 1) by making private and public spaces more secure and; 2) increasing natural surveillance - Cozens*, et al.* (2005).

 Increased security of private and public spaces allow for these space to be more defensible and have more resilience to crime and disorder. Theory around natural surveillance suggests that in areas that are well connected, well lit and generally in a rough amphitheatre layout have increased natural surveillance. Increased natural surveillance leads to more protective factors surrounding an individual or community through increased connectivity through the physical layout of an area and the social connections within that area - Cozens*, et al.* (2005). CPTED encourages planning of transportation infrastructure, service infrastructure, community resources, industrial zones, commercial zones and residential zones in a way that spatially and socially assists to reduce crime potential. CPTED encourages both practical and aesthetic provision for these zones to support risk reduction. This approach can be beneficial before a neighbourhood is established - Crowe*, et al.* (1994). CPTED can be more difficult to implement after a neighbourhood is established as fixed points have been established including the construction of transport and service infrastructure, however it is not impossible to modify these fixed points.

Community resources including physical resource such as: parks, streams, sports fields and forests and social resources such as: police stations, community centres, dental surgeries, doctors surgeries can be created with changes to zoning and investment in infrastructure. It is important to note that the cost of these modifications will vary depending on the scale of modification which may influence the economic viability of these modifications. CPTED theory suggests several points of influence for reducing crime through environmental design; provide a clear border definition of controlled space; provide a clearly marked transition from public to semi-public to private space; locate gathering areas in places with natural surveillance and access control and away from the view of potential offenders; place safe activities in unsafe locations; provide natural barriers to conflicting activities; improve the scheduling of space to

provide for effective and critical intensity of uses; design space to increase the perception of natural surveillance; overcome distance and isolation through improved communications and design efficiencies - Chandola (2001); Cozens*, et al.* (2005); Crowe*, et al.* (1994)

Interventions for Risk Reduction – Community Support

Supporting individuals and communities through effective and connecting initiatives from public, private or voluntary enterprise is a valuable way to reduce the impact of crime on individuals and communities by providing more protective external influences - Kawakami*, et al.* (2011); Kirby *et al.* (2006). The quality of community resources and the ability for individuals to access these resources greatly influence the extent to which the protective external influence of these resources can be utilized. Health and social service provision is a major contributor the neighbourhood differences in health outcomes - Kirby*, et al.* (2006). Strategic placement of community support within the physical and social environments is essential in reducing the risk factors associated with exposure to criminal activity. Assessment of existing community risk and protective factors must be undertaken in order to assist the strategic placement of these resource to utilize their effectiveness - Kirby*, et al.* (2006).

Strategic placement of public services including police, community health facilities and government agencies assist in creating an image of stability and organisation. The placement of these services within the physical and social environment of a neighbourhood is critical in providing protective external influences to individuals and communities from the risks of exposure to criminal activity. Individual and collective private enterprise in terms of social and economic influence provides the basis for increased connectivity and support beyond the extent to which public services can reach. Public and private enterprise have the ability to support the voluntary sector in providing support services to individuals and communities. Voluntary sector enterprise including community social groups, sports teams, church and other religious groups, church and other religious youth groups , voluntary health service and voluntary community watch patrols provide an important external protective niche of support beyond the capacity of the public and private sectors.

Community support in all forms provides the basis for communities to become a collective protective influence over each individual through specific community resource allocation. Strategic placement of these specific community resources aid the efficacy of these resources in reducing the risk and harm to individuals from criminal activity - Kirby*, et al.* (2006).

2.4 – Crime and Health in New Zealand

Introduction

This section explores the research examining the impact of crime on health outcomes in New Zealand. Much of the research in New Zealand is focused on environmental influences on health but has not considered crime as a contributing variable. Research around the theme of crime is focussed primarily on direct outcomes including domestic assault, family violence and rape - Pawson*, et al.* (1993). This study aims to broaden the thinking around the impact that crime and the perception of crime in a neighbourhood may have on individuals and on the community as a whole. This section links with Section 2.3 and develops theories and examples discussed in a New Zealand context, including; examining theories around primary causes of crime in New Zealand and the impact of disorder and disorganisation community structure and wellbeing.

Crime in New Zealand

Limited research has been conducted examining the spatial and temporal patterns of crime in New Zealand. Much of the research that exists is directed mainly towards analysis of numbers of reported crime, victimisation of crime and restorative justice between offenders and victims - Mayhew *et al.* (2007); Morris *et al.* (2003).

Studies tend to focus on the direct impacts from criminal incidents that people have experienced and examine the impact that this has had upon them - Triggs (1997). Newbold 2000 explores the way in which crime is viewed, analysed and theories around criminal activity in a New Zealand setting. Newbold highlights the applicability of theories on the motivators for criminal activity through many of the same processes in a New Zealand setting. Socio-economic status is highlighted as a driver from the social environment that can amplify the volatility for the creation and perpetuation of environmental conditions suitable for criminal activity to occur - Newbold (2000). Theories around the notorious underreporting of sexual assault are confirmed as applicable in a New Zealand context. Additionally, domestic violence, predominantly against women and children is highlighted as an area of criminal justice that is of particular concern with New Zealand experiencing relatively high rates compared to similar countries - Newbold (2000).

Newbold highlights inequality as a strong driver of criminal activity in New Zealand; this links with theories around imbalances in the physical, economic, community, institutional and social domains of a neighbourhood - Matthews*, et al.* (2010) Newbold suggests that the high rates of violence, particularly domestic violence are likely being driven by the increasing marginilisation of at risk communities through underinvestment in critical resources needed to support healthy and vibrant communities. Socio-economic

stress is seen as a driving factor for domestic violence; increases in unemployment, reduction to benefit payments and an increasing gap between rich people and poor people in an income sense have been correlated with corresponding increases in overall rates of crime and in particular, violent crime.

Pawson et al. (2003) examined the spatial patterning of rape and fear in Christchurch. They based their research on incidents that had been reported in the newspapers. They found based on a small sample size that areas with higher reported rape rates that there was a corresponding fear of crime particularly among women - Pawson, *et al.* (1993). Thornley (2004) examined the spatial and temporal analysis of burglary in Christchurch. Although this study did not examine the direct impact of crime on health it did suggest that the spatial patterning of burglary is closely associated with socio-economic deprivation in Christchurch - Thornley (2004). This study aims to build upon the work of these two studies and provide research about the possible association between crime and health in Christchurch.

Psychological stress from an external influence can largely explain the inability to cope with socioeconomic changes; the method for dealing with stress is largely cultural and is not easily addressed - Gleeson *et al.* (1998); Matthews, *et al.* (2010); Newbold (2000).The response to crime in New Zealand has largely been penal and responsive through mechanisms in the criminal justice system. Crime prevention has been targeted towards individual level interventions aimed at changing behavioural outcomes. The need for research examining the causes of crime is necessary in understanding and being able to plan to reduce crime potential and reduce the downstream negative impacts on health and wellbeing in New Zealand. Newbold reiterates the importance of socio-economic conditions as a major driver for crime potential and also links the notion of perpetuated cultural norms that differ across different groups in society, particularly based on education and occupational differences - Newbold (2000).

Community Cohesion

Millie 2005 explored methods through which anti-social behaviour could be reduced. They found that perception of difference or heterogeneity based on a lack of understand through either lack of exposure or limited opportunities for community interaction impacted significantly on peoples' ability gauge and adopt wider social norms - Millie *et al.* (2005). Newbold supports this notion by suggesting that targeted interventions based on strengthening community spirit and pride in an area can potentially reduce overall crime and delinquency rates. Spatial influence from imbalances in the environmental domains on crime rates although well known through social disorganisation theory has largely been under-researched in New Zealand; congruently the indirect impact of crime on the health and wellbeing of individuals and communities has also largely been under-researched. This research aims to bridge that gap.

As has been researched, unequal and inequitable access to community resources is a significant driver of crime potential. Pearce 2006 suggests that access to community amenities in New Zealand is significantly unequal. Pearce noted that there was a clear difference within major cities between advantaged and disadvantaged neighbourhoods and access to community resources - J. Pearce*, et al.* (2006). Witten 2003 found that access to community resources varied significantly within urban environments with disadvantaged communities having poorer access to community resources. Pearce 2011 supported the notions presented by Pearce 2006 and Witten 2003; Pearce 2011 found that after adjusting for key confounders that there was a significant association between multiple environmental deprivers and negative health outcomes of people in disadvantaged communities.

 The structural role of the physical and built environments is an integral part in increasing or decreasing access to resources at a neighbourhood level - Gindroz*, et al.* (2005). The provision of neighbourhood resources in areas most at risk from crime and delinquency is important in reducing the confounding influence of socio-economic conditions. Targeted investment in areas that currently have poor access in New Zealand will help to provide those areas with higher levels of support through focused intention on meeting the specific needs of each particular community - Gindroz*, et al.* (2005); J. Pearce *et al.* (2011).

3. Methods

Crime data

The crime data for this study was obtained from the statistics department of New Zealand Police. The information provided included the geographic location, date, and time of day, scene description and offence description for each recorded incidence of assault and burglary for the calendar years 2008-2010 in Christchurch. These dates were selected to match the most up to date health data that was available. The data was categorised into assault (violent crime) and burglary (property crime). Assault and burglary are commonly used indicators of violent and property crime - Breetzke (2010b); some studies expand the violent crime category to include rape and murder, however it was determined based on the nature of these crimes and the hypothesis around assault that this data would not be requested. The property crime indicator 'Burglary' includes all offences recorded across residential, commercial and industrial sites. It was decided to include all different types of burglary offences in this study in order to reflect the total prevalence of burglary within a geographic area. The crime data was provided using easting and northing co-ordinates; however due to the sensitivity of both the crime and health data, this data was aggregated to census area unit level (CAU). A three year property and violent crime average was calculated for each CAU in order to offset outliers this was categorised at a rate per 1000 people. This is consistent with research

regarding the spatial analysis of crime with many articles aggregating crime data to census area unit or census tract level over a period of time - Andresen (2006); Wilcox *et al.* (2003).

Health data

The health data for this study was obtained from the statistics department of the Ministry of Health. The information provided included the patients' diagnosis, event start date, a unique identifier, geographical domicile of residence, gender and ethnicity for the calendar years 2008-2010. These dates were selected as they are the most up to date health data that was available and in the same regard as the crime data, they were selected to provide a three year average. Research has suggested that people that are in stressful situations are more likely to present with mental health issues such as anxiety and physical health issues such as a heart attack - Stafford*, et al.* (2007). We sought to obtain mortality data for the same time period however this was not available; similarly we sought to obtain primary data regarding stress related calls to healthline, however due to low numbers this data was deemed not suitable for analysis.

The morbidity data used regarding heart attack and anxiety admissions is consistent with studies conducting similar research - Sundquist*, et al.* (2006). Heart attack admissions were classified under the following ICD-10 codes (International Statistical Classification of Diseases and Related Health Problems 10th Revision); **I00–I99** Diseases of the circulatory system. Heart attack admissions represent the strain that the body can be put under from the feelings of stress from external or internal factors; there are several factors that contribute to heart attacks occurring with stress being one of them, this study seeks to control for many of these factors to independently assess the impact of crime on heart attack admissions. Anxiety admissions were classified as under the following ICD-10 codes; **F00–F99** Mental and behavioural disorders. Anxiety admissions represent the strain that an individual's mental and emotional state can be put under by stress; again there are several factors that can contribute to anxiety admissions. Some of the categories occur naturally or can be classified as genetic; however stress can increase the likeliness or bring forward the onset of these conditions.

There are limitations to using the heart attack and anxiety ICD-10 data as not all conditions are classified as directly stress related; however literature suggests stress on the body and mind is likely to amplify the chances of these disorders and illnesses occurring; attempts have been made to control for confounding variables. Duplicates were removed based on the unique identifier to ensure that heart attack and anxiety incidence was measured instead of prevalence; this measure ensured that each person was only being measured once over the 3 year period if they had multiple admissions over that time period. These variables were then age adjusted to give a more accurate representation of the rates of heart attack and anxiety admissions per 1000 people per CAU.

Control variables: compositional

Census data was obtained from Statistics New Zealand based on the 2006 New Zealand Census. Information provided included dwelling information, household information, family information, extended family information and personal information at the CAU level. Each of these sections included a wide range of variables from income, to methods of transport, to the method of home heating. Based on the review of literature (see Tables 3.1 and 3.2). a number of control variables were selected in this study, these include; percentage Maori, median family income ($NZ), percent with no religious affiliation, percent never married, percent of home ownership, percentage unemployed and percentage regular smoker These variables were then calculated as a percentage of the total population of each of the CAU's.

The New Zealand Deprivation Index (NZDep) is a measure of relative physical and material deprivation in New Zealand; the index is compiled using various variables collected from within the census; many studies examining crime and/or health have used a similar index. Based on previous literature and the likely influence of particular variables within index it was determined to use the individual variables; median family income, percentage of home ownership and percentage unemployed as independent variables rather than using NZ Dep as a composite measure of deprivation

Control variables: contextual

Contextual control variables were obtained from the GeoHealth Laboratory at the University of Canterbury. Based on literature the following contextual control variables were included in the analysis: access to public green space (SQKMper1000people), general practitioner (GP) within 3 kilometres (per 1000 people), fast food outlets (within 3 kilometres) and total community resources (per 1000 people) (see Tables 3.1 and 3.2). The access to GP's and fast food outlets was calculated from the population weighted centroid of each census area unit to determine the accessibility to these locations from the population centre of each of these areas.

Access to public greenspace and total community resources were determined to be a total count of availability of these resources to the people within each census area unit in which they are located; although of course, these resources can service people from outside of the census area unit that they are located. These variables were then calculated as a count per 1000 people to create a uniform measure for analysis.

Table 3.1- Independent control variable selection – Heart Attack

Heart Attack	Reference	Finding
Ethnicity	Cheuk Chan, W. Wright, C. Riddel, T. Wells, S. Kerr, A. Gala, G. Jackson, R. (2008) 'Ethnic and socioeconomic disparities in the prevalence of cardiovascular disease in NZ' Journal of NZ Medical Association 121:1285	Positive relationship between Maori and higher heart attack rates.
Unemployment	Sundquist, K. T., H. Yang, M. Li, X. Johansson, S. Sundquist, J. (2006). "Neighbourhood violent crime and unemployment increase the risk of coronary heart disease: a multilvel study in an urban setting." Social Science and Medicine **62**: 2061-2071.	Positive relationship between higher rates of unemployment and higher heart attack rates.
Low Income	Augustin, T. Glass, T. James, B. Schwartz, B. (2008) Neighbourhood Psychosocial Hazards and Cardiovascular DiseaseL The Baltimore Memory Study	Positive relationship between low income neighbourhoods and higher heart attack rates.
Age	Jousilahti, P. Vartiainen, E. Tuomilehto, J. Puska, P. (1999) 'Sex, age, cardiovascular risk factors and coronary heart disease: A prospective follow up study of 14,786 middle aged men and women in Finland' Journal of the American Heart Association 99: pp 1165-1172	Positive relationship between age cohorts 50-59 and 60+ when associated with other risk factors and higher heart attack rates.
Greenspace	Lee, A. Maheswaran, R. (2010) "The health benefits of urban green spaces: a review of the evidence" Journal of Public Health 33(2) pp 212-222	Found that in some studies access to greenspace was linked with positive physical health outcomes
Fast Food	Larson, N. Story, M. Nelson, M. (2009) "Neighbourhood Environments – disparities in access to healthy foods in the US" American Journal of Preventive Medicine 36(1) pp 77-81	Links in some studies showing an association between fast food accessibility and increased risk of heart attack incidence
Smoking	Cullen, P. Schulte, H. Assmann, G. (1998) "Smoking, lipoproteins and coronary heart disease risk" European Heart Journal 19(11) pp 1632-1641	Significantly increase in heart attack rates in smokers compared with non-smokers and passive smokers
Sources - - Augustin*, et al.* (2008); Cheuk Chan *et al.* (2008); Cullen *et al.* (1998); Jousilahti *et al.* (1999); Larson *et al.* (2009); Lee *et al.* (2010); Sundquist*, et al.* (2006)		

Table 3.2 – Independent control variable selection - Anxiety

Anxiety	Reference	Finding
Religion	Ellison, C. Burdette, A. Hill, T. (2009) 'Blessed assurance: religion, anxiety and tranquillity among US adults' Social Science Research 38:3 pp 656-667	Positive relationship between more frequent religious attendance and beliefs and lower rates of anxiety
Community Resources	Bernard, P. Charafeddine., R. Frolich, K. Daniel, M. Ketsens, Y. Potvin, L. (2007). "Health inequalities and place: a theoretical conception of neighbourhood." Social Science and Medicine **65**: 1839-1852.	Poorer neighbourhood access to resources associated with poorer health outcomes
Employment	Waghorn, G. Chant, D. (2005) 'Employment restrictions among persons with ICD-10 anxiety disorders: characteristics from a population survey' Anxiety Disorders 19 pp 642-657	Positive relationship between increase restrictions on employment and higher rates of anxiety.
Low Income	Lofors, J. Ramirez-Leon, V. Sundquist, K. (2006) 'Neighbourhood income and anxiety: a study based on random samples of the Swedish population' European Journal of Public Health 16(6) pp 633-639.	Positive relationship between low income neighbourhoods and higher rates of anxiety after adjusting for contextual variables.
Marital Status	Liu, H. Umberson, D. (2008) 'The times they are a changin': marital status and health differentials from 1972 to 2003' Journal of Health and Social Behaviour 49 pp 239-253	Positive relationship between higher married rates and lower rates of anxiety.
Doctor Access	Bissonnette, L. Wilson, K. Bell, S. Ikram Shah, T. (2012) "Neighbourhoods and potential access to health care: The role of spatial and aspatial factors" Health and Place	Poor access to doctor associated with poorer health outcomes.
Home Ownership	Cairney, J. B., M. (2004). "Home ownership, mortgages and psychological distress." Housing Studies **19**(2): 161-174.	Lowest levels of stress and anxiety associated with mortgage free home ownership
Sources - - Bernard*, et al.* (2007); Bissonnette *et al.* (2012); Cairney *et al.* (2004); Ellison *et al.* (2009); Liu *et al.* (2008); Lofors *et al.* (2006); Waghorn *et al.* (2005)		

Study Site Selection

The study site of the Christchurch Urban Area or 'Christchurch City' was determined based on the Christchurch City Council Territorial Authority boundaries. The 'Christchurch City' and 'Banks Peninsula District' are located within the Christchurch City Council Territorial Authority boundary. It was determined based on the methodology from studies in similar contexts that the study be limited to the 'Christchurch City' or Christchurch Urban Area - Tan *et al.* (2009). Outlying census area units located to the west and south of the 'Christchurch City' limit were included based on their geographic location within the Christchurch Urban Area and their concentration of population measured by their population weighted centroid indicating close spatial proximity to other urban census area units. Some studies have excluded semi-rural census area units or census tracts based on small numbers and the possibility of significantly skewing data (reference these studies). Based on the limited area units with low numbers and their classification within the 'Christchurch City' District, it was determined to include them in the study area. Similarly the census area units located within the 'Banks Peninsula District' were deemed officially not a part of the main urban area of Christchurch or 'Christchurch City' and on this basis they were excluded from the study area.

Variable Selection and Creation

Literature suggests that census area units or census tracts usually contain approximately 4,000 people; around this number is optimum, however they can range from between 1,500 – 8000 people depending on the geographic nature of an area. Census area units in the Christchurch Urban Area range from between 228- 5703 people with an average of 3060.83 people per census area unit. Section 3.1 illustrated the sources and nature of data variable. In order to create a consistent method of analysis each of the independent contextual variables and compositional census variables was either calculated as a percentage of the total or count per 1000 people at the CAU level. The health data was age-stratified based on the admission data to determine an admission rate per 1000 people at the CAU level. The crime data was aggregated up from easting and northing (x, y) level to a rate per 1000 people per CAU. From this point the data was analysed in SPSS to determine whether any of the variables had significant skewness or kurtosis; based on this analysis and in line with other research from literature each of the variables were classified into quintiles. These variables were classified into quintiles were used for the remainder of the analysis.

Geocoding

Due to the nature of the data provision the only variable necessary for geocoding was each of the crime variables 'assault and burglary'. Data was provided using easting and northing (x, y) co-ordinates and no issues were determined in geocoding these points within the Christchurch Urban Area. Issues can arise

with geocoding if the data being geocoded is based on street address locators; however due to the provision of the crime data none of these issues were encountered.

Regression Analysis

Regression analysis was conducted using multiple regression analysis in SPSS. Regression was undertaken by initially running a baseline model containing all the control variables. Next, the crime variables (assault and burglary) were added to the baseline equations after controlling for the contextual and compositional controls in order to assess the independent effect that the crime variables had on these two negative health outcomes. The results of this analysis show the strength of association measured by the 'coefficient value', the standard error (within a 95% CI) and whether or not the association is statistically significant as shown by the *significant at the 0.05 level and ** significant at the 0.01 level indicators. Spatial analysis was conducted using ESRI ArcMap 9.3 and 10. Spatial clustering analysis was performed using the Getis-Ord Gi* as part of the spatial statistics tool within ArcMap with the results showing values higher and lower in magnitude than might be expected from a random distribution. All maps are displayed using the New Zealand Transverse Mercator 2000 (NZTM 2000), with the distance measure displayed in kilometres (km).

4. Results

This chapter provides the results of analysis including a descriptive analysis of the independent variables, and an examination of the spatial and temporal trends of assault, burglary, heart attack admissions and anxiety admissions. The results of the multivariate regression analysis are also provided. The chapter begins by exploring the independent variables and bivariate correlations between them. The chapter then investigates the descriptive temporal and spatial results of assault, and burglary, as well as the heart attack admissions and anxiety admissions. The chapter concludes with analysis of the empirical regression results highlighting key findings and whether or not these are reflective of results found in previous literature.

Descriptive Analysis of variables

The descriptive results of the independent variables are provided in Table 4.1. The results indicate a wide variation in compositional and contextual effects across the Christchurch Urban Area. The first independent variable 'Maori %' shows a mean level across the Christchurch City CAU's of 7.37%; this is in contrast to the New Zealand mean level of 14.04% and demonstrates a much lower than average representation across Christchurch of Maori people. Based on previous literature in New Zealand investigating ethnic and socioeconomic disparities in the prevalence of cardiovascular disease, that there is likely to be a lower than average rate of heart attacks in Christchurch or clustering of heart attack admissions rates in areas that have higher proportions that are Maori - Cheuk Chan, *et al.* (2008). The second independent variable measures total family income as a median value across a CAU - 'Median Income ($NZ)' shows a mean level across the Christchurch City CAU's of $60,304 (NZ), this is representative of the New Zealand average of $59,000 (NZ); the standard deviation of $15,061 (NZ) and the difference between the minimum of $30,100 (NZ) and maximum $100,000 (NZ) indicates a high likelihood of spatial income inequality - Tan, *et al.* (2009). The third independent variable 'No Religion %' shows a median value of 35.09% across the Christchurch City CAU's, this is representative of the New Zealand average of 34.7%; the lack of variation across the Christchurch City Area as represented by the relatively small standard deviation of 4.30% indicates that this variable is unlikely to confound the results spatially; the literature is not conclusive but suggests that more frequent religious worship attendance is associated with lower anxiety risk - Rasic *et al.* (2011).

The fourth independent variable 'Never Married %' with a value of 33.51% is slightly higher than the New Zealand average of 31.37% and the significant difference between the minimum and maximum values per CAU indicates that this variable is spatially stratified throughout Christchurch. Previous work has shown that higher levels of people that are not married is associated with higher rates of anxiety - Liu, *et al.*

(2008). The fifth independent variable 'Home Ownership %' has a mean of 51.87% which is lower than the New Zealand average of 66.9%; there is a significant variation between the minimum and maximum values for the Christchurch City CAU's with a maximum of 73.85% and a minimum or 10.34%; higher rates of anxiety have been recorded by people that rent, with lower rates of anxiety recorded by mortgage free home owners - Cairney*, et al.* (2004).

The sixth independent variable 'Unemployed %' has a mean of 2.94% this is significantly lower than the New Zealand average of 5.1%, this may be due to the urban setting that this study is conducted in, future research could be investigate the association between urban and rural variations in employment rates. Unemployment has been linked with higher rates of cardiovascular disease in Sweden - Sundquist*, et al.* (2006), spatial variation in Christchurch appears to be low, which may indicate that unemployment may not be a confounding variable.   The seventh independent variable 'Greenspace SQKM per 1000' shows a significant variation between the minimum (0.0002 SQKM per 1000) and the maximum (22.03 SQKM per 1000); previous literature suggests that results can be mixed with regard to greenspace and positive health outcomes, given the variation in greenspace provision in Christchurch it is likely that it could have a confounding affect - Lee*, et al.* (2010).

The eighth independent variable 'Doctor within 3KM per 1000' indicates significant spatial variation with a 39.22 difference in general practitioner per 1000 people across Christchurch City CAU's. Literature suggests that good spatial access to primary care reduces the risk of negative health outcomes - Bissonnette*, et al.* (2012). Given the large variation in general practitioner provision it is likely that this variable may confound the results.

The ninth independent variable - 'Regular Smoker per 1000' shows a mean of 145.64 people per 1000 which is lower than the New Zealand average of 19.9 percent or 199.00 people per 1000. Similar to a number of the other variables the high standard deviation and difference between the minimum and maximum values indicate that there is significant variation in the prevalence of smoking with Christchurch City CAU's. Literature suggests that there is a significant association between smoking and heart disease; however it is difficult to know whether it is likely to occur in this setting - Cullen*, et al.* (1998).

The tenth independent variable 'Fast Food within 3KM per 1000' shows a relatively low provision of fast food outlets. Previous literature has found links with access to fast food and poor health outcomes however the maximum of 5 per 1000 people indicates that this is unlikely to be a confounding variable - Larson*, et al.* (2009). The eleventh independent variable 'Community Resources per 1000' shows a strong variation in community resource provision; previous literature suggests that areas with poorer

neighbourhood access to community resources can often have poorer health outcomes; given the large variation in this study, it is likely that this variable will confound the results - Bernard, *et al.* (2007).

The three-year mean assault rate in Christchurch is 9.85 per 1000 people per year. Comparison with international crime rates is difficult for a number of reasons. However the United Nations have compiled national levels of crime rates per captia - UN (2002). New Zealand assault rates were determined to be 8.07 per 1000 people per year, compared to other countries; Sweden (6.90), Scotland (12.14), England and Wales (8.34), South Africa (12.10) and Canada (7.50) in 2002 - UN (2002). These figures suggest that New Zealand has an average assault rate in comparison to these selected countries; additionally, these figures suggest that Christchurch has a reasonably high assault rate per 1000 people per year. The large standard deviation in assault rates indicates strong spatial clustering of assault rates in Christchurch.

The three year mean burglary rate in Christchurch is 18.49 incidents per 1000 people per year. As with assault rates there is limited empirical burglary rates worldwide however the same United Nations document shows that the New Zealand burglary rate in 2002 was 15.11 per 1000 people per year compared with other countries; Sweden (13.52), Scotland (8.66), England and Wales (14.94) South Africa (8.68) and Canada (8.76) - UN (2002). Research conducted in 2004 in Christchurch shows that the average burglary rate varied between 18.00 per 1000 people per year and 22.00 per 1000 people per year between 1998 and 2003 - Thornley (2004). The results indicate that the burglary rate in Christchurch has remained consistently within those same levels. The standard deviation, minimum and maximum values indicate that there is likely to be significant spatial clustering of burglary rates in Christchurch.

The results of the bivariate correlation analysis (in Table 5.2) shows a few interesting trends. Overall there is low co-linearity among the independent and dependent variables. Home ownership is inversely related to people that have never been married (-.890**) and those that are unemployed (-.779**). Assault rates have a (.734**) correlation with the percentage of Maori people and an inverse correlation with median income (-.744**). The last correlation to note is the inverse correlation between fast food outlet provision and doctor provision (-.870**). Kawachi et al. (1999) suggests that inequalities in unemployment and income are likely to be linked with social disorganisation and relative deprivation and lead to crime - Kawachi Kennedy *et al.* (1999). The results of this analysis suggest that this could be replicated in Christchurch.

Table 4.1 –Descriptive Statistics of the selected set of variables (per CAU)

Independent Variables	Mean	SD	Min	Max
1. Maori (%)	7.37	4.14	1.86	21.31
2. Median Income ($NZ)	60304	15061	30100	100000
3. No Religion (%)	35.09	4.30	25.11	43.19
4. Never Married (%)	33.51	9.07	19.66	63.38
5. Own Home (%)	51.87	14.41	10.34	73.85
6. Unemployed (%)	2.94	1.09	1.09	6.07
7. Greenspace (SqKm per 1000)	.43	2.11	.0002	22.03
8. Doctor with 3km (per 1000)	4.81	4.99	.00	39.22
9. Regular Smoker (per 1000)	145.64	92.99	.00	606.3492
10. Fast Food within 3km (per 1000)	2.96	1.42	1	5
11. Community Resources (per 1000)	20.31	28.98	.00	254.90
12. Assault Rate (per 1000)	9.85	30.55	.61	322.62
13. Burglary Rate (per 1000)	18.49	16.07	3.55	139.27

Table 4.2 – Independent Variable Bivariate Correlation – Christchurch Urban Area.

Independent Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Maori (%)	1												
2 Median Income ($NZ)	-.757**	1											
3 No Religion (%)	.531**	-.429**	1										
Never Married (%)	.509**	-.708**	.465**	1									
Own Home (%)	-.487**	.677**	-.257**	-.890**	1								
Unemployed (%)	.544**	-.735**	.380**	.792**	-.779**	1							
Greenspace (SqKm per 1000)	-.044	.230*	.009	-.376**	.358**	-.221*	1						
Doctor with 3km (per 1000)	-.058	.278**	-.022	-.535**	.534**	-.376**	.415**	1					
Regular Smoker (per 1000)	.662**	-.543**	.397**	.349**	-.340**	.371**	-.128	.066	1				
Fast Food within 3km (per 1000)	.195*	-.389**	.128	.642**	-.611**	.487**	-.447**	-.870**	.115	1			
Community Resources (per 1000)	-.045	.013	-.009	-.138	.199*	-.063	-.018	.172	.062	-.155	1		
Assault Rate (per 1000)	.734**	-.744**	.416**	.642**	-.686**	.615**	-.022	-.274**	.521**	.394**	-.249**	1	
Burglary Rate (per 1000)	.434**	-.575**	.318**	.695**	-.686**	.619**	-.128	-.513**	.274**	.584**	-.275**	.668**	1

1 = Maori %. 2= Median Income ($NZ). 3= No Religion (%). 4 = Never Married (%). 5 = Own Home (%). 6 = Unemployed %. 7 = Greenspace (SqKm per 1000). 8 = Doctor within 3km (per 1000). 9 = Regular Smoker (per 1000) 10 = Fast Food within 3km (per 1000). 11 = Community Resources (per 1000). 12 = Assault Rate (per 1000). 13 = Burglary Rate (per 1000).

** statistically significant at the 0.01 level

*statistically significant at the 0.05 level

Spatial and temporal trends of crime

Assault

The temporal results for the violent crime indicator 'Assault' provide an interesting comparison with results found in the literature. There is a temporal monthly trend in assault rates over the 3 year period in Christchurch in August and November, with a smaller spike recorded over the months February-March (see Figure 4.1). The highest peak in assault rates is in November which is the last month of spring. McDowall et al. (2011) founds that winter (June, July and August) and spring (September, October and November) are generally not characterised as peak seasons for assault - McDowall *et al.* (2011); with assault peaks more common in summer (December, January and February) - McDowall*, et al.* (2011). The peak in offences in summer is consistent with previous literature however these results provide some interesting points for further research to explain potential influences on the winter and spring peaks - McDowall*, et al.* (2011).

The temporal hourly trend in assault rates of the three year period indicates two major peaks occurring between 10:00-10:59 and 15:00-15:59 with a smaller peak occurring between 18:00-18:59. These peaks occur throughout a gradually increasing trend from 05:00- 05:59 to 23:00-23:59 with a rapid drop in assault rates between 00:00-01:00 to 04:00-04:59 (see Figure 4.2). The findings from this research are consistent with findings conducted in Sydney, Newcastle and Wollongong in Australia - Briscoe *et al.* (2001); Jochelson (1997). Jochelson (1997), for example, examined assault rates in Sydney by the time of day from 1995-1996. Their results show a very similar trend to the findings in this research as they found three main peaks occurring within a gradually increasing trend from 05:01-06:00 to 23:01-24:00 with a rapid reduction in rates between 00:01-05:00. The first spike occurs between 10:01-12:00; the second spike between 15:01-17:00 and the third spike between 21:01-23:00. Jochelson notes some observations from the research around the potential indicators that are likely to be linked with higher assault rates. These indicators include; assault arising from personal conflict; assault based on racism and indifference; unprovoked assault and lastly; alcohol consumption prior to assault - Jochelson (1997). Briscoe et al. (2001) found similar results in regard to the hourly trend of assaults in association with assaults on-licensed alcohol premises with assault rates peaking at midnight after increasing significantly through the day and increasing rapidly from 3pm and again at 9pm; common assault was noted as being higher in both residential and outdoor settings - Briscoe*, et al.* (2001). Weekly assault trends show a sharp increase in the level of recorded assaults from Friday-Sunday, dropping significantly on a Monday then increasing gradually to Friday (see Figure 5.3). Nelson et al. (2001) found a similar trend when investigating the temporal incidence of violence crime in Cardiff, Wales and noted the lowest point as a Monday, with a gradual increase in violence rates through to Friday, with the peak occurring

on Saturdays. Additionally Nelson noted that Saturdays experiences 27% of the weekly total for Cardiff - Nelson *et al.* (2001). Similar weekly patterns were identified by both Jochelson (1997) and Briscoe et al. (2001) who both found a gradually increasing trend from Monday to Thursday with a rapid increase from Friday to Sunday in Sydney. There is significant spatial patterning of assault in Christchurch with a band of Quintile 4 and 5 (higher rate areas) being observed primarily within the central business district (CBD) and to the areas east and west (see Figure 4.4). Quintile 1 and 2 (lower rates areas) can be observed primarily north, north-west and are distantly south from the CBD. Hot spot cluster analysis indicates that there are spatial hotspots and cold spots of assault (see Figure 5.5). There is spatial clustering of census area units that are 1.96-2.58 and >2.58 standard deviations above the mean (average) assault rate for the Christchurch Urban Area; these area units are located to the east of the CBD.

Additionally there is a clear clustering of census area units that are -1.96- -2.58 and >-2.58 standard deviations below the mean (average) assault rate for the Christchurch Urban Area; these area units are located to the north west of the CBD, with two area units located approximately 10km to the south and 15km south east of the CBD. This spatial patterning is broadly reflective of the pattern of deprivation in the Christchurch Urban Area (see Figure 1.1 – Background Information) with the exception of the highly deprived areas to the west of the CBD, pockets north-west of the CBD and areas approximately 7km west of the CBD. Kawachi et al. (1999) found that there were two social characteristics that were associated with areas of high crime; these were the degree of relative deprivation (measured by income inequality) and degree of social organisation (measured by 'social capital' and 'collective efficacy' - Kawachi*, et al.* (1999), both these characteristics typically occur in CBDs. Similarly Tan et al. (2009) found that violent crime in particular was significantly clustered in areas of high deprivation within the city of Sheffield (UK) - Tan*, et al.* (2009). Pantazis (2000) suggests that a lack of social and cultural resources in addition to material deprivation may leave some areas without the contacts or organisational ability to cope with high levels of crime and disorder - Pantazis (2000). Ackerman et al. (2004) suggests that there may also be an association between the economic and structural conditions of an area and the ability of the individuals within those communities to access adequate social, economic and cultural resources - Ackerman *et al.* (2004). The visual perspective suggests that the pattern of assault in Christchurch may be related to relative levels of deprivation; although this may not be universally applicable (see Figure 4.5). Previous literature suggests that the structural deprivation of social, economic and cultural resources and amenities is likely to amplify the impact of deprivation on the ability of communities to cope with and reduce levels of violent crime. This may be the case in Christchurch - Pantazis (2000).
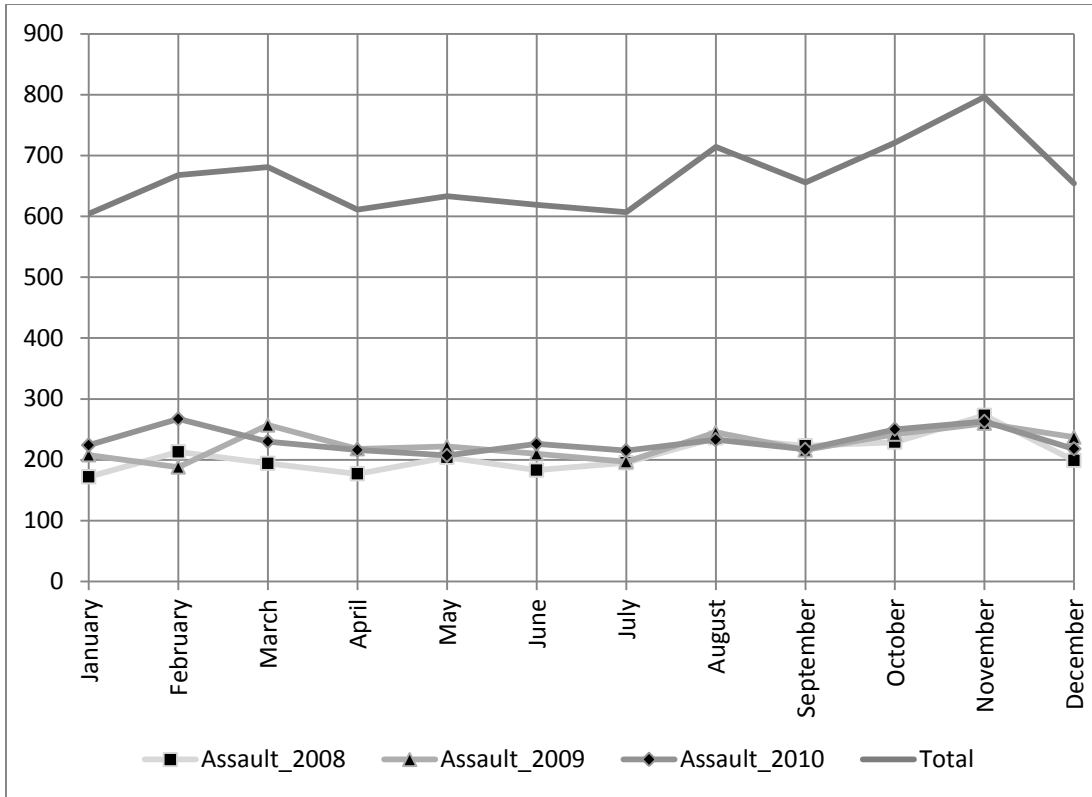
Figure 4.1 – Total Christchurch assault offence count per month 2008-2010 (Calendar Years)
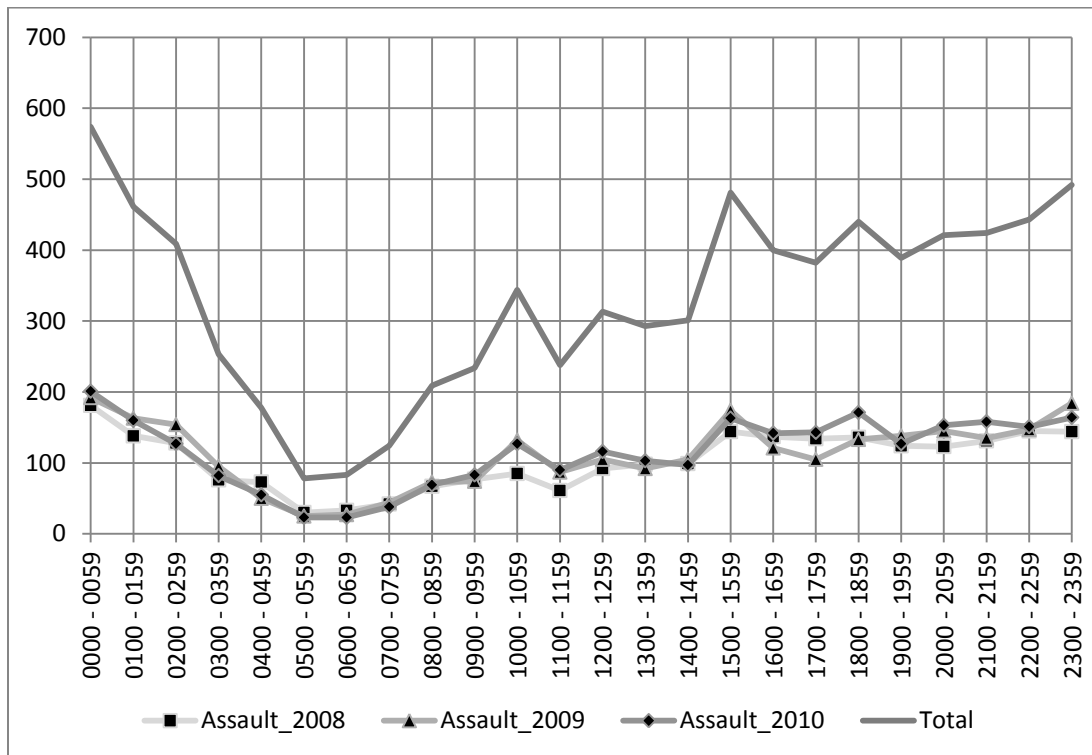

Figure 4.2 – Total Christchurch assault offence count per hour 2008-2010 (Calendar Years)
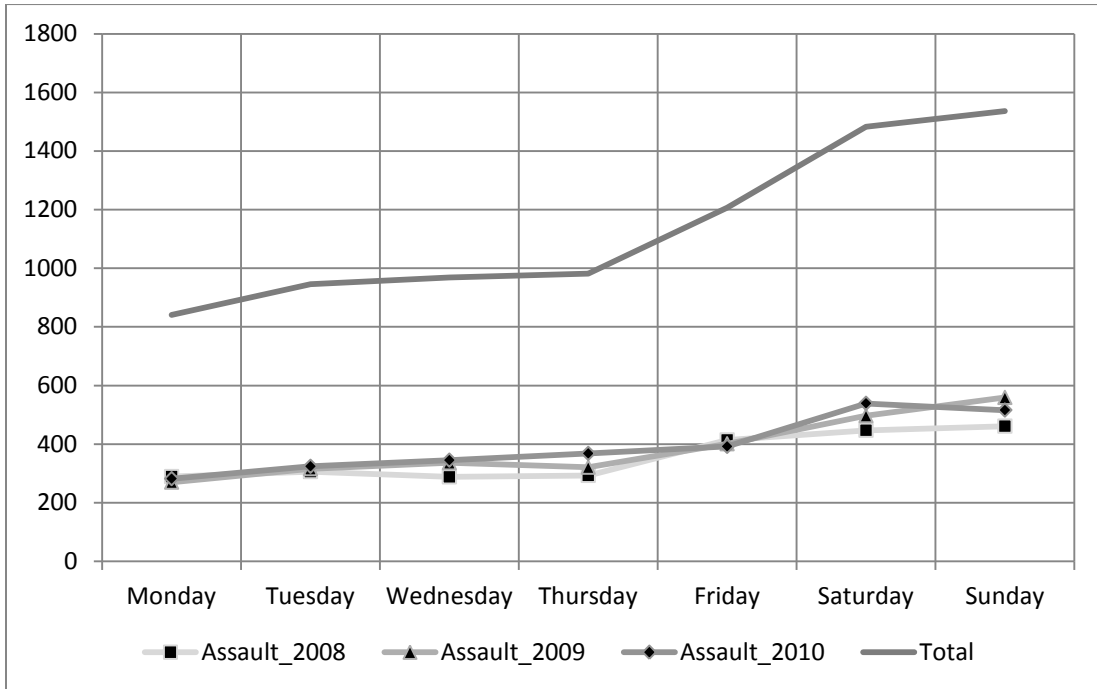
Figure 4.3 – Total Christchurch assault offence count per day 2008-2010 (Calendar Years)
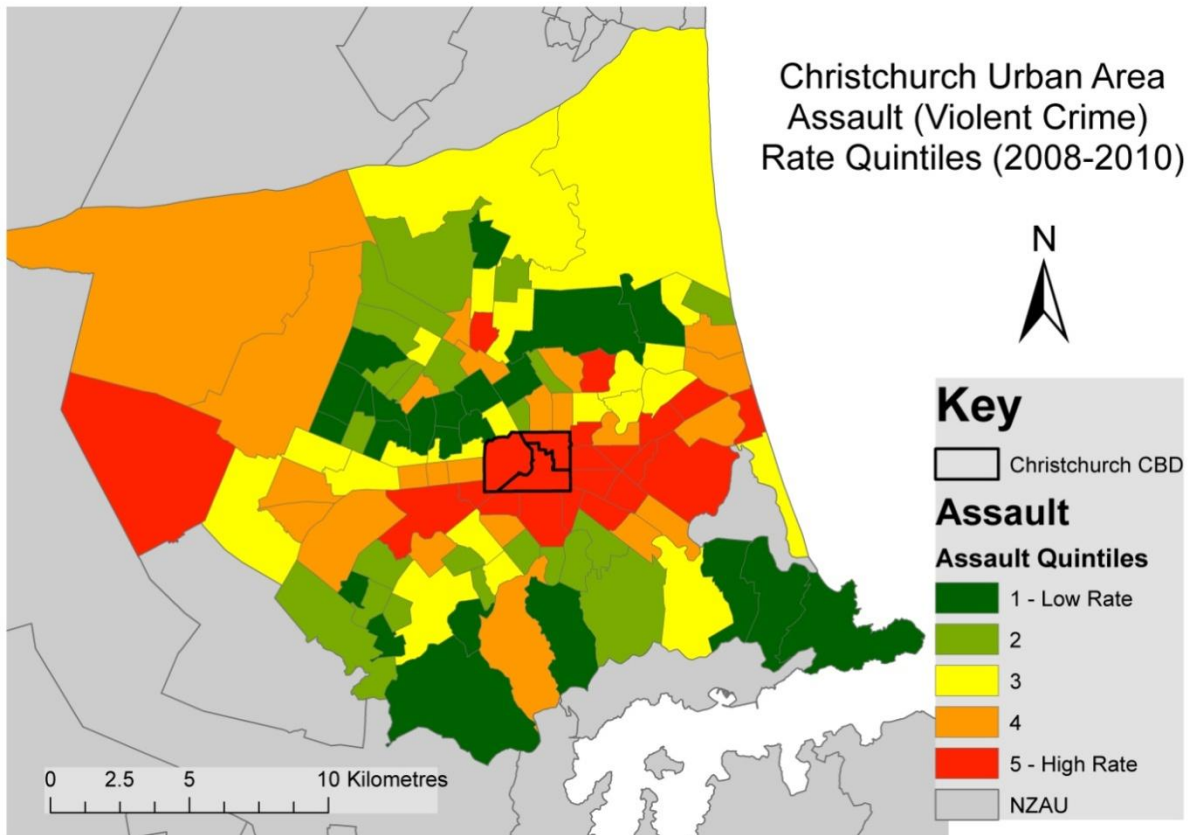

Figure 4.4 – Christchurch Urban Area Quintile Assault Rates per CAU (2008-2010)
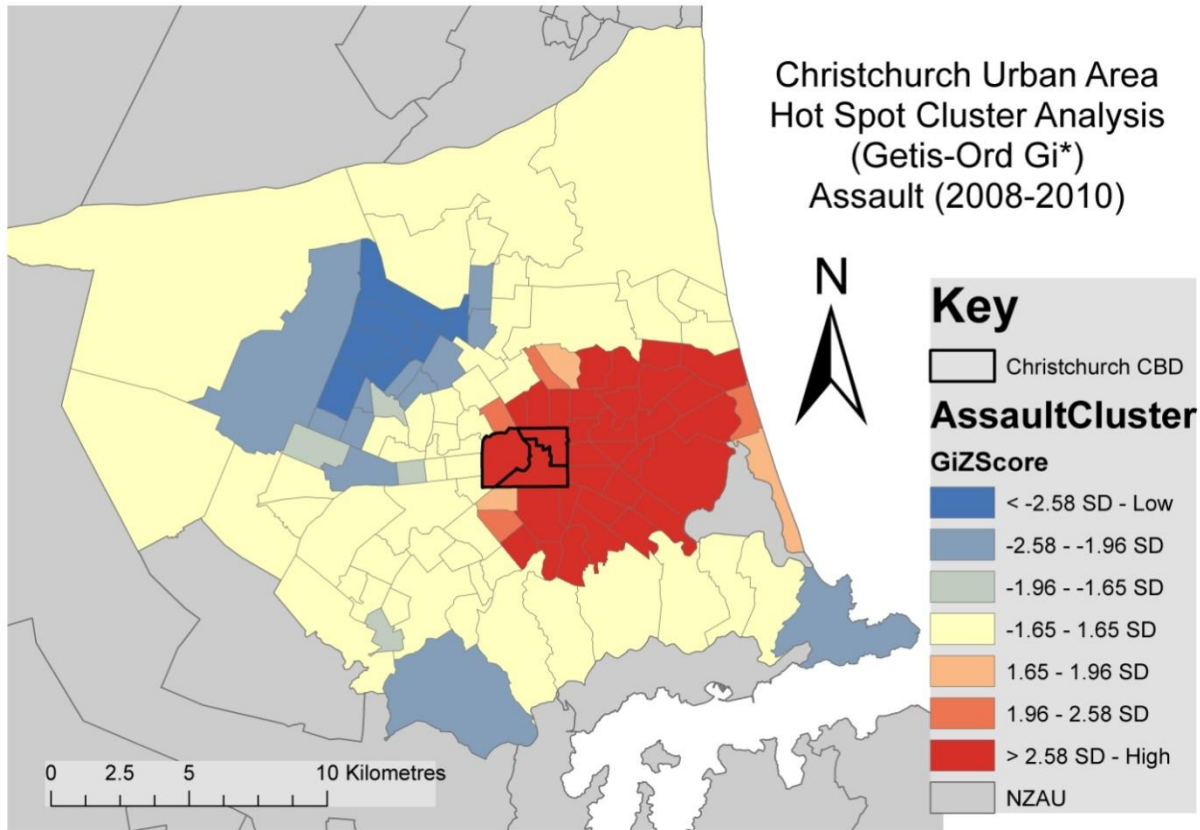
Figure 4.5 – Christchurch Urban Area Quintile Assault Rates Cluster Analysis per CAU (2008-2010)

Burglary

The spatial and temporal trends of 'Burglary' are different to that of the violent crime indicator 'Assault'. A monthly and seasonal trend emerges from the 3 year period with a peak in the winter months of July and August; there is a gradual increase from March through to July and a gradual decrease from August through to December with January and February remaining comparatively lower when compared to the rest of the year (see Figure 4.6).

Literature on the seasonal patterns of burglary is mixed. For example, McDowall et al. (2011) found a seasonal drop in burglary rates during the winter months and an increase during the summer months - McDowall, *et al.* (2011) when exploring the crime rates from 88 cities over a 24 year period. Sorensen (2004) on the other hand found a seasonal peak in burglary rates during the winter months with a reduction in rates during summer - Sorensen (2004) for recorded burglaries in Denmark during 2002. Lastly, Thornley (2004) examined burglary trends within Christchurch for the period 2000-2003 and found a drop in burglary rates during the summer months and an increase during autumn with a peak during the winter months - Thornley (2004). Thornley

suggests that although there is a peak in burglaries during winter it is not as significant a peak as is found in other literature. All researchers believe that further research is needed in this area - McDowall, *et al.* (2011); Sorensen (2004); Thornley (2004). Figure 4.7 indicates three clear hourly peaks in burglary rates throughout Christchurch. These occur at 08:00-08:59, 12:00-12:59 and 17:00-17:59; there are rapid decreases in rates between each peak and a significant reduction in rates from 21:00-21:59 to 05:00-05:59 (see Figure 4.7). These results suggest that burglaries are primarily reported during main meal times. Sorensen (2004) details the hourly trends in burglary for Denmark and found a pattern that is reflective of the findings in this study; they found that there were two main peaks with the first being at 12pm (Midday) and the second at 8pm - Sorensen (2004). Thornley (2004) found a similar trend in Christchurch suggesting that the time of day that burglaries occur is consistent with traditional work and sleep patterns - Thornley (2004).

 Weekly burglary rates show a steady trend from Monday-Wednesday with a sharp increase from Thursday-Saturday before declining on Sunday (see Figure 5.8). Sorensen (2004) again found patterns similar to this Christchurch study; a steady rate of burglary offences from Monday to Thursday, a peak from Friday to Saturday and a rapid decline on Sunday in Denmark - Sorensen (2004). Lastly, Thornley (2004) found similar results in Christchurch demonstrating a steady burglary rate during the week with a reduction during the weekend - Thornley (2004).

Although there is a lack of empirical case study evidence, criminological theorists outline some issues surrounding the reporting of burglary offences as there is often a lag time between when the offence was committed and when the victims identify that they have been burgled; this may impact the times recorded in this study around standard meal times of breakfast, lunch and dinner - Sorensen (2004). In addition, some theory suggests that burglary offences are more likely to occur during the traditional working time (Monday-Friday) and is more likely to occur in places with higher unemployment rates - Sorensen (2004); Thornley (2004). Hot spot cluster analysis indicates that census area units in and around the CBD exhibited above average burglary rates in Christchurch.

CAU's with lower than expected burglary rates are located further away from the CBD. Ackerman (2004) found that there was a lower incidence of property crimes in areas with little income inequality (low relative deprivation), similarly property crimes was found to be clustered in and around areas of high deprivation adjacent and sprawling from the CBD - Ackerman, *et al.* (2004). Quintiles 4 and 5 (high burglary rates) are mostly representative of the deprived areas within Christchurch (see Figure 4.9).

Thornley (2004) examined the socio-economic aspects to burglary incidence in Christchurch and found that overall burglary occurred either within deprived CAU's as classified by the NZDep Index and adjacent CAU's - Thornley (2004). Kawachi et al. (1999) found similar results in the United States, highlighting the association between relative deprivation, social disorganisation and the presence of burglary in particular - Kawachi*, et al.* (1999). Thornley (2004) and Kawachi et al. (1999) expanded upon this by suggesting that opportunity theory had an integral role to play in the spatiality of burglary offences whereby if the conditions for burglary to occur were favourable (high unemployment, lack of routine, social disorganisation and material deprivation) then burglary was more likely to occur in those areas - Kawachi*, et al.* (1999); Thornley (2004).

Figure 4.6 – Total Christchurch burglary offence count per month 2008-2010 (Calendar Years)
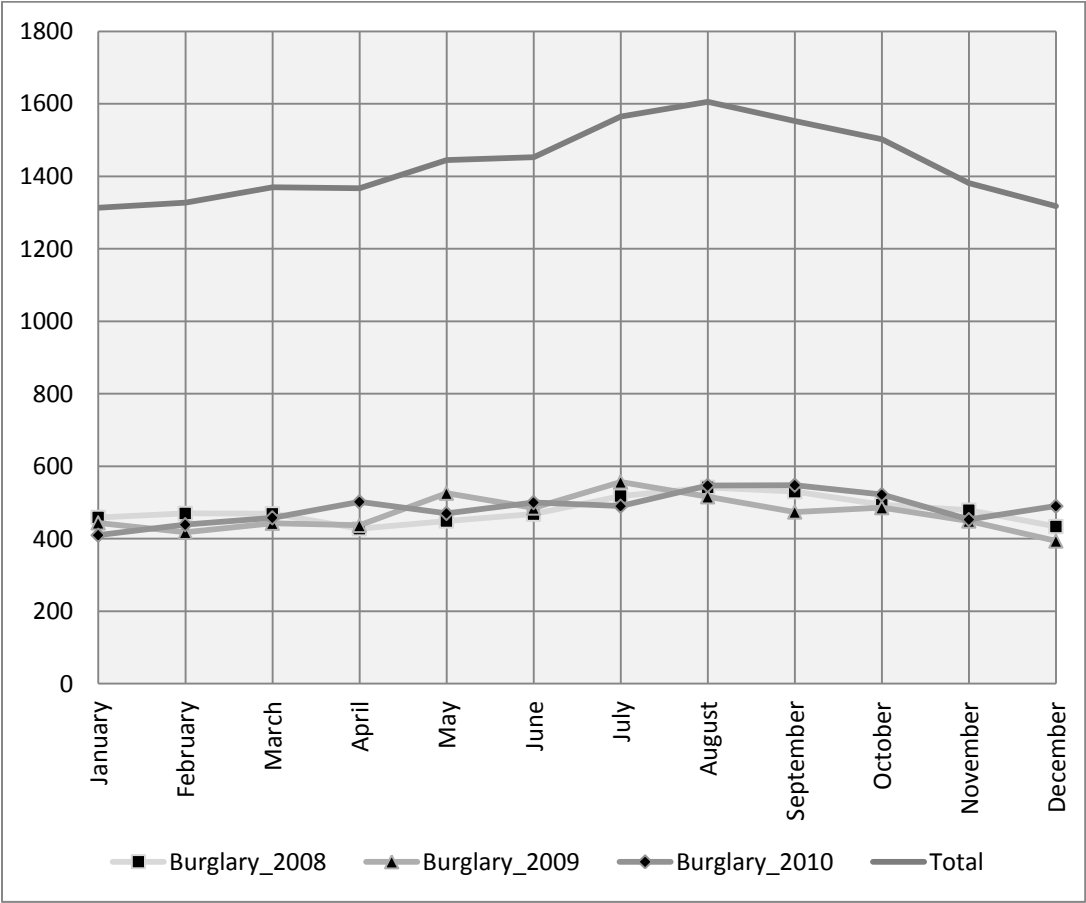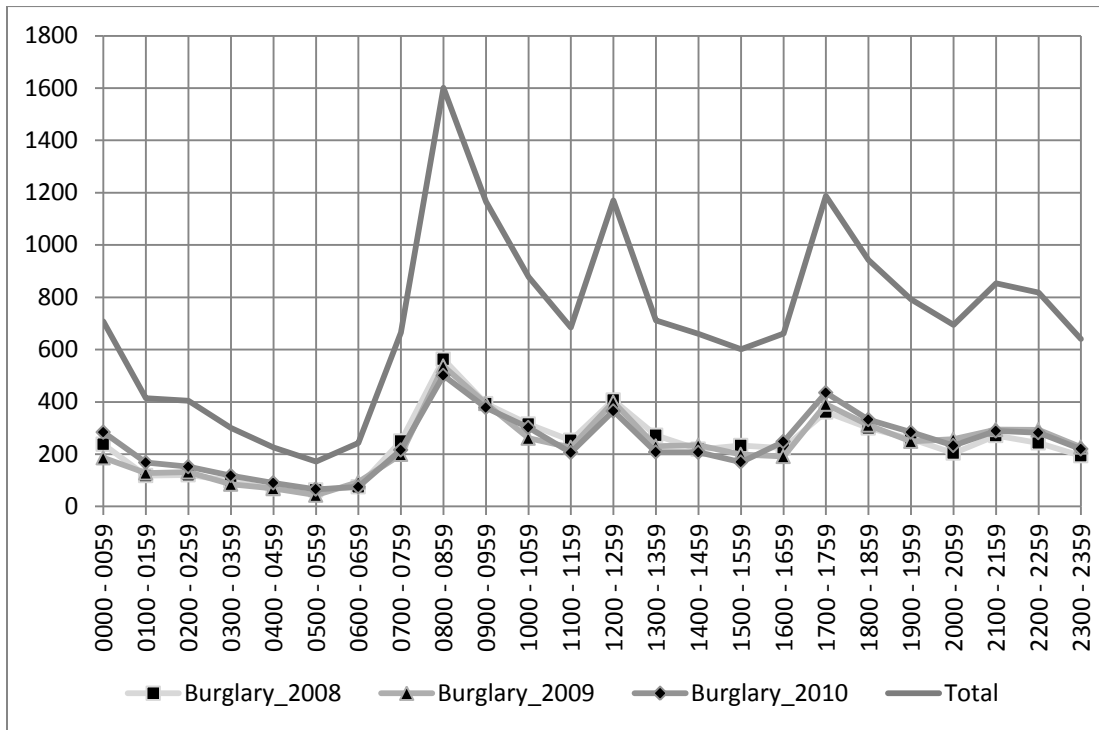
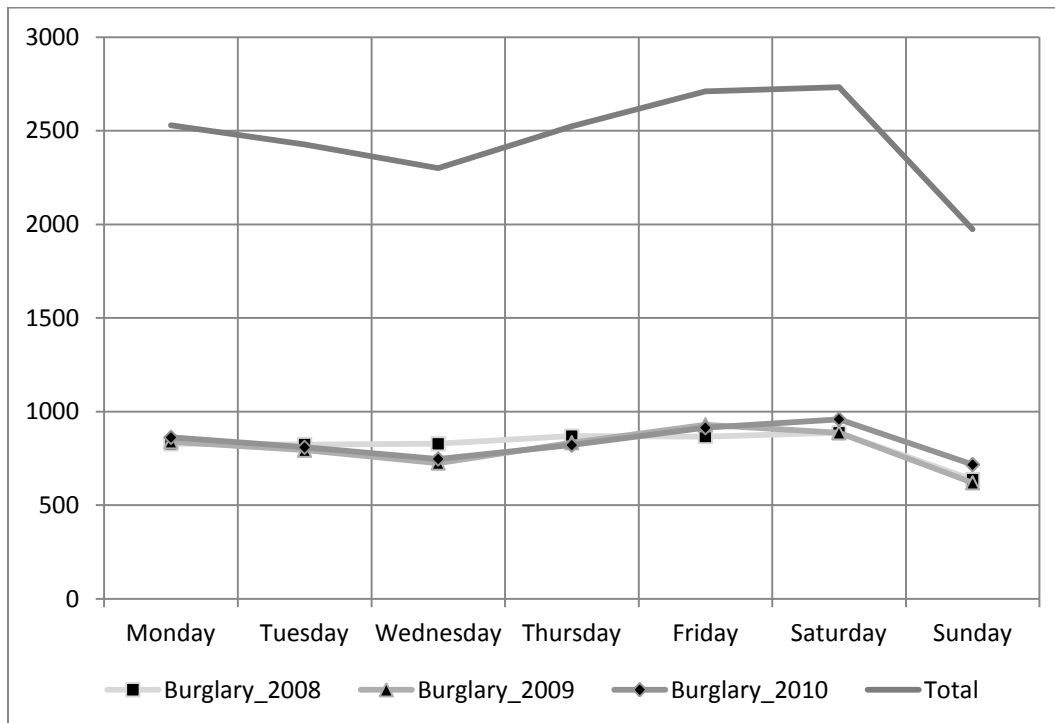**Figure 4.7– Total Christchurch burglary offence count per hour 2008-2010 (Calendar Years)**

Figure 4.8 – Total Christchurch burglary offence count per day 2008-2010 (Calendar Years)
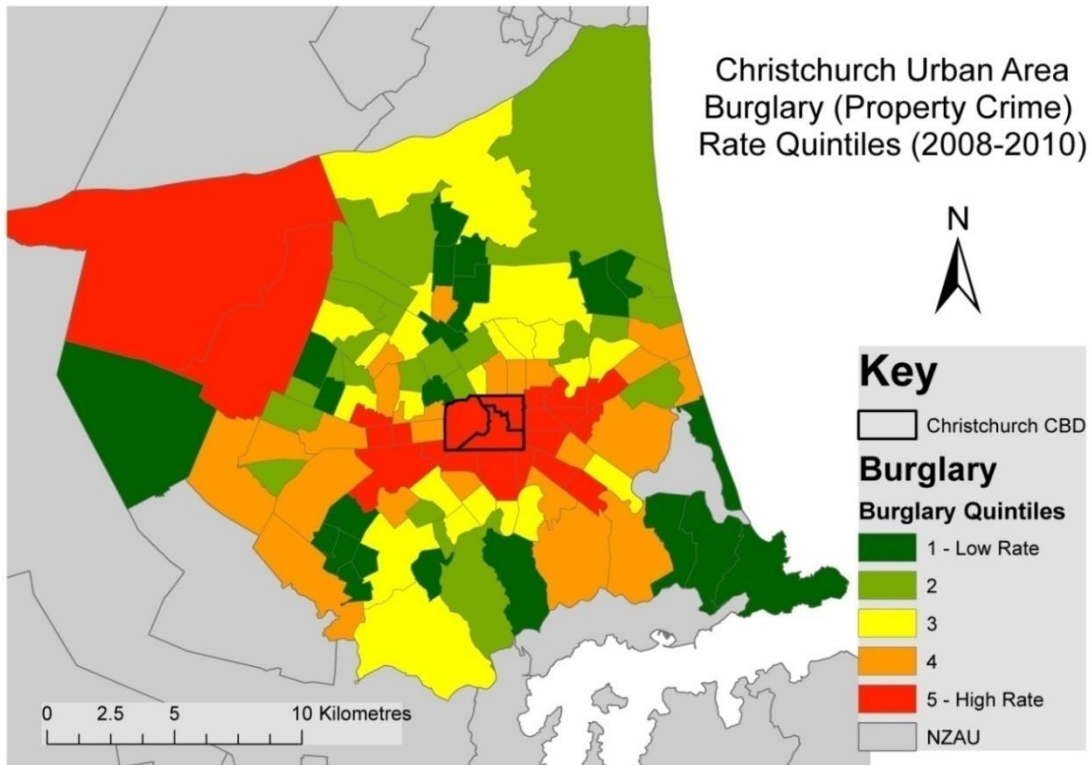
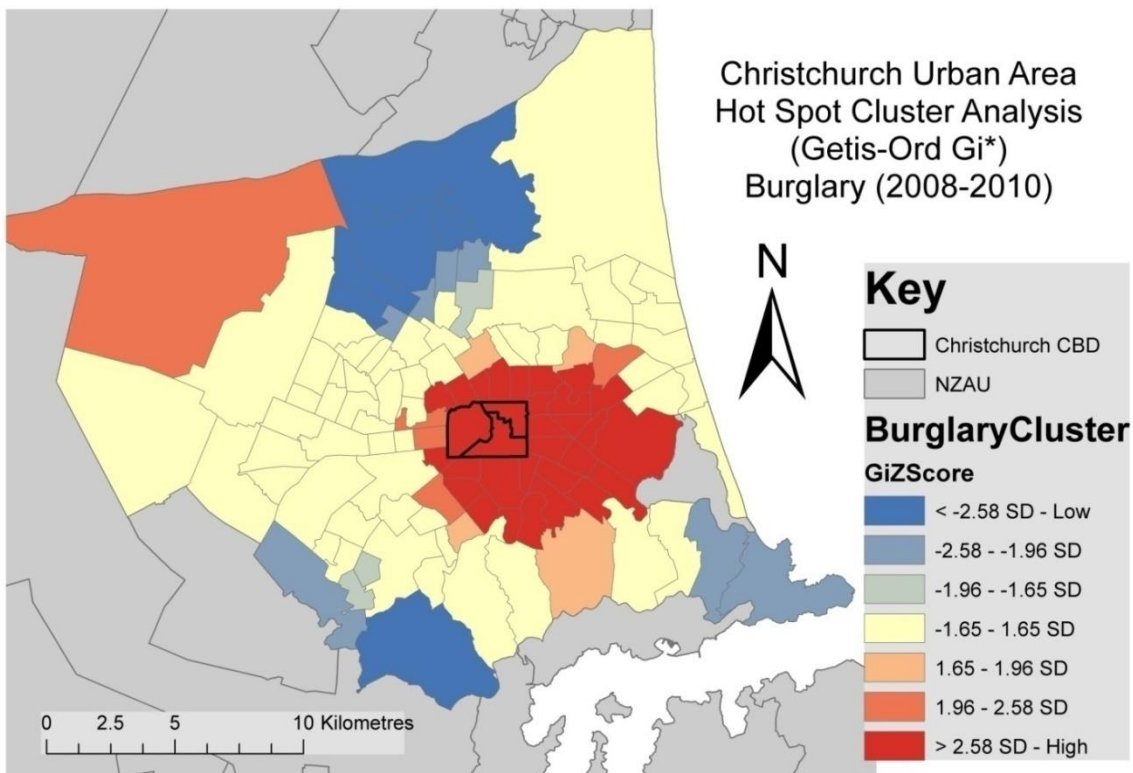**Figure 4.9 – Christchurch Urban Area Quintile Burglary Rates per CAU (2008-2010)**

Figure 4.10 - Christchurch Urban Area Quintile Burglary Rates Cluster Analysis per CAU (2008-2010)

Heart Attack Admissions

'Heart Attack Admissions' show a monthly/seasonal trend with several spikes occurring in the months of March and May; troughs occur in the months of February, April and June (see Figure 4.11). There is also spike from July through to September with a gradual reduction from September through until January These results indicate that there is a seasonal increase in heart attack admissions around the winter months (June, July, August) with two spikes during the autumn months (March, April, May) in Christchurch. Gerber et al. (2006) also found that there was an increase in the rate of sudden cardiac death (SCD) during winter months with a slight delay into spring with a slightly higher rate of myocardial infarction (MI) in Olmsted County, Minnesota - Gerber *et al.* (2006). Very little research has occurred in New Zealand examining the seasonality of heart attacks (myocardial infarction and cardiovascular disease - CVD); the most recent study was done by Douglas et al. (1990) who found that there was a major seasonal variation in coronary deaths in New Zealand - Douglas *et al.* (1990). He found that there was a peak in the winter months of June, July and August and a reduction during the summer months of December, January and February - Douglas*, et al.* (1990).

More recent international literature has supported the findings of a winter peak in heart attack admission rates - Hernanadez *et al.* (2004); Kriszbacher *et al.* (2008); Pell *et al.* (1999). For example, Hernandez et al. (2004) examined the seasonal variation of heart attack admissions in Valencia, Spain over a 4 year period and found that there was a higher incidence of heart attack admissions during winter months with the lowest recorded incidence during the summer months - Hernanadez*, et al.* (2004). Similarly, Pell et al. (1999) found that in coronary heart disease exhibits a winter peak and summer trough in Glasgow - Pell*, et al.* (1999). Kriszbacher et al. (2008) found that although incidence rates were high during winter that the peak in incidence occurred during the spring months in Hungary, indicating a slightly different result to other research - Kriszbacher*, et al.* (2008). Overall the literature suggests that in most case studies there is an observable winter peak in heart attack admissions. This Christchurch based research reflects these observations whilst through a winter peak and summer trough; more research is needed to examine the temporal trend in heart attack admissions in New Zealand to explain the variation in the autumn and spring months.

A number of spatial patterns emerge with regards to the distribution of heart attack admissions in the Christchurch Urban Area. Quintile 4 and 5 (high heart attack admission rates) are concentrated mainly in the east of Christchurch with pockets of Quintile 4 throughout the west of the city and pockets of Quintile 5 north-west and south-west of the CBD. The areas in the east are representative of relatively deprived and low income characteristics; however not all deprived census area units have high rates of heart attack admissions.

Smaller pockets in the north and south-west of Christchurch represent areas with older populations; however not all areas with older populations are represented in Quintiles 4 and 5, with many census area units in the north-west of the city classified as either Quintile 1 or 2 (see Figure 4.12)

Hot spot cluster analysis illustrates a clear stratified spatial pattern in heart attack admissions. Heart attack admission rates that are classified 1.96-2.58 and >2.58 standard deviations above the mean (average) rate for the Christchurch Urban Area are spatial prominent in the eastern part of the city. In contrast heart attack admission rates -1.96- -2.58 and >-2.58 standard deviations below the mean (average) rate for the Christchurch are predominantly located in the north-west of the city (see Figure 4.13).

There are two interesting observations that can be made from these results, firstly; the spatial clustering of higher than average heart attack rates is representative of many of the deprived census area units within the Christchurch urban area. The interesting observation is that none of the deprived census area units to the west, north and south have higher than average heart attack rates. Secondly; areas that are known to have higher rates of older populations are not represented as areas with high heart attack rates but rather quite the opposite; some areas with older populations are represented within close proximity or -1.65 - + 1.65 standard deviations from the mean (average) heart attack rate for the Christchurch Urban Area, with additional census area units represented within -1.65 - -1.96 and >-1.96 standard deviations below the mean.

These findings suggest that there may be an association between relative deprivation (income inequality) and heart attack admissions however this may not universally applicable to all areas. Boardman (2004) suggests that there are number of variables (intrinsic and extrinsic) that have the potential to influence heart attack admission rates including; age, race, family history and diet. Boardman suggests from their findings that there are other factors from the physical and social environment that have the potential to influence heart attack prevalence; highlighted in particular are lack of access to quality food sources, neighbourhood incivility, inadequate or lack of social support and personal and emotional causes of stress - Boardman (2004). Sundquist (2006) also found factors such as public safety and social instability as well as other intrinsic determinants and lifestyle choices were associated with higher heart attack rate prevalence - Sundquist, *et al.* (2006).
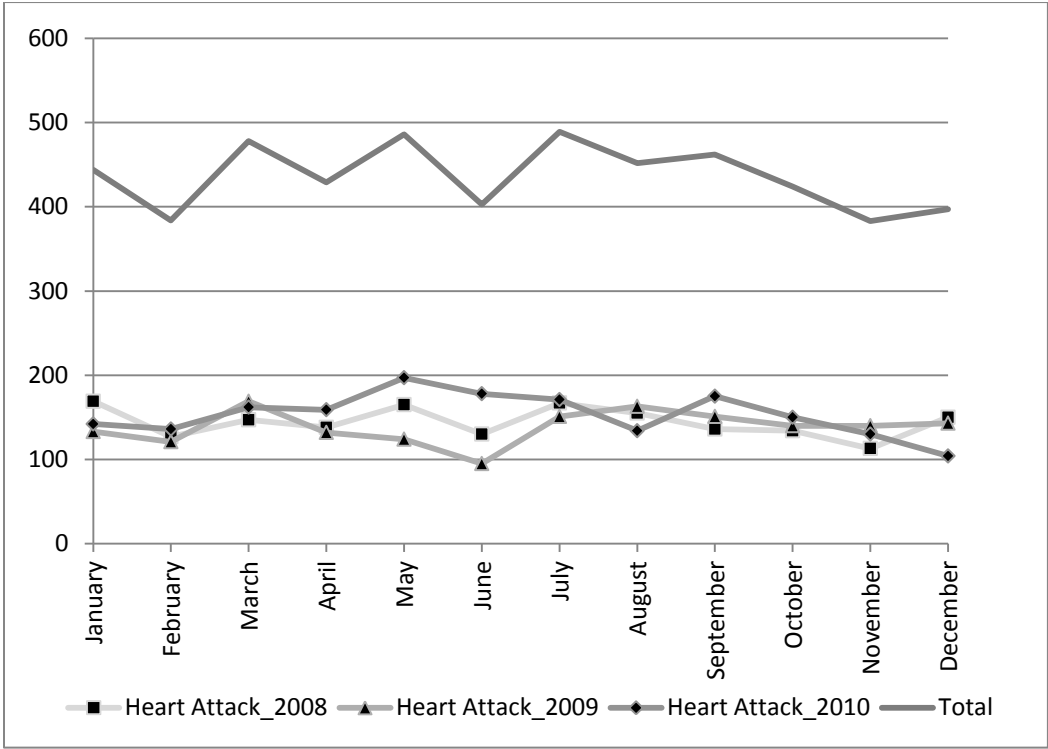
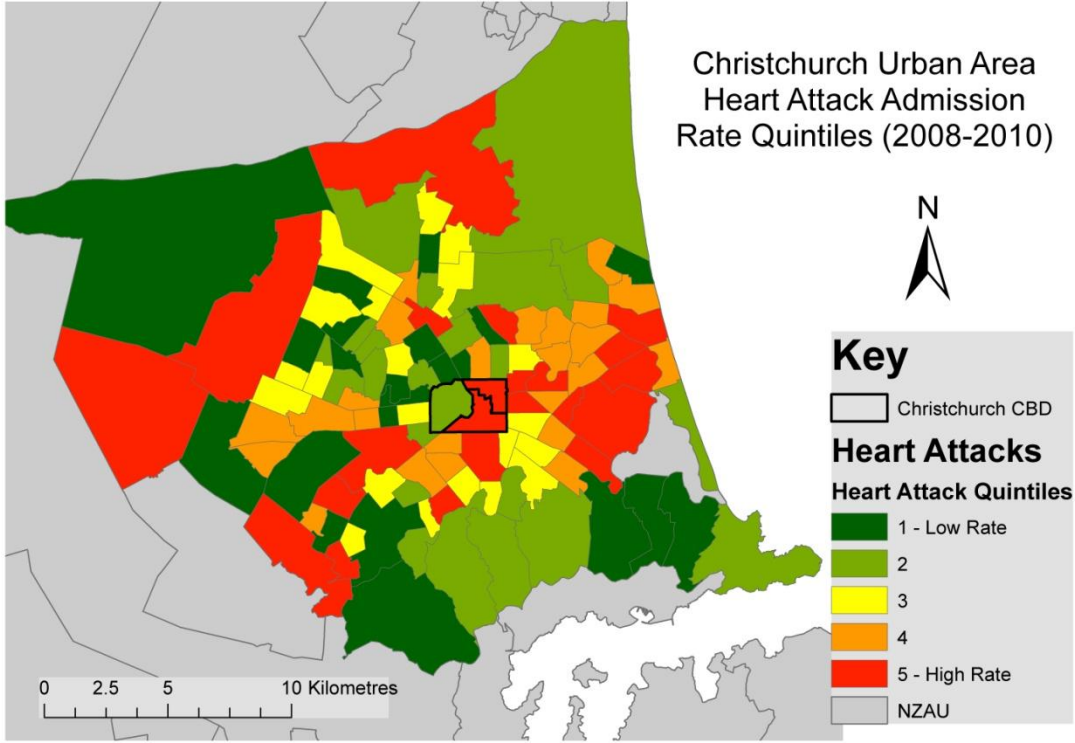**Figure 4.11 – Total Christchurch heart attack admission count 2008-2010 (Calendar Years)**

Figure 4.12 – Christchurch Urban Area Quintile Heart Attack Admission Rates per CAU (2008-2010)
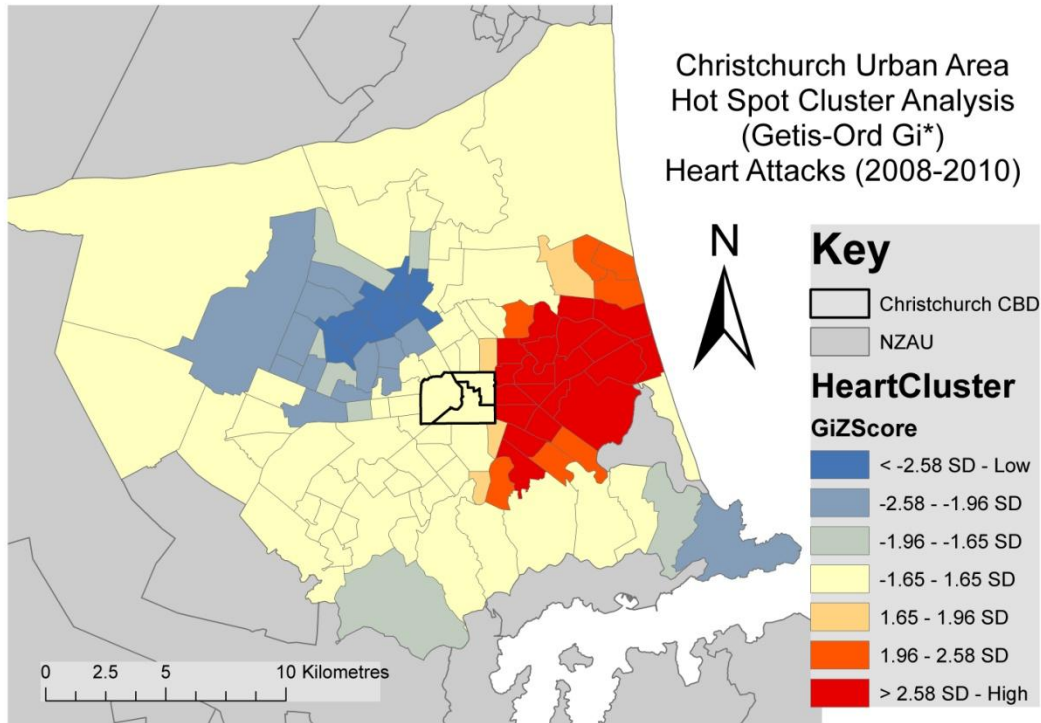
Figure 4.13 - Christchurch Urban Area Heart Attack Quintile Admission Rates Cluster Analysis per CAU (2008-2010)

Anxiety Admissions

Anxiety Admissions exhibit seasonal and monthly patterns in the Christchurch Urban Area. The results show an overall reasonably uniform trend throughout the year (see Figure 4.14) however it is important to note that there appears to be a seasonal increase during winter (June, July August) and spring (September, October, November) months with a small peak during March. These findings are consistent with literature which suggests that there is commonly a seasonal peak in anxiety and depression during the winter months. Harmatz et al. (2000) found that rates of depression and other mood disorders were more prevalent during the winter months and less prevalent during summer in Massachusetts, USA; and similarly Oyane et al. (2008) found that in Norway rates of anxiety and depression were higher during the winter months and comparatively lower during the summer months - Harmatz *et al.* (2000); Oyane *et al.* (2008). These studies also highlight that although there is a seasonal peak in anxiety and depression during winter that the overall yearly pattern is relatively stable. There is a lack of research specifically in the Christchurch and New Zealand in regard to the seasonality of anxiety; more research is required in this area.

There is a spatial concentration of anxiety admission rates in Christchurch in areas of deprivation to the east, south and west of the CBD; although overall the spatial location of census area units with higher anxiety admission rates does not wholly represent the pattern of deprivation in Christchurch. Census area units

classified as Quintile 4 and 5 occur further north and less to the east of the CBD as the pattern of deprivation. This indicates that there is an association between deprivation and higher rates of anxiety but as with heart attack admissions this may not be universally applicable. Molarius et al. (2009) found that there was an association between low income neighbourhoods and higher rates of anxiety after adjusting for contextual variables in Sweden - Molarius *et al.* (2009).

Anxiety admission hot spot cluster analysis demonstrates some interesting patterns that show there is a clear clustering of area units with anxiety admission rates 1.96-2.58 and >2.58 standard deviations above the mean (average) rate for Christchurch in the eastern part area of the city. In contrast there is a clear clustering of area units with anxiety admission rates -1.96- -2.58 and >-2.58 standard deviations below the mean (average) rate for the Christchurch in the west of the city. These patterns show similarities to the heart attack admission rates for Christchurch with a clustering of above average area units in the east of the city; however when examining the spatial clustering in more detail the results show that heart attack admissions are clustered further to the east of the city with anxiety admissions clustered north, south and closer to the CBD.

Additionally; three census area units in the west of Christchurch classified between 6 and 9 (10 most deprived) on the NZDep Index have lower than expected anxiety admission rates when compared with areas in Christchurch classified within the same deprivation level. A similar pattern emerges with two census area units in the south of Christchurch; these areas are categorised as level 3 and 4 (1 least deprived) on the NZ Dep Index, however they experience comparatively higher than average anxiety rates. Evans (2003) examined the built environment influence on mental health outcomes and found that 'neighbourhood quality' defined by a lack of physical and social amenities/attributes within a neighbourhood is associated with higher rates of anxiety and other mental health issues - Evans (2003). Likewise Guite et al. (2006) found an association between the presence of community facilities (libraries and community centres) and lower rates of anxiety and depression in London - Guite *et al.* (2006).

Finally, Mair et al. (2008) highlights the importance of the 'economic core' of a neighbourhood and also highlighting the association between strong social connectivity and social capital with reduce rates of anxiety and depression from the critical review of 45 studies from the United States, England, The Netherlands, Wales and Scotland - Mair *et al.* (2008). The results of this previous work suggests that the presence of neighbourhood incivility and disorganisation is associated with increased presence of depressive symptoms and that in the studies that examined neighbourhood context (built environment); that the provision of zoning

for economic activity and ability for social and community agencies to promote connectivity were associated with reduced anxiety rates - Mair*, et al.* (2008)
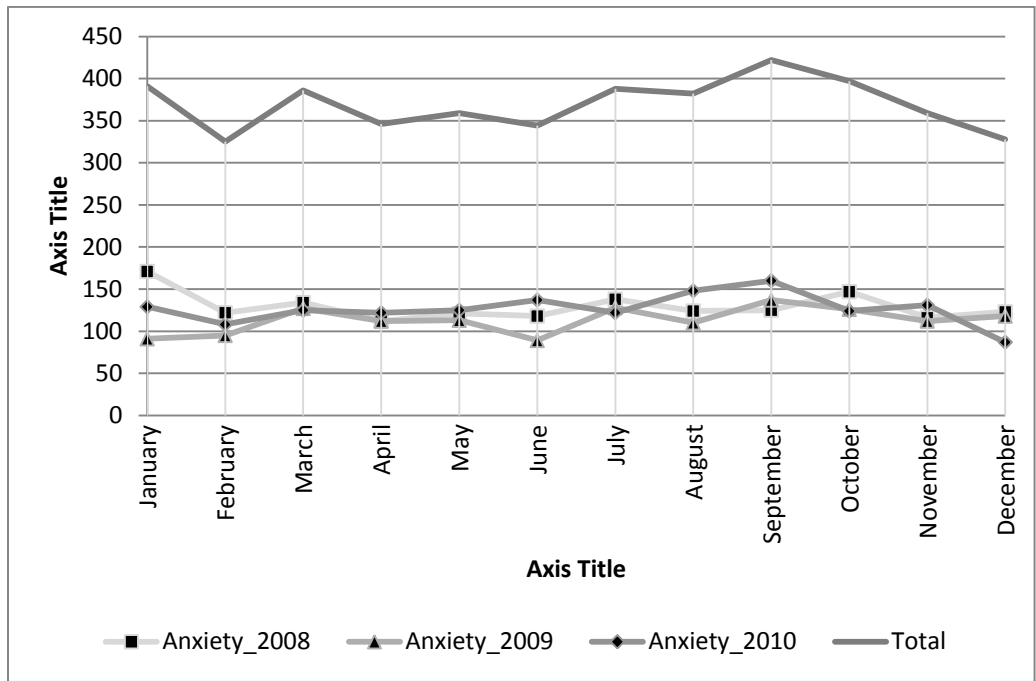

Figure 4.14 – Total Christchurch anxiety admission count 2008-2010 (Calendar Years)
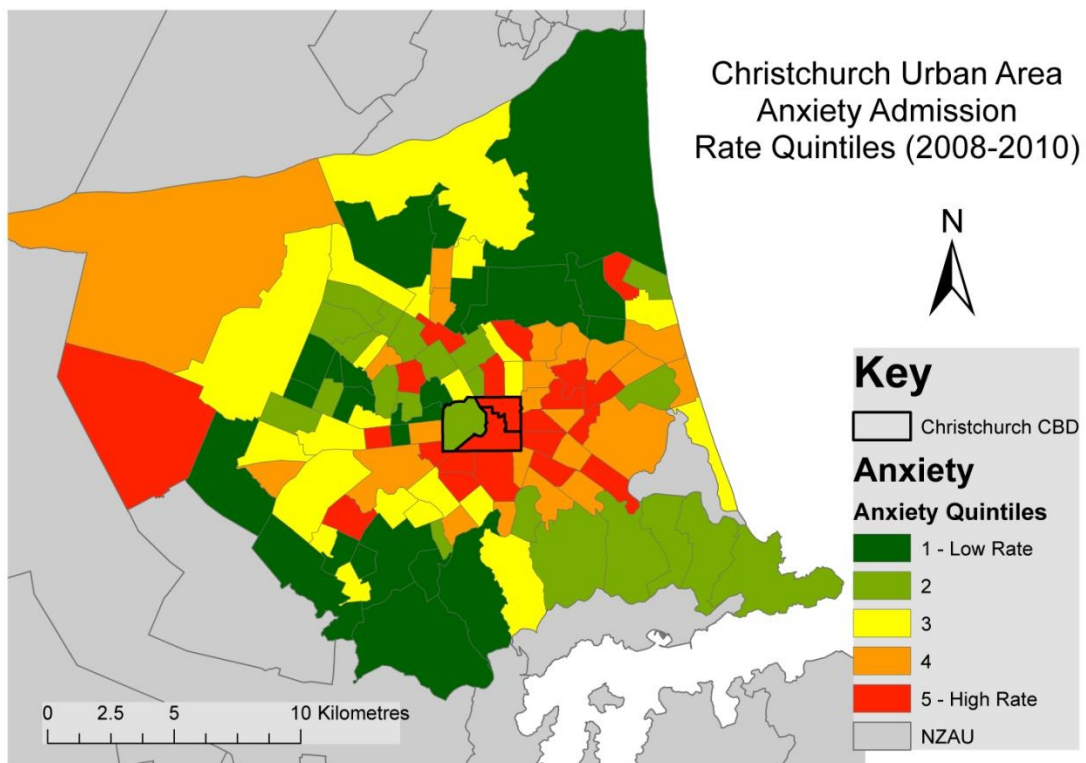
Figure 4.15 - Christchurch Urban Area Quintile Anxiety Admission Rates per CAU (2008-2010)
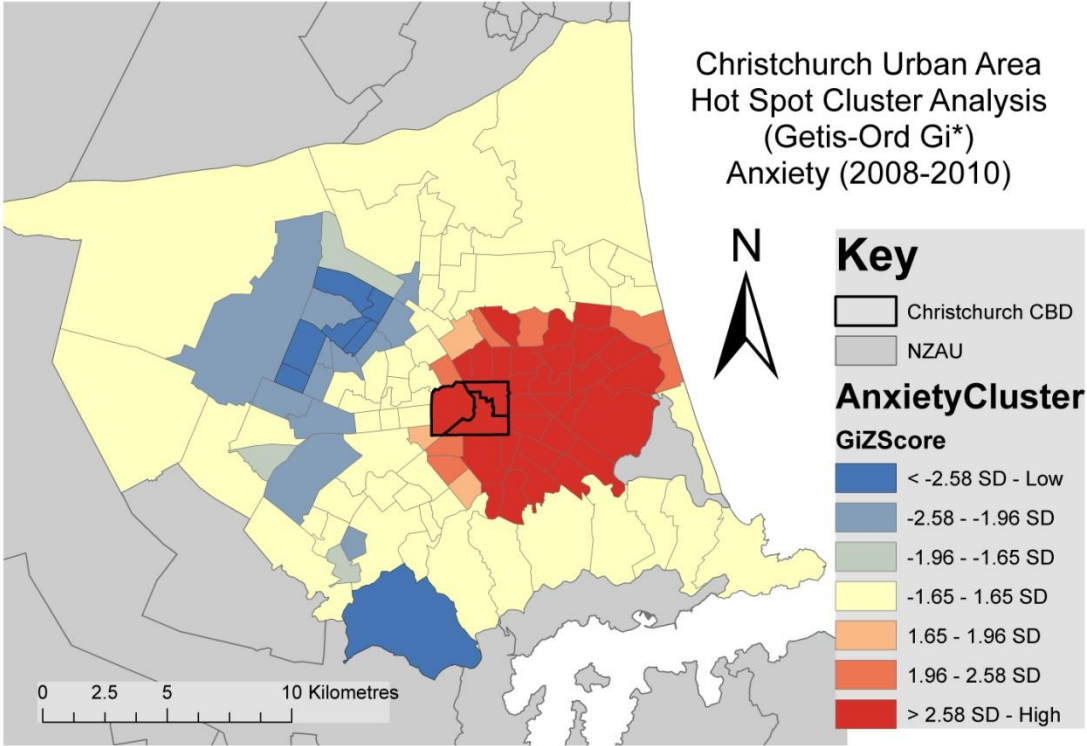
Figure 4.16 - Christchurch Urban Area Anxiety Quintile Admission Rates Cluster Analysis per CAU (2008-2010)

Multivariate Regression Results

Heart attack

Table 4.3 shows the results of three regression models; Model 1 shows the results of the 'baseline' regression model; Model 2 and 3 shows the results of the regression after assault (Model 2) and burglary (Model 3) have been included (i.e. after controlling for the independent variables) The results from Model 1 show a negative relationship between income and heart attack rates (-.520**). This finding is similar to previous literature that demonstrates this negative relationship. Augustin et al (2008) for example found that people living in the lowest quartile of affluence (low-socio-economic) were approximately 3 times more likely to suffer a myocardial infarction (heart attack) in Baltimore, USA - Augustin, *et al.* (2008). Similarly, Kawachi et al (1997) found in the USA that income inequality was strongly correlated with increased rates of death from coronary heart disease (precursor for myocardial infarction) - Kawachi *et al.* (1997). Model 1 also indicates there is a negative relationship between the number of community resources in an area and heart attack rates; independent of crime (-.201**). Witten et al. (2003) found that there was a relationship between reduced access to community resources and negative health outcomes for residents in New Zealand. In her work, community resources were defined under six domains; 1) recreational amenities; 2) public transport and communication; 3) shopping and banking facilities; 4) educational services; 5) health services; and; 6) social

and cultural services. Matthews et al (2010) also found that neighbourhoods with reduced access to community amenities/resources or increased exposure to community hazards were more likely to experience negative health outcomes including heart conditions. Lastly, Pearce et al. (2006) found that there were significant disparities in access to community resources within urban areas between the least deprived and most deprived areas in an urban settings within New Zealand - J. Pearce, *et al.* (2006).

Model 2 analyses the relationship between heart attack admission rates and assault after controlling for all the independent variables. The findings show that the assault rate in an area has a significant relationship with the heart attack rate (.513**). Similarly the findings also show that income remains statistically significant but reduces in value from (-.520** to -.359**). These figures are similar to previous literature around this topic. For example, Sundquist et al. (2006) found that there was a significant correlation between increased rates of violence (including assault) and levels of coronary heart disease and corresponding likelihood of myocardial infarction (heart attack) in Sweden - Sundquist, *et al.* (2006). Wilkinson et al. (1998) similarly found that higher mortality rates were closely associated with violent crime, particularly homicide and aggravated assault in a review of studies from Canada, UK, Spain, Brazil, Italy, Russia, Chile, Israel, Finland and the USA - Wilkinson *et al.* (1998).

Model 3 examines the relationship between heart attack admission rates and burglary after controlling for the effect from the independent compositional and contextual variables. The findings show that there is no statistically significant relationship between burglary rates and heart attack rates. The results also show that income remains a statistically significant indicator (.501**) of heart attack rates in this same analysis. Wilcox et al. (2003) found that when assessing the impact of crime on perceptions of safety that there was a relationship between burglary and feelings of being unsafe; however the relationship between violent crimes and feelings of being unsafe were much higher - Wilcox, *et al.* (2003).

Numerous researchers - Middleton (1998); Wilcox, *et al.* (2003); Wilkinson, *et al.* (1998) highlight the relationships between violent crime and mortality. These same articles find that there is no link, or there is no mention of property crimes including burglary. Robinson et al. (2000) highlighted that the impact or knowledge of violent crime is likely to be more acute and heighten feelings of fear and of being unsafe; property crime is more likely to impact the individual/household that was targeted through feelings of invasion and anger and correspondingly increase awareness with the local environment rather than acutely increase levels of stress - Robinson, *et al.* (2000)

Table 4.3 – Heart Attack Indicator Multivariate Regression Analysis

Heart Attack – Indicators (Quintiles)			
	Model 1+	Model 2++	Model 3+++
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Maori (%)	.169 (0.151)	.022 (0.151)	.168 (0.151)
Median Income ($NZ)	-.520 (0.166)**	-.359 (0.166)**	-.501 (0.167)**
No Religion (%)	-.191 (0.116)	-.218 (0.111)	-.200 (0.116)
Never Married (%)	-.204 (0.242)	-.150 (0.232)	-.242 (0.243)
Own Home (%)	.009 (0.215)	.229 (0.218)	.023 (0.217)
Unemployment (%)	.099 (0.155)	.132 (0.149)	.071 (0.155)
Greenspace (SqKm)	-.049 (0.100)	-.154 (0.102)	-.075 (0.105)
Doctor (within 3Km)	.033 (0.178)	-.005 (0.171)	.026 (0.179)
Regular Smoker (%)	.013 (0.113)	.013 (0.110)	-.064 (0.113)
Fast Food (within 3km)	-.087 (0.187)	-.170 (0.181)	-.118 (0.189)
Community Resources (per1000)	-.201 (0.087)**	-.122 (0.087)	-.182 (0.089)**
Assault (per 1000)		.513 (0.161)**	
Burglary (per 1000)			.124 (0.132)
+Model 1 shows the uncontrolled multivariate regression analysis			
++Model 2 shows the multivariate regression analysis independently controlling for 'Assault Rates'			
+++Model 3 shows the multivariate regression analysis independently controlling for 'Burglary Rates'			
*statistically significant at the 0.05 level			
**statistically significant at the 0.01 level			

Multivariate Regression Results

Anxiety

Table 4.4 provides the results of three regression models pertaining to anxiety admissions. Model 1 shows the uncontrolled multivariate regression results. Model 2 shows regression analysis between anxiety admission rates and assault after controlling for the various independent compositional and contextual variables. Model 3 controls for the same variables as Model 2 and examines the relationship between anxiety admission rates and burglary. Model 1 provides the regression results for each independent variable with anxiety admission rates; as can be seen from the table the only the community resources variable (-.286**) has a statistically significant association with the anxiety admission rates dependent variable. As outlined in the Methodology chapter, the community resources variables is made up of the following; early childhood education centres, primary schools, high schools, libraries, community centres, public swimming pools, marae, churches, temples and mosques. The selection of these variables is consistent with literature with Pearce et al. (2006) selecting resources under the following categories; 1) recreation amenities 2) shopping facilities 3) education facilities 4) health facilities 5) cultural service. The analysis undertaken in this research primarily focuses on; 1) recreational amenities; 2) educational amenities and; 3) social and cultural amenities. These amenities all provide a place for people to meet. The discussion section will expand upon this more and examine theories around social capital to explain these results.

Model 2 demonstrates the results of multivariate regression analysis between anxiety admission rates and assault after controlling for the selected compositional and contextual variables. The results show that assault rates have statistically significant indicator value (.474**) and that Community Resources remains statistically significant at (-.213**). Whitley et al. (2005) suggests that rates of anxiety are closely linked with the ability to access health-promoting community involvement and use of services. Whitley reports that the fear of crime in an area can reduce the feeling of safety and increase feelings of anxiety; the fear and presence of crime in an area decrease the ability for people to engage in community events and utilise services - Whitley, *et al.* (2005).

 Similarly Chandola (2001) found that increased fear of crime was associated with poor self-rated mental health; however poor self-rated mental health was found to have high co-linearity with socio-economic factors including income - Chandola (2001). In addition Chaix et al. (2006) examined the spatial clustering of recorded mental disorders and associated characteristics. They found that higher rates of mental disorders were located in areas with high contextual neighbourhood deprivation and high social disorganisation (as a proxy for crime) - B. Chaix, *et al.* (2006). The literature is by no means conclusive but it does provide evidence

of an association between the presence of violent crime and mental disorders including anxiety. Model 3 shows the multivariate regression analysis between anxiety admission rates and burglary after controlling for the independent variables. Model 3 demonstrates that there is no association between anxiety rates and burglary; however the association between increased community resources and reduced anxiety rates remains statistically significant (.280**). Previous literature referred to earlier highlighted the lack of association between rates of burglary and rates of heart attack admissions; Model 3 has demonstrated that there is also a lack of association for mental health incidence.

Table 4.4 – Anxiety Indicator Multivariate Regression Analysis

Anxiety – Indicators (Quintiles)			
	Model 1+	Model 2++	Model 3+++
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Maori (%)	.268 (0.136)	.133 (0.136)	.268 (0.137)
Median Income ($NZ)	-.102 (0.150)	.047 (0.150)	-.096 (0.152)
No Religion (%)	.010 (0.105)	-.012 (0.100)	.008 (0.106)
Never Married (%)	-.110 (0.218)	-.049 (0.209)	-.118 (0.221)
Own Home (%)	-.078 (0.194)	.134 (0.197)	.071 (0.197)
Unemployment (%)	.156 (0.140)	.205 (0.134)	.153 (0.141)
Greenspace (SqKm)	-.072 (0.091)	-.170 (0.092)	-.081 (0.095)
Doctor (within 3Km)	.239 (0.161)	.225 (0.154)	.244 (0.163)
Regular Smoker (%)	.056 (0.103)	.007 (0.099)	.055 (0.103)
Fast Food (within 3km)	.331 (0.169)	.260 (0.163)	.323 (0.172)
Community Resources (per1000)	-.286 (0.079)**	-.213 (0.078)**	-.280 (0.081)**
Assault (per 1000)		.474 (0.145)**	
Burglary (per 1000)			.039 (0.119)

+Model 1 shows the uncontrolled multivariate regression analysis

++Model 2 shows the multivariate regression analysis independently controlling for 'Assault Rates'

+++Model 3 shows the multivariate regression analysis independently controlling for 'Burglary Rates'

*statistically significant at the 0.05 level

**statistically significant at the 0.01 level

5. Discussion

5.1 | Crime and Health

The results of this research indicate that there is an independent statistically significant association between violent crime (assault) and both heart attack and anxiety admissions. This is a significant finding and is consistent with research conducted investigating the same association. For example, Sundquist et a. (2006) found a statistically significant association between violent crimes and higher incidence of cardiovascular disease in Sweden - Sundquist*, et al.* (2006). In this work, property crime (burglary) was deemed to have no statistically significant association with either heart attack or anxiety admissions; this is consistent with research such as Robinson et al. (2000) which found that property crimes tend to cause less psychological distress then violent crimes such as assault - Robinson*, et al.* (2000). These results support research that has identified crime as an environmental stressor and highlight the importance of the environmental influence on health in addition to individual lifestyle choices - Cantillon *et al.* (2003); Taylor *et al.* (1990). Taylor et al. (1990) suggests the level of crime within an area can influence residents' perception or fear of crime which can have an impact in altering the way that they deal with their feelings of safety and wellbeing. Cantillon (2003) illustrates the association between social disorganisation theory and feelings of unease among residents; in their review of the literature they suggest the perceived level of violence as well as the actual level of violence at a neighbourhood level can impede individual and community wellbeing and engagement in social, community and economic activities thus increasing their risk for various types of negative health outcomes.

The relationship between the impact of crime on health and wellbeing are explored in far more detail in the fear of crime field - Jackson *et al.* (2009); Stafford*, et al.* (2007). Stafford et al. (2007) demonstrated that in London people that live in areas that have a higher fear of crime had poorer health outcomes compared to areas with areas with lower fear of crime rates - Stafford*, et al.* (2007). These findings are supported by Jackson et al. (2009) who found there was an association between fear of crime and real cycles of decreased health and perceived vulnerability to victimisation. Similarly, Tan et al. (2009) found that there was a high

degree of association between the spatial patterning of crime and health deprivation rates at the community level. Tan measured that health outcome variable by those that either die prematurely or whose quality of life is impaired by poor health outcomes - Tan*, et al.* (2009). The results from this study in Christchurch support the findings from these articles and other literature that the presence of crime in an area is associated with higher rates of poor health outcomes; in this case both heart attack and anxiety admissions. The literature highlights the association between violence and negative health outcomes as important and emphasises the link between violence and ill-health.

The results of the empirical analysis in this work have shown that the presence of violence has a significant impact on the wellbeing of communities. Previous research has shown that rates of violence are closely associated with social disorganisation and in some cases material deprivation in a neighbourhood - Breetzke (2010a); Kubrin *et al.* (2003). Breetzke (2010) for example, examined violent crime rates in Tshwane, South Africa and found marginal support for the association between social disorganisation and violent crime. Kubrin et al. (2003) found in their review across many contexts that higher rates of violent crime were associated in most cases with the objective ecological extent of social disorganisation (measured by poor social connectivity, and social control) - Breetzke (2010a); Kubrin*, et al.* (2003). The findings from Christchurch show that although violent crime is closely linked with material deprivation that the theory of social disorganisation is needs further research in this context. This can mostly be attributed to the association found in both models between the 'Community Resources' (measuring places allowing social interaction) variable and heart attack and anxiety rates; however given that this variable only remains constant for anxiety admissions further research is required to examine the extent to which violent crime is associated with social disorganisation in Christchurch.

An important concept to investigate is the impact that the presence of crime is likely to have on behaviour in an area. Foster et al. (2008) investigated the impact that the presence of neighbourhood crime has on constraining physical activity; they found that neighbourhood crime was likely to affect activities that occurred outdoors such as biking, sports, gardening, outdoor leisure time walking for transport and walking for recreation - Foster*, et al.* (2008). The association with reducing physical activity was not the only issue. The lack of social interaction for residents to engage with their local community as a result of recorded crime or the fear of crime is associated with limiting mental functioning and increasing the likelihood of anxiety occurring - Evans (2003). Dahlgren (1991) examined the extrinsic (external) influences on individual health and found that both social and community resources and networks are important extrinsic indicator of health

outcomes for an individual - Dahlgren*, et al.* (1991). In this regard, crime can be viewed as have an influence on individual and community health beyond what is able to be control and modified at an individual level. Dahlgren et al. (1991) explains that variables such as individual lifestyle factors are more easily modifiable for an individual than modifying social and community networks or living and working conditions. This suggests that individuals are more able to change dietary and exercise habits with greater ease than community level problems such as high violent crime rates - Dahlgren*, et al.* (1991). As Foster et al. (2008) and Evans (2003) demonstrate, crime has a significant impact in reducing the ability for individuals to engage in normal activities - Evans (2003); Foster*, et al.* (2008). Freedman et al. (2011) demonstrates that prolonged or chronic exposure to living in a high crime neighbourhood was associated with poorer health outcomes - Freedman*, et al.* (2010). The research demonstrates that acute and chronic exposure to high levels of crime and neighbourhood instability is associated with poorer health outcomes. It is important then to examine ways in which you can reduce the prevalence and incidence of violent crime and increase the degree of social organisation within neighbourhoods in order to reduce the impact that crime has on the health of individuals and communities.

The stressful nature of violent crime and neighbourhood disorder has been associated with higher rates of both physical and mental health outcomes in the Christchurch context. Literature suggests that the fear of crime increases the feelings of stress and anxiety among at an individual and community level - Jackson*, et al.* (2009); Stafford*, et al.* (2007). Acute and chronic stress has been highlighted as a precursor for negative health outcomes - Fink (2010); Krieger (2011); impacting the body through the presentation physical and mental illnesses. The presence of violent crime indicates one method through which stress is placed upon individuals through an external source - Krieger (2011). Higher and prolonged exposure to stress has been demonstrated to have chronic impact on the ability of people to conduct normal activities and the reduction in cognitive and physical functioning. Frequent exposure to stressful situations is harmful to human health - Fink (2010). It is of value that the presence and fear of violent crime has been associated with stress-related health conditions including heart attack and anxiety admissions as this provides a link between external sources of stress and the impact of stress upon individuals and communities - Stafford*, et al.* (2007).

5.2 | Income

The results of this research show that there is a statistical association between income and rates of Heart Attack Admissions'. These findings are important as they show that the overall presence of a low level of income is associated with poorer physical health conditions. Previous literature has shown how areas with an overall lower median income are more susceptible to poorer health outcomes. For example Wilkinson et al.

(2006) found that the most economically disadvantaged in terms of income were more likely to have poorer health outcomes - Wilkinson *et al.* (2006). This appears to be the case in this research; however income is not statistically associated with higher anxiety rates indicating that although relative income inequality is an important indicator of poorer health outcomes in cannot be universally applied in the Christchurch context. Kawachi et al. (1999) suggests that health outcomes can be affected by the distribution of income, but that this influence may not be universally applicable as the evidence has shown that in some cases that this impact can be partly mediated by investment in social goods - Kawachi Kennedy (1999). The results from this study suggest that the spatial patterning of income can explain heart attack rates. This finding suggests that low income is a partial indicator of poorer health outcomes. More research is required to more fully understand this relationship

5.3 | Community Resources

The presence of community resources was statistically associated both reduced heart attack and anxiety admissions. This analysis included community resources as one variable constructed through the following categories; 1) recreational amenities (pools and sports facilities); 2) educational amenities (early childhood centres, primary schools, intermediate schools and high schools) and; 3) social and cultural amenities (libraries, community centres, marae, churches, mosques and temples). Access to healthcare facilities was measured as a separate variable and no statistical association was found between their presence and heart attack or anxiety admissions.

The community resources variable broadly represents places that people are able to meet and engage in physical, educational or social activities. Wen et al. (2007) found that there was an association between the spatial provision of social resources and the impact on health outcomes in Chicago, USA - Wen *et al.* (2003). Similarly Boardman (2004) found that the availability and provision of social or 'community resources' provided an important buffer in reducing the impact of stress levels on health outcomes in Detroit, USA leading to possibly reduced negative health outcomes. - Boardman (2004). Lastly, Bernard et al. (2007), explored the influence of community resources on neighbourhood health outcomes and found 5 domains (physical, economic, social and cultural, institutional and local sociability) were important in influencing the health of individuals and communities - Bernard*, et al.* (2007).

The lack of community resources has often been linked with relative deprivation and income inequality; however this is not always the case. Macintyre et al. (2008) investigated whether the lack of community resources was related to the deprivation level of an area; they found that in some cases this was apparent

however over the study area this did not remain consistent - Macintyre *et al.* (2008). Macintyre et al. (2008) emphasised the importance of the 'ecological hypotheses of urban resources that are linked to the complex relationship between the age, history, geographical location, density and the residential, commercial and industrial mix of land use as important indicators of community resource provision rather than the sole indicator of individual physical and material deprivation. The results of this result suggest that in order to reduce negative health outcomes in Christchurch, key role-players should increase the number of community resources.

5.4 | Discussion Synopsis

Overall, the results of this research are consistent with past literature. The results show that there is an independent statistical association between violent crime and both physical and mental health outcomes in Christchurch. The results support the view from literature that crime is an environmental stressor - Riger (1985) and can influence health. The independent association highlights the importance of crime reduction strategies to help reduce the impact of crime on the health and wellbeing of individuals and communities. Results from this study suggest that median income and community resources are also statistically associated with a reduction in poor health outcomes. 'Median Income' has been shown to be associated with a reduction in heart attacks; and 'Community Resources' have been shown to be associated with a reduction in the mental health indicator 'Anxiety Admissions'.

 The findings are representative of theories investigated in the literature review of this study in particular the interventions for risk reduction regarding crime prevention and community support - Bernard*, et al.* (2007). Additionally, it is a significant finding that the results demonstrate both compositional (median income) and contextual (community resources) mediating variables. This suggests that the spatial impact that crime has on health is sensitive to the changes in neighbourhood composition and context whilst also having an independent impact on community health.

6. Conclusion

This study examined the independent impact of crime on community health outcomes at a neighbourhood (CAU) level. The study aimed to analyse the spatial and temporal pattern of crime in the Christchurch Urban Area; the spatial and temporal pattern of stress related health outcomes in the Christchurch Urban area; and the association between patterns of crime and stress related health outcomes at a neighbourhood (CAU) level. The results indicate that there is a statistically significant association between violent crime (assault) rates and heart attack and anxiety admissions rates; these findings are significant as they demonstrate, for the first time in a New Zealand context, that crime (in particular violent crime) has an independent association with negative health outcomes when controlling for variables that have been shown in other studies to confound the results. The results also indicated that two compositional and contextual variables are statistically associated with reducing negative health outcomes; these variables are 'Median Income' and 'Community Resources'. This study is significant as it demonstrates the association between crime and health in a New Zealand context. Until now this area of research had previously been under-researched, particularly in New Zealand.

The results have implications for both Public Health and Policing in New Zealand. The findings add credence to the theory and research around crime as a public health problem and as an environmental stressor. Literature suggests that a mix of both proactive and responsive measures is needed to reduce the impact that crime has on the health of individuals and communities. Initiatives to help prevent the prevalence of crime should continue or be commenced and additionally initiatives to help provide support to communities at risk from the exposure of crime should continue or be commenced.

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