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Geographic variation of clinically diagnosed mood and anxiety disorders in Christchurch after the 2010/11 earthquakes

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ABSTRACT

The 22nd February 2011 Christchurch earthquake killed 185 people, injured over 8000, damaged over 100,000 buildings and on-going aftershocks maintained high anxiety levels. This paper examines the dose of exposure effect of earthquake damage assessments, earthquake intensity measures, liquefaction and lateral spreading on mood and anxiety disorders in Christchurch after this event. We hypothesise that such disorders are more likely to develop in people who have experienced greater exposure to these impacts within their neighborhood than others who have been less exposed, but also live in the city. For this purpose, almost all clinically diagnosed incident and relapsed cases in Christchurch in a 12 months period after the 2011 earthquake were analysed. Spatio-temporal cluster analysis shows that people living in the widely affected central and eastern parts after the 2010/11 earthquakes have a 23% higher risk of developing a mood or anxiety disorder than people living in other parts of the city. Generally, mood and anxiety-related disorders increase with closer proximity to damage from liquefaction and moderate to major lateral spreading, as well as areas that are more likely to suffer from damage in future earthquakes.

1. Introduction

On the 22nd February 2011, the city of Christchurch (New Zealand) was hit by a shallow magnitude (Mw) 6.2 earthquake occurring just 9 km south of the Central Business District (CBD). This 'Christchurch' earthquake produced a Peak Ground Acceleration (PGA) among the highest ever recorded and strong ground shaking affected much of the Christchurch urban environment (Giovinazzi et al., 2011). As a consequence, two multi-story buildings collapsed in the CBD, a number of unreinforced masonry buildings partially collapsed, and rockfall, landslides, and cliff collapses occurred on the Port Hills near the epicentre. Much of the eastern suburbs of Christchurch experienced substantial liquefaction,[1] which caused extensive damage to buildings and buried services like freshwater, sewerage, and stormwater systems. In total, 185 people died in the event, over 8000 were injured, and over 100,000 buildings were damaged, destroyed or demolished (Canterbury Earthquake Recovery Authority, n. d.).

The Christchurch earthquake is part of an earthquake sequence initiated following the 4th September 2010 Mw 7.1 'Darfield' earthquake, which was located ~35 km to the west of Christchurch. Over the next 18 months, over 10,000 aftershocks occurred, including three large earthquakes which migrated eastward across the city area: the 'Christchurch' earthquake, the Mw 6.2 'Christchurch II' earthquake on the 13th June 2011 and the Mw 5.9 'Christchurch III' earthquake on the 23rd December 2011.

Following such events, in addition to deaths, injuries and damage to properties and infrastructure, high prevalence rates of adverse stress-related mental health outcomes have also been observed. These included Post-Traumatic Stress Disorder (PTSD), depression, anxiety, Acute Stress Disorder (ASD) or sleep disturbances (Chadda et al., 2007; Dorahy and Kannis-Dymand, 2012; Eksi and Braun, 2009; Kadak et al., 2013; Liu et al., 2011; Shinfuku, 2002; Suzuki et al., 1997; Varela et al., 2008; Wang et al., 2011; Zhang et al., 2011, 2012; Zhou et al., 2013). Out of this list, PTSD, anxiety, and depression haven been most often examined in the literature and are commonly found together after natural disasters (Madianos and Evi, 2010). For example, Zhang et al. (2012) found high prevalence rates of PTSD, anxiety, and depression after the

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[1] Liquefaction is a process where saturated soil turns into silt and loses its carrying capacity when shaken (Kalkan, 2012).

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2010 Yushu earthquake (China). Dell'Osso et al. (2014) identified higher PTSD and depression symptom scores, as well as a strong interrelationship between these disorders in young adults after the 2009 L'Aquila earthquake (Italy).

For the 2011 Christchurch earthquake, Duncan et al. (2013) found high levels of hyperarousal, re-experiencing, anxiety, and depression in 101 treatment-seeking individuals two to eight weeks after the event. Reed (2013) analysed the temporal variation of 524 arrival complaints for anxiety and stress to the Christchurch Public Hospital's Emergency Department between May 2010 and April 2012 and found a significant increase in anxiety cases one month after each major earthquake in the 2010/11 Christchurch series. These two examples confirm the same effect for Christchurch in the short-term, but it was unclear if these high levels were still present a year or more after the event. A newspaper article from April 2013 indicated this by reporting an increased demand for mental health care services since the earthquakes and a very high number of prescriptions for depression, anxiety, insomnia, and pain compared to the rest of New Zealand (Carville, 2013). Also, reports about the high levels of stress caused by the frustration of living in broken homes, dealing with insurance issues and often long-lasting claims, as well as coping with ongoing aftershocks, led to the assumption that there may be a significant long-term change in mood and anxiety disorders since the earthquakes (Atkinson, 2013; Canterbury Earthquake Recovery Authority, 2013).

While many studies have been carried out in the initial weeks or months after an earthquake event (Kadak et al., 2013; Liu et al., 2011; Wang et al., 2011; Zhang et al., 2012; Zhou et al., 2013), a number of studies have found PTSD and other mental health outcomes to be still highly prevalent even several years after a traumatic event: Zhang et al. (2011) and Xu and Song (2011) (one year after the 2008 Wenchuan earthquake (China)), Başoğlu et al. (2004) (more than one year after the 1999 Marmara earthquake (Turkey)), and Chen et al. (2007) (two years after the 1999 Chi-chi earthquake (Taiwan)). High levels of traumatic stress symptoms were even found four years after such an event in exposed subjects (Goenjian et al., 2000; Kılıç et al., 2006; Livanou et al., 2005; van den Berg et al., 2012).

Identified risk factors triggering the development of such mental disorders after natural disasters include socio-demographic factors such as being female or middle-aged, having low social support or low socio-economic status (Chen et al., 2007; Galea et al., 2005; Kadak et al., 2013; Norris and Elrod, 2006; Wang et al., 2011; Xu and He, 2012; Xu and Song, 2011; Zhang et al., 2011; Zhang et al., 2012; Zhou et al., 2013), medical factors such as co-morbidity with other mental disorders or history of psychiatric conditions (Galea et al., 2005; Kadak et al., 2013), and disaster-related experiences such as being seriously injured, seeing dead people, living in a prefabricated house after the event or feelings of fear and threat to life (Chen et al., 2007; Galea et al., 2005; Kadak et al., 2013; Wang et al., 2011; Xu and He, 2012; Xu and Song, 2011; Zhang et al., 2011; Zhang et al., 2012; Zhou et al., 2013). Disaster-related experiences can be categorised into objective (e.g. being injured) and subjective features (e.g. feelings of fear), which together determine the extent of exposure to the disaster. This measure has been stated to be the most important risk factor for developing PTSD after a disaster (Galea et al., 2005) and can be used to evaluate the dose of exposure effect, which assumes that living in an area with higher levels of exposure is closely linked to higher levels of stress and psychological symptoms that may finally result in a mental disorder.

Strategies to assess the dose of exposure effect include measuring the level of exposure in differently affected groups (severe vs. less severe or affected vs. unaffected) (Bödvarsdóttir and Elklit, 2004; Dell'Osso et al., 2013; Dorahy and Kannis-Dymand, 2012; Goenjian et al., 2000; Maruyama et al., 2001; Rowlands, 2012; Şahin et al., 2007), measuring different levels of exposure to individual exposure variables like the extent of damage to the property/home or loss of possessions (Başoğlu et al., 2004; Bergiannaki et al., 2003; Sattler et al., 2006; Sharan et al., 1996; Wang et al., 2011; Xu and He, 2012), or using a distance based approach (Groome and Soureti 2004; DiMaggio et al., 2010).

The last two strategies have been used within this paper to assess the effects of different earthquake impact variables on incident and relapsed cases of mood and anxiety in Christchurch residents up to one year after the three largest earthquakes: 'Darfield', 'Christchurch' and 'Christchurch II'. The inclusion of almost all clinically diagnosed mood and anxiety cases gives the study a unique quality.

The main aim of this study is to examine the spatio-temporal change of mood and anxiety disorders in Christchurch between 2009 and 2012, and to identify earthquake exposure variables that may cause such disorders.

It is important to know what causes mood and anxiety disorders, and when, as well as where they may occur, to initiate early intervention since they are a great burden on society (Madianos and Evi, 2010). The New Zealand Burden of Diseases, Injuries and Risk Factors Study (NZBD) states that anxiety and depressive disorders were the second leading causes of health loss[2] in New Zealand in 2006, and are risk factors for suicide, self-harm, and coronary heart diseases (Ministry of Health, 2013a).

In Christchurch not everyone was exposed to the same level of impact and stress due to the earthquakes.

It is hypothesised that mood and anxiety disorders occurred predominantly in, or nearer to the highly affected eastern parts of the city where people have been exposed to liquefaction and lateral spreading in their community, or experienced higher levels of earthquake shaking intensity. Furthermore, in the context of ongoing aftershocks, it is hypothesised that people living in, or nearer to neighborhoods at greater risk of further damage in any future earthquake due to poor soil conditions were more likely to develop a mood or anxiety disorder than people living in less prone parts of the city.

Although there have been studies in the past that assessed the relationship between the level of exposure to an earthquake expressed by the affectedness of the community or the proximity to the epicentre and mental health outcomes (Dorahy and Kannis-Dymand, 2012; Groome and Soureti, 2004; Reed, 2013; Rowlands, 2012), the role of the exposure to the level of impact to the neighborhood, as well as the known risk of damage to the home in future earthquakes is still not fully understood. This paper contributes by filling this gap with the intention to derive recommendations to better target mental health care services for those in most need in future seismic events.

2. Methods

2.1. Data

Earthquake impact variables included Canterbury Earthquake Recovery Authority (CERA)[3] land zones, hazards intensity measures consisting of Peak Ground Acceleration (PGA) and Modified Mercalli Intensity (MMI), liquefaction and lateral spreading.

After the 2011 Christchurch earthquake, CERA undertook land classification based on area-wide damage assessments to

[2] Health loss measures the gap between a population's current state of health and an ideal state of health.

[3] The Canterbury Earthquake Recovery Authority (CERA) is the agency established by the Government to lead and coordinate the ongoing recovery effort following the September 2010 and February 2011 earthquakes.