PRE-TRAUMA SOCIAL DETERMINANTS OF HEALTH AND PTSD SYMPTOMS AFTER THE 2010 EARTHQUAKE IN CHILE: A PROSPECTIVE LONGITUDINAL STUDY IN A NATIONAL SAMPLE OF ADULTS

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Rodrigo A. Figueroa[1,2], Camila Bas[1], Oslando Padilla[3], Paula F. Cortés[2], Devin G. Atallah[2,4]

[1]Department of Psychiatry, Pontificia Universidad Católica de Chile School of Medicine.

[2]National Research Center for Integrated Natural Disasters Management (CIGIDEN), Chile.

[3]Department of Public Health, Pontificia Universidad Católica de Chile School of Medicine.

[4]Department of Global Health & Social Medicine, Harvard Medical School.

Author Note:

Correspondence to Dr. Rodrigo Figueroa, Camino El Alba 12351, Las Condes, Santiago, Chile (zip code 7620002). Email: rfiguerc@uc.cl. Phone: +56 2 2354 1801. Email: rfiguerc@uc.cl.

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Abstract

The 8.8 earthquake that struck Chile in 2010 caused 525 deaths, two million displaced, and 30,000 million US dollars in losses. The objective of this research was to find pre-disaster independent socioeconomic risk factors of Post-Traumatic Stress Disorder (PTSD) symptoms through an analysis of a cohort of adults from the 2009 National Socioeconomic Characterization Survey (CASEN) database. We analysed all the individuals 18 years old or older on 2009 who were followed after the earthquake and completed the Davidson Trauma Scale (DTS) three months after the earthquake in the Post-Earthquake CASEN. We calculated bivariate and multivariate associations between pre-earthquake location, demographic, housing, health, and occupation variables and post-earthquake PTSD symptoms. Data from 27,593 adults were analysed. PTSD symptoms were associated with location (proximity to epicenter) and several social determinants of health: rurality, sex, age, Mapuche origin, poverty, rental value, educational level, occupation stability, health insurance, self-rated health status and presence of recent illness. The risk of PTSD after a natural disaster could be strongly associated with social determinants of health. The fight against poverty and social inequities is imperative in order to increase community resilience to disasters.

BACKGROUND

Natural disasters are becoming a global public health threat. Between 2002 and 2011 natural disasters affected 268 million people around the world, killed 107,000 annually and caused economic damages estimated at 143 billion US dollars (Guha-sapir, Hoyois, & Below, 2013). Climate change and population growth in areas of risk would increase the number of disasters in future years (Guha-sapir, Hargitt, & Hoyois, 2004). On 27th February 2010 (F27) Chile was shaken by a 8.8 magnitude earthquake and tsunami that struck the central and south coasts of the country (epicentre 35.909ºS, 72.733ºW, near Chillán and Concepción) (USGS, n.d.-b). More than 500 people died, 2 million partially or completely lost their houses, 370,000 dwellings resulted with damage, economic costs exceeded 30,000 million US dollars (Gobierno de Chile, 2010), and tsunami warnings were activated all along the Pacific coasts (USGS, n.d.-a). In the aftermath of the disaster there was misinformation, pillaging and looting, which may have increased the perception of risk in the population (Baeza, 2010).

Among the many public health consequences of disasters, Post-Traumatic Stress Disorder (PTSD) is one of the most prevalent (Galea, Nandi, & Vlahov, 2005). According to the tenth edition of the International Classification of Diseases (ICD-10), PTSD is a "delayed and/or protracted response to a stressful event or situation of an exceptionally threatening or catastrophic nature, which is likely to cause pervasive distress in almost anyone..." (WHO, 2016). It has been estimated that 30-40% of those directly affected, 10-20% of the responders (rescuers, firemen, military), and 5-10% of the general population would develop PTSD during the first year after a natural disaster (Galea et al., 2005).

Several risk factors of PTSD after disasters have been found in the previous literature, including female gender, minority status, lesser education, and pre-disaster psychopathology (North, Oliver, & Pandya, 2012). Most of them can be included in the concept "Social Determinants of Health", defined by the World Health Organization as "... conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels" (WHO, n.d.). It has been estimated that around half of the variation in health could be determined by them, whereas the health system, the genes and the physical environment only account for 25%, 15% and 10%, respectively (Canada, 2009). Large-scale studies by the US Center for Disease Control (CDC) have begun to map psychological trauma itself to be a powerful social determinant of health showing how the number and type of traumatic events an individual experiences is associated with the development of a wide range of health problems throughout the life-course in various generations (Dube, Felitti, Dong, Giles, & Anda, 2003). The WHO (2014) publication on social determinants of mental health calls for increased research on trauma and the impact of social, economic, and environmental stressors in order to be able to effectively develop multileveled interventions and policies aimed at reducing key inequalities at both local and global levels. Little research, however, explores the social determinants of mental health in low- and middle-income countries (WHO, 2014). An exception can be seen in Myer, Stein, Grimsrud, Seedat, and Williams (2008) research in South Africa, which like Chile, has been classified as an upper middle income country (Kaiser Family Foundation, 2012). Meyer et al. (2008) found that after adjusting for demographic characteristics and life events, high levels of psychological distress were associated with participants among marginalized groups with lower socioeconomic status in South African society. These findings corroborate suggestions by life-course trauma researchers (e.g. Klest, 2012) to deepen understandings of the impact of social historical and

contextual factors on trauma, such as conditions of concentrated poverty and prior histories of victimization.

In terms of the impact of trauma from natural disasters, most of the risk factors previously identified in the literature have been found from small, post-disaster transversal studies (Dirkzwager, Grievink, van der Velden, & Yzermans, 2006; Norris, Friedman, & Watson, 2002; Yzermans et al., 2005), which is reasonable given the unpredictable nature of most disasters that precludes anticipation and research planning and funding. This limits the causal inference and increases the recall bias of these findings, making it essential to find ways to anticipate disasters and follow cohorts of individuals from before to after the event has struck, in order to increase the validity and causal inference of these results.

The Chilean National Socioeconomic Characterization Survey (CASEN), a government-driven instrument applied every two or three years since 1985 to a nationally-representative sample of individuals in order to regularly measure the situation of households and population regarding demographics, education, health, housing, employment, and incomes offers an unusual source of information from a cohort of people that were followed since 2009 (before the earthquake) and were affected by a disaster of national proportions in 2010. A few months before the earthquake struck, the Government of Chile administered the 2009 version of the CASEN (Ministerio de Desarrollo Social, n.d.-a). Three months after the earthquake, the Government decided to apply the Post-Earthquake CASEN to a representative subsample of 80,575 individuals previously surveyed, in order to measure the impact of the earthquake on several socioeconomic factors of the population (Ministerio de Desarrollo Social, n.d.-b). It included a module to measure PTSD symptoms for all individuals 18 years old or older who were present at home during a face-to-face interview of the residents of selected households. According to the official Post-Earthquake

CASEN report, 12% of the population in Chile had high PTSD symptomatology (as defined by a Davidson Trauma Scale [DTS] score ≥ 40) three months after the earthquake, reaching 20-25% in those regions that were declared "in a state of catastrophe", with higher rates in females and people with lower economic income.

The aim of this research was to identify pre-trauma independent socioeconomic risk factors of PTSD symptomatology after the earthquake, increasing causal inference and avoiding recall bias.

METHODS

This research used the data from the 2009 (pre-earthquake) and 2010 (post-earthquake) CASEN database. It can be downloaded for research purposes from the web page of the Ministry of Social Development of the Government of Chile (Ministerio de Desarrollo Social, n.d.-a).

The Post-Earthquake CASEN survey was applied to a representative subsample of the households surveyed in the CASEN 2009. The objective was to obtain information about the impact of the earthquake on the welfare of the population. The represented population are the households and adults that were surveyed in 2009. The study units are the households and their inhabitants.

Eight modules comprise the Post-Earthquake CASEN survey: (1) follow-up, resident, emerging issues: ethnicity, disability, heritage and internet access; (2) education; (3) employment and impact on independent activities; (4) income and financial assets; (5) health; (6) strategies for participation and social capital; (7) housing; and (8) psychosocial impact (PTSD symptoms) (Ministerio de Desarrollo Social, n.d.-a).

Sampling design

Chile is organized into 15 regions, subdivided into 346 districts; 13.4% of the population live in rural areas. In the post-earthquake CASEN the sample was obtained through a bietapic stratification of the geopolitical districts and sections of the territory, selecting urban and rural sample units in proportion to the answer rates in the CASEN 2009. It covered all the districts in Chile except those that were inaccessible due to distance or lack of roads. Sixty-seven strata were considered. An independent sample was obtained from every strata, and the sum of them represents the whole country. Some districts were required to participate because of their socioeconomic importance in a region or their high level of destruction after the earthquake and tsunami. In these cases the stratification was made in just one stage. Fifty-six urban and twenty-three rural districts were required to participate.

There were 71,460 households surveyed in the CASEN 2009. The theoretical sample size of the Post-Earthquake CASEN was 22,000 households, in order to avoid relative errors greater than 8% in all regions and provinces affected by the earthquake and tsunami; 27,000 households were selected to compensate losses for failure to answer (Figure 1), comprising 80,575 individuals.

Data collection

The Post-Earthquake CASEN survey comprised open and closed, single and multiple choice questions that were applied face-to-face by an interviewer to the same individual who answered the questions in the CASEN 2009 or, in the case that he or she was absent, by any person 18 years old or older. The survey was applied between 13th May and 28th June 2010. The Post-Earthquake CASEN can be considered a longitudinal survey, because it assessed the same households and people that were interviewed in the CASEN 2009. Given the large migration that followed after the earthquake, search activities were conducted for the migrant households, with

the sole purpose of maintaining the same individuals surveyed in 2009, avoiding sample loss. Some of these activities included asking neighbours, relatives or co-workers for the current location of the searched household, and if this was not successful, making contact with local institutions that could inform about the households and individuals sought.

The database of the Post-Earthquake CASEN survey allows inference to the populations living in particular households between November 2009 and June 2010 in all the regions of the country. In order to avoid biases it is essential to apply the included expansion factors that correct for selection probabilities, loss of answers and coverage errors.

PTSD symptoms

PTSD symptoms were screened in all adults 18 years old or older who were present at the moment of the interview with the Davidson Trauma Scale, Spanish version (DTS) (Bobes et al., 2000; Davidson et al., 1997), which is a self-rated instrument that measures the frequency and severity of PTSD symptoms according to the DSM-IV criteria in a 0-4 Likert scale. It was adapted to refer to the earthquake and tsunami as the index trauma. It was validated in Chile in a sample of victims of the F27 earthquake (Leiva-Bianchi & Araneda, 2013).

Variables

From the 373 variables of the Post-Earthquake CASEN Survey database, we selected 22 for analysis because they were the most closely related to putative predictors of PTSD according to previous research and theoretical background (Brewin, Andrews, & Valentine, 2000; Neria, Nandi, & Galea, 2008). All variables were kept as original, except the following: “region” was simplified dividing the country into three zones: a) regions VI, VII and VIII (declared to be in a state of catastrophe); b) regions V, RM and IX (severely affected by the earthquake); and c) the

rest of the country, distant from the epicentre and with less seismic disruption. In the variable "health insurance" we compiled all the different public health insurances into just one called "public", while maintaining other categories. Rental value of the dwelling and per capita corrected family income were categorized in intervals (see Supplementary Material for a detailed description of variables).

For the multivariate analysis, we created a new composite variable, "employment stability", with two categories: a) unstable or nonexistent, which compiles inactive, unoccupied and service/unqualified workers with unstable jobs; and b) stable, which includes professionals, students and unspecified stable occupations.

Data analysis

All the people who answered the DTS and were 18 years old or older on the CASEN 2009 were considered for analysis. Missing data was included in the analysis and detailed in the tables. We evaluated PTSD symptoms in both the full sample and several subsamples. All computations were performed with the correction of expansion factors. Categorical variables were described by absolute and relative frequencies. Bivariate analyses were calculated by t-student and ANOVA. Multivariate analyses were performed using ANCOVA to compare PTSD symptoms in different subsamples in terms of potential risk factors. All calculations were made through the complex sample section of the SPSS software version 17. The significance level was defined as $P < 0.05$.

RESULTS

Sample

Of the 80,575 Post-Earthquake CASEN individuals included, 50,410 were excluded from the analysis because they were younger than 18 years old on the CASEN 2009 or did not answer the

DTS survey. Overall, we analysed data from 27,593 adults (median age 47, ICR 35-60), representing 5,751,048 individuals after the application of expansion factors, of which 67% were female, 24% lived in towns located in regions declared in a state of catastrophe (VI, VII and VIII Regions), 13.5% were below the poverty line, and 4% were illiterate.

Bivariate analyses

Table 1 shows the results of bivariate analyses. The covariates associated with PTSD symptoms were location of residence (P<0.000), rurality (P=0.04), sex (P<0.000), marital status (P<0.000), educational level (P<0.000), literacy (P<0.000), indigenous origin (P=0.002), activity status (P<0.000), occupation (P<0.000), per capita corrected family income (P<0.000), rental value of the dwelling (P<0.000), poverty status (P<0.000), sanitation index of the house (P<0.000), quality of the house (P=0.001), fragile wall in the house (P<0.000), external insider (P<0.000), overcrowded housing (P<0.000), type of health insurance (P<0.000), self-rated health status (P<0.000), disability (P<0.000), and having any health problem in the last 30 days (P<0.000).

Multivariate analyses

In a multivariate logistic-regression model (Table 2), significant predictors of PTSD were living in a region declared in state of catastrophe as compared with the rest of the county (beta, 16.742), living in a rural area (beta, -1.601), being female (beta, 6.590), belonging to the Mapuche people as compared to not identifying with any indigenous people (beta, 1.967), being inactive as compared with employed (beta, -2.137), having an unstable employment (beta, 1.947), living in a house with a monthly rental value of $50.000 or less as compared with a house with a monthly rental value of $400.001 or more (beta, 5.546), being under the poverty line (beta, 2.494), not having any health insurance as compared with having a private health insurance (beta, 2.135), having a very bad or bad self-rated health status as compared with a good or very good (beta, 3.881), having had any health problem in the last 30 days (beta, 1.791), and each additional year of age (beta, .047).

DISCUSSION

Several risk factors identified in our analysis had already been reported in the literature. Both personal and social factors seem to affect the risk of developing PTSD (Kroll, 2003). In our sample, we confirmed an association between PTSD symptoms and living closer to the epicentre of the earthquake (Başoğlu, Kiliç, Salcioğlu, & Livanou, 2004), being female, being older, having any medical condition and having lower socioeconomic status (Brewin et al., 2000). Additionally, we found novel associations related to housing, demographics, health and employment.

Regarding housing, low rental value and urban location were all independently associated with more frequency and intensity of PTSD symptoms. This could be explained by the lower seismic resistance of cheaper dwellings, and greater exposure to scenes of destruction, pillaging, crime and looting in urban locations (Baeza, 2010).

In relation to demographic factors, PTSD symptoms were higher in individuals who identified themselves as belonging to the Mapuche people compared with those who did not identified with any indigenous group. This finding is interesting for many reasons. In part, because the association was not lost after controlling for other variables, it is plausible to argue that participants who identified as Mapuche may have increased risk for PTSD related to their status as members of a racialized minority group, or other associated factors that were not included in the analysis. For example, the Mapuche group in Chile has survived significant experiences of collective trauma, cultural loss, and devastating colonial injuries related to the invasion and conquest of their territory by the Spanish Empire, and later by Chilean settler expansion, raising the issue of the impact of indigenous Historical Trauma (HT) and transgenerational

transmissions as potential associated factors. Hartmann and Gone (2014) argue that, in contrary to the individual-level PTSD diagnosis, HT specifically sheds light into "how experiences with colonization—such as loss of land, language, and cultural practices—contribute in important ways to current psychological distress" (p. 275). In this light, the findings from the current study point toward the importance of better understanding how HT and intergenerational trauma may uniquely interact with the trauma from national disasters in Mapuche communities throughout Chilean society. Also, these findings on the increased vulnerability in participants who identified as Mapuche, may overlap with research completed in the USA that relates identifying with a racialized minority group, such as "Hispanic" in US contexts, to greater risk of PTSD in crisis conditions (Brewin et al., 2000). Finally, it should be noted that there are transcultural issues that could render the DTS as an invalid instrument to capture post-traumatic psychopathology in the Mapuche ethnic group.

In relation to age evidence is controversial, being reported that the younger the age of trauma the higher the risk of PTSD. However, this finding came mostly from studies in military population (Brewin et al., 2000). In our study the age appears as a significant risk factor independently, increasing the frequency and intensity of symptoms of PTSD with each more year of age. This could be due to a greater accumulation of trauma, but would have to undertake additional studies to determine possible associations of this correlation.

Regarding the health dimension, both low self-rated health and the presence of recent conditions were associated with more frequency and intensity of PTSD symptoms. Also related to the health dimension, there is a trend that shows those affiliated to exclusive health insurances such as private and those for the military and/or for the copper industry was independently associated with a lower risk of more frequency and intensity of PTSD symptoms. In Chile workers in these

employments used to enjoy better social security benefits (e.g. health access, lower out-of-pocket payments and lower insurance price readjustments every year), which could help to mitigate the perception of vulnerability to stress (Brewin et al., 2000).

We also found that higher PTSD symptoms was associated with lower stability or existence of employment. Stable occupation could be a protective factor for various reasons such as greater economic security, greater social affiliation and/or greater self-fulfilment. Different aspects of employment seem to adjust its predictive power. Really powerful is the importance of access to financial stability as a potential resilience factor, especially during times of uncertainty and instability related to the natural disaster. This also, again, raises the issue of the accumulation of trauma and whether some of the higher levels of PTSD that came up with participants with higher-levels of socioeconomic deprivation is related to the accumulation of trauma.

We cannot fail to mention the enormous impact of post-disaster PTSD on public health. In Chile, PTSD was in the 45th position in the ranking of burden of disease in 2007 (Departamento de Epidemiología, 2008), with a 12-month prevalence of 2.4% (Vicente et al., 2006). Given that during the first year after F27 the annual cumulated incidence of PTSD could have increased 5 times (from 2% to 10%), its position in the ranking could have ascended that year to second place, surpassing gallbladder disorders, alcohol dependence, hepatic cirrhosis, motor vehicle accidents, physical sequelae of assaults, or peptic ulcers. This figure represented a real epidemiological emergency that required secondary and tertiary preventive actions from the public health sector such as massive social communication campaigns, massive and coordinated community support and granting access to evidence-based treatments such as Trauma-Centred Cognitive-Behavioural Therapies or Eye Movement Desensitization and Reprocessing (EMDR) (WHO, 2013).

According to the model developed at a York University Conference held in Toronto in 2002 (Mikkonen & Raphael, 2010) there are fourteen Social Determinants of Health: aboriginal status, disability, early life, education, employment and working conditions, food insecurity, health services, gender, housing, income and income distribution, race, social exclusion, social safety net, and unemployment and job security. In our research, we have confirmed an independent relationship between higher frequency or severity of PTSD symptoms and several variables related to those determinants: lack of health insurance; female gender; low rental value; poverty; aboriginal status; and employment instability. This marks the importance of a multi-systemic approach to prevention and management of the psychological effects of disasters, including interventions aimed at modifiable lifestyle, social, community, socioeconomic, cultural and environmental factors.

Furthermore, although this study did not directly provide evidence for cumulative effects, these findings may provide insight into the importance of taking into account the "accumulation of trauma" and the increased vulnerability of socially oppressed groups (e.g. Garbarino, 2001). As Garbarino (2001) summarizes: "Risk accumulates; opportunity ameliorates" (p. 362). This perspective has been substantiated by large-scale studies on Adverse Childhood Experiences (ACE) which have demonstrated a dose-response association between the number and type of traumatic events an individual experiences and the development of mental health problems in adulthood (e.g. Edwards, Holden, Felitti, & Anda, 2003).

The findings of the current study point toward the importance of better understanding historical trauma, polyvictimization and the accumulation of trauma, and the ways in which poverty, racism, legacies of colonialism, and gender-based inequities, may all intersect to create complex

risks for low-income, socially marginalized families throughout natural disaster conditions. In fact, the specific application of a social ecological, intergenerational and accumulative model of risk may be helpful in future research on social determinants of mental health under conditions of natural disasters in Chile. It is quite possible that a large-scale crisis could be the final blow for oppressed groups who have already faced significant daily social vulnerabilities and obstacles.

In this light, our findings, even indirectly, may point toward meaningful linkages across issues of geological/physical space, social place, and psychological trauma. First, we show how 'Place Matters' in terms of your spatial proximity to a specific natural disaster event. However, our findings then reach further into a more transdisciplinary territory, suggesting that 'Place' also matters in terms of your social positionality. Future research is needed that, when seeking to better understand natural disaster-related trauma, accounts for social inequities and the dynamics and interactions between and across multiple levels of Chilean society.

To the best of our knowledge this is the first longitudinal analysis of Social Determinants of Health of PTSD before and after a disaster in a sample of adults from all the regions and districts of a country. The large sample size allows high statistical power, minimizing the risk of type II error. Tracking methodologies used in the CASEN 2009 and the Post-Earthquake CASEN contributed to avoiding sample losses that could introduce bias into the estimates. All this allows us to propose that our findings are valuable and informative to the fields of public health, disaster medicine and psychotraumatology. However, the results of this research should be treated with caution for several limitations. First, the representativeness of the sample to the national population of adults is limited. Given that the DTS needed to be self-rated by adults, our sample excluded all those adults that were absent during the interview, over-representing females.

Second, the screening instrument used for the detection of PTSD symptoms was modified to find specific, post-earthquake symptoms, thus generalization to other kinds of trauma is not guaranteed. Third, several variables, including PTSD symptoms, were assessed by self-report, which may challenge the accuracy and objectivity of the data. In fact, the DTS measures PTSD symptoms, not PTSD formally assessed by a structured clinical interview, even though the DTS has been shown to have good sensitivity and specificity for the diagnosis of PTSD (18,28) and is suitable for very large samples where structured clinical interview is not feasible. Finally, the DTS was not applied in the CASEN 2009, so it is not possible to determine precisely how much was an increase of the PTSD symptoms.

Declaration of Interests

There are no conflicts of interest declared by any author.

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