

Exploring an anniversary effect three years after the February 2011 Christchurch Earthquake

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Abstract

The anniversary of a traumatic event can lead to psychological distress. Though triggers of psychological distress have been generally documented in the trauma literature, the impact of earthquake anniversaries is less well understood, particularly in relation to when distress symptoms are most heightened. The present study investigated an anniversary effect on psychological distress three years after the February 2011 Christchurch earthquake, whether this effect differed in communities with different levels of physical impact or financial resource, and if it was more pronounced before or after the anniversary. Respondents were from six Christchurch suburbs differing in socioeconomic status and physical damage from the earthquake. Psychological distress was assessed via self-report measures of posttraumatic stress, depression, and anxiety. Assessment took place 2-3 weeks before the third anniversary (n = 300) and 2-3 weeks after it (n = 300). Symptoms of posttraumatic stress and depression were greater after the anniversary than before, particularly in medium to low socioeconomic status suburbs and those suburbs that experienced greater physical damage from the earthquakes. Contrary to predictions, the findings demonstrate a delayed anniversary reaction that manifested in the weeks following the earthquake anniversary.

Keywords: Earthquakes, distress, anniversary

Media coverage (Hilton, 1997), situational cues (Antony & Rowa, 2005), intrusive images (Birrer, Michael, & Munsch, 2007), and external stressors (Mitchell & Ronzio, 2011) can cause distress many years after a traumatic event. The anniversary of a traumatic event can also trigger psychological distress. This *anniversary effect* has been documented in relation to floods (Assanangkornchai, Tangboonngam, Samangsri, & Edwards, 2007), terrorist attacks (Daly et al., 2008), war (Morgan, Kingham, Nicolaou, & Southwick, 1998) and earthquakes (Ye, Fan, Li, & Han, 2014); findings generally support heightened psychological distress around the anniversary of the traumatic event. However, there is a paucity of research into whether that distress is heightened *before* or *after* the anniversary several years after the event. Such an understanding may help to direct resources accordingly, to reduce heightened distress around the anniversary of a traumatic event.

Assanangkornchai et al. (2007) investigated, over a 1 year period, the psychological effects of the 2000 Hat Yai flood. Distress gradually declined over the year; however, the final measurement 3 to 4 weeks before the first anniversary showed increased distress in areas most affected by the floods. Assanangkornchai et al. interpreted these findings as an anniversary reaction. Given flooding is an annual event in the area, it is however possible that an anniversary reaction could be distress about imminent future flooding, rather than memories of past flooding.

Morgan et al. (1998) found that of their 59 Gulf War I veteran participants, 18 experienced an anniversary reaction 2 years after deployment. Participants identified the month of their most severe war-related trauma and an anniversary reaction was evident if their posttraumatic stress (PTS) symptoms were most prevalent in that month. In a second study of the same population, Morgan, Hill, Fox, Kingham, and Southwick (1999) found anniversary effects in a small number of veterans 6 years post-service, showing the long-term presence of an anniversary effect. Daly et al. (2008) found an increase in PTS symptoms among disaster relief workers 2 weeks either side of the first anniversary of the 9/11 terrorist attacks. While these studies provide evidence of anniversary effects across a range of traumatic events which share some similarities with earthquakes,

there are characteristic differences which justify an investigation of earthquake anniversary effects.

There is evidence that earthquake memories for survivors can be vivid (Er, 2003) and distressing (Fan, Zhang, Yang, Mo, & Liu, 2011) around one year after the disaster, but people are also able to show considerable resilience (Bonanno, 2004; 2005). Ye et al. (2014) followed 1,573 adolescents 6, 12, 18, and 24 months following the Wenchuan earthquake. They found rates of depression at 27%, 41%, 32%, and 38% respectively, indicating a high stability of depression as well as a spike around the first and second anniversary. What is currently unclear, and therefore important to address, is the degree to which symptoms increase immediately before or immediately after anniversaries in community groups exposed to earthquakes. Such information will allow for more targeted efforts to reduce the negative impacts of such events.

On 22 February 2011, a 6.3 magnitude earthquake hit Christchurch, New Zealand, resulting in widespread destruction and loss of life (185 deaths; Potter, Becker, Johnston, & Rossiter, 2015). It followed a 7.1 magnitude earthquake in September 2010 which caused major infrastructure damage but no loss of life. The region experienced thousands of aftershocks that continued for years after the initial earthquakes (Dorahy et al., 2016), serving as a constant reminder of the earthquake and the continual danger of living in a seismically active region. In addition, every year the city of Christchurch stops at 12.51pm on 22 February to remember the events of that day (Harris, 2018).

The present study investigated if an anniversary effect of psychological distress was more pronounced immediately before or after the third anniversary of the February 2011 Christchurch earthquake. The analysis accounted for socioeconomic status (SES) and the amount of physical damage caused by the earthquake in each suburb assessed, given the established impact of these factors on psychological distress (Dorahy et al., 2015). Psychological distress is represented by the severity of PTSD, depression, and anxiety symptoms. Some previous studies found heightened symptoms of distress before the anniversary, others report heightened symptoms after, and some measured participants' symptoms either side of the anniversary and merged them. It is therefore unclear when in the anniversary period heightened psychological distress may be experienced most severely. Given memory cues begin to become apparent in the lead-up to the anniversary,

we predicted higher psychological distress, after controlling for physical impact from the earthquakes and socioeconomic resources, in the weeks preceding the anniversary compared to following the anniversary.

Method

Participants

This study recruited residents from six Christchurch suburbs ($n = 100$ per suburb, $N = 600$). The sample comprised 215 males (35.8%) and 385 females (64.2%) aged between 18 and 91 years ($M = 52.66$, $SD = 18.03$). Fifty participants from each suburb were surveyed before the anniversary ($n = 300$) and another 50 participants from each suburb were surveyed after it ($n = 300$) to reduce the impact of practice effects associated with a repeated measures design. For pre-anniversary data collection, 433 (29.8%) households declined to participate, while no one was home in 718 (49.5%) households (although a data processing error meant some data in this category were unknown), resulting in a total response rate of 20.7%. For post-anniversary data collection, 296 (20.5%) households declined to participate, while no one was home in 847 households (58.7%), resulting in a total response rate of 20.8%. See Appendix 1 for a breakdown of the number of houses approached in each suburb to reach the quota.

Suburbs in Christchurch were unequally affected by the earthquake. While some were relatively unaffected (particularly those in the West and North of the city), others were significantly affected (e.g., homes uninhabitable, major sewage, electricity, and water disruptions). The researchers (Dorahy et al., 2016) selected three suburbs which were severely physically affected by the earthquakes as assessed by high levels of housing damage and destruction, (i.e., many homes in these areas were no longer safe to enter and others experienced prolonged loss of utilities and major structural damage). These suburbs were chosen to reflect not only physical damage, but also three different levels of SES as determined by the 2006 census, which at the time of the initial earthquake contained the most recent data for each suburb across the city. The remaining three suburbs had comparatively less physical damage (i.e., few demolished or severely damaged houses, little utility disruption) and were matched on SES (low, medium, and high) based on census data.

Procedure

Participants were recruited using a door-to-door approach. Data collection started 3 weeks before the third anniversary (22 February 2014) of the earthquake and lasted 2 weeks, during which 50 participants from each suburb were surveyed. Another 50 participants from each of the same suburbs were surveyed in a 2-week period starting a week after the 22 February anniversary. To ensure the sample was more representative, a systematic method was used for recruitment; on each street the researcher started at the lowest number, working progressively until the quota for that area was reached. The post-anniversary assessments started at the next house on from the last house assessed pre-anniversary.

Question and response options were read to those who agreed to participate and on completion the participants received a one-page sheet outlining services available to those affected by the earthquake, including a free counselling service. Participants were also given a \$5 coffee voucher in exchange for their time. This study was approved by the University of Canterbury Human Ethics Committee (HEC 2013/160; 13.1.2014).

During the first data collection window (1-15 February 2014) 39 aftershocks occurred in the Canterbury region. The strongest of these was M3.9 and 5 kilometres deep. Of the 188 people who reported this aftershock to GeoNet, 99.46% ($n = 187$) experienced light or weak shaking. During the second data collection window (1-15 March 2014) 26 aftershocks occurred in the region, the strongest of which was M3.6 and 9 km deep. Of the 581 people who reported it, 99.14% ($n = 576$) reported light or weak shaking.

Measures

Participants completed a questionnaire battery assessing psychological distress: the Modified Posttraumatic Stress Symptom Scale (MPSS-SR; Falsetti, Resnick, Resick, & Kilpatrick, 1993), the Patient Health Questionnaire (PHQ-9; Spitzer, Kroenke, Williams, & Patient Health Questionnaire Primary Care Study Group, 1999), and the Generalized Anxiety Disorder scale (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006). Demographic information related to sex, age, and place of residence during the earthquakes was also collected, as well as where they were living at the time they answered the questionnaire.

The MPSS-SR contains 17 items that correspond to the DSM-IV criteria for Posttraumatic Stress Disorder

(PTSD; Falsetti et al., 1993). For PTS symptom severity, the focus of this paper, items were anchored to the earthquake and rated on a 6-point scale (0 = "not at all distressing" to 5 = "extremely distressing") over the past 2 weeks (e.g., "do you often make efforts to avoid thoughts or feelings associated with the event(s)?"). Total scores for severity were created by summing all items, with a minimum possible score of 0 and a maximum of 85. Higher scores indicate greater PTSD symptom severity, with scores of or above 29 suggesting PTSD. The psychometric properties of the scale are well supported in the literature (e.g., Cronbach's alpha > .95, Falsetti et al., 1993) and in the current study, with internal consistency at $\alpha = .90$.

The PHQ-9 comprises nine items measuring symptoms of depression (Spitzer et al., 1999) on a 4-point scale (0 = "not at all" to 3 = "nearly every day") of how often in the past week a participant felt each symptom (e.g., "little interest or pleasure doing things"). Scores from each item are summed, with higher scores indicating a greater frequency of depression symptoms. Scores above 5, 10, 15, and 20 represent levels of depression in the mild, moderate, moderate-severe, and severe range, respectively. The PHQ-9 is a reliable and valid measure of depression severity ($\alpha > .85$ in Kroenke, Spitzer, Williams, & Löwe, 2010; $\alpha = .89$ in the current study).

The GAD-7 is designed to measure general anxiety symptoms using a 7-item questionnaire (Spitzer et al., 2006) rated on a 4-point scale (0 = "not at all" to 3 = "nearly every day") of how often in the past week the participant felt bothered by a particular problem (e.g., "trouble relaxing"). The sum of all items provides a total score between 0 and 21, with a higher score indicating a greater frequency of anxiety symptoms. Scores over 8 are considered to suggest an anxiety disorder. The GAD-7 has good psychometric properties ($\alpha = .89$ in Löwe et al., 2008; $\alpha = .91$ in the current study).

Data Analysis

Analysis was undertaken with SPSS version 23, using three 3-way between-subject Analyses of Variance (ANOVA) models where the independent variables were Anniversary (two levels: before and after), SES (three levels: low, medium, and high), and damage (two levels: physically affected and relatively unaffected). The dependent variables were PTS severity, depression severity, and anxiety severity. The data are available at <https://osf.io/njykt/>.

Results

The sex ratio did not significantly differ between participants who responded before or after the anniversary, $\chi^2(1, N = 600) = 3.83, p = .061$ (68.0% females before anniversary and 60.3% afterwards). However, mean age did differ between participants who responded before or after the anniversary, $t(598) = 3.23, p = .001, d = 0.26$. Those responding after the anniversary ($M = 55.02, SD = 17.87$) were significantly older than those responding beforehand ($M = 50.16, SD = 18.11$). Assumptions for ANOVA (e.g., normal distributions, homogeneity of variance) were met for all of the scales (Field, 2013). Table 1 shows the means and standard deviations for each scale across suburbs.

Posttraumatic Stress

There was a significant main effect of anniversary for the PTS severity scores ($F(1, 588) = 9.54, p = .002, \eta_p^2 = .02$) with higher severity after the anniversary than before it. There was also a significant main effect for suburb SES ($F(2, 588) = 16.62, p < .001, \eta_p^2 = .05$). Participants from the medium SES suburbs had higher scores than low ($p = .005$) or high ($p < .001$) SES suburbs. The low SES suburbs had significantly higher severity scores than the high SES suburbs ($p = .031$). In addition, there was a significant main effect of suburb damage ($F(1, 588) = 6.87, p = .009, \eta_p^2 = .01$) with those in the high damage suburbs reporting higher severity scores than those in the low damage suburbs. There were no interaction effects.

Depressive Symptoms

A significant main effect of anniversary was also evident for depressive symptoms ($F(1, 588) = 8.02, p = .005, \eta_p^2 = .01$), again with higher severity after the anniversary compared to before. There was also again a significant main effect for suburb SES ($F(2, 588) = 8.76, p < .001, \eta_p^2 = .03$), with participants from the low ($p = .004$) and

medium ($p < .001$) SES suburbs demonstrating higher depression scores than the high SES suburbs. There was a significant main effect of suburb damage ($F(1, 588) = 6.63, p = .010, \eta_p^2 = .01$), with those in the high damage suburbs reporting higher severity scores than in the low damage suburbs. Unlike PTS, there was also a significant interaction between SES and damage ($F(2, 588) = 4.35, p = .013, \eta_p^2 = .02$). Participants from low and medium SES suburbs living in high damage areas reported more depression symptoms than those in low damaged areas. However, the high SES suburbs showed no difference across levels of damage.

Anxiety Symptoms

There was no significant main effect of anniversary for the anxiety scores ($F(1, 588) = 1.98, p = .160, \eta_p^2 < .01$). There was, however, a significant main effect for suburb SES ($F(2, 588) = 8.30, p < .001, \eta_p^2 = .03$). Participants from the high SES suburbs had lower anxiety scores than those from the low ($p = .030$) or medium ($p < .001$) SES suburbs. In addition, there was a significant main effect of suburb damage ($F(1, 588) = 6.87, p = .009, \eta_p^2 = .01$), with those in the high damage suburbs reporting higher anxiety. There were no interaction effects.

Without a control sample assessed at another time of the year, it was difficult to gauge the true impact of the anniversary effect. Achterhof et al. (2018) assessed participants from the same suburbs as the current study ($N = 412$) 10-11 months after the same earthquake and used the same measures of depression and anxiety. Comparing their total PHQ ($M = 3.63; SD = 4.62$) and GAD ($M = 3.25; SD = 3.72$) scores with total before and after scores in the current study showed lower scores before the third year anniversary compared to approximately one month before the first anniversary for both the PHQ, $F(1, 710) = 17.21, p < .001, \eta_p^2 = .03$, and GAD, $F(1, 710) = 7.29, p = .001, \eta_p^2 = .01$.

Table 1
Means and Standard Deviations (in parentheses) for each scale by suburb

| | | Low SES | | Medium SES | | High SES | |
|------------------|--------|--------------|-------------|--------------|-------------|-------------|-------------|
| | | High Damage | Low Damage | High Damage | Low Damage | High Damage | Low Damage |
| MPSS-SR Severity | Before | 6.62 (10.28) | 3.26 (5.44) | 8.04 (7.57) | 7.58 (9.75) | 2.62 (5.88) | 1.94 (6.54) |
| | After | 8.68 (12.18) | 5.10 (9.63) | 11.02 (9.63) | 7.90 (8.73) | 5.04 (7.29) | 5.26 (7.03) |
| | Total | 7.65 (11.26) | 4.18 (7.84) | 9.53 (8.74) | 7.74 (9.21) | 3.83 (6.70) | 3.60 (6.96) |
| PHQ-9 | Before | 3.76 (5.83) | 1.88 (3.84) | 3.38 (4.21) | 2.08 (4.44) | 1.04 (2.66) | 1.10 (3.93) |
| | After | 4.32 (6.40) | 2.72 (6.58) | 5.48 (5.74) | 3.00 (4.68) | 1.58 (2.97) | 2.76 (4.08) |
| | Total | 4.04 (6.10) | 2.30 (5.38) | 4.43 (5.12) | 2.54 (4.56) | 1.31 (2.82) | 1.93 (4.07) |
| GAD-7 | Before | 3.62 (5.39) | 2.00 (3.55) | 3.56 (4.52) | 2.94 (4.70) | 1.26 (3.28) | 1.24 (3.55) |
| | After | 3.74 (5.53) | 2.26 (4.87) | 4.88 (5.40) | 2.50 (4.54) | 1.94 (3.77) | 2.36 (3.24) |
| | Total | 3.68 (5.43) | 2.13 (4.24) | 4.22 (5.00) | 2.72 (4.60) | 1.60 (3.53) | 1.80 (3.43) |

However, the post-third year anniversary scores were not significantly different to scores reported just prior to the first anniversary on the PHQ, $F(1, 710) = .71, p < .40, \eta_p^2 = .001$, and GAD, $F(1, 710) = .94, p < .33, \eta_p^2 = .001$.

Discussion

This study investigated whether psychological distress was higher before or after the third anniversary of the February 2011 Christchurch Earthquake, accounting for differences in SES and physical damage. The scores for depression and anxiety were similar to scores 10-11 months after the earthquake; these symptom severities at the third anniversary similar to those evident in the first year after the earthquake indicate a general anniversary effect. Contrary to expectations, however, symptoms were elevated in the immediate weeks following the anniversary of the earthquake, compared to the weeks immediately preceding the event. Regardless of the anniversary, participants from low and medium SES suburbs generally had more PTS symptom severity and greater frequency of depressive and anxiety symptoms than participants from higher SES suburbs. In addition, those living in suburbs with high levels of damage had more PTS, depression, and anxiety symptoms than those in less affected suburbs (except when comparing high SES suburbs).

Greater psychological distress after the anniversary may be explained by individuals being less able to avoid thoughts and feelings about the earthquake than before the anniversary. We expected that memory cues becoming apparent in the lead-up to the anniversary would increase distress; perhaps less salient cues may be present in the immediate environment prior to the anniversary compared to the day of the anniversary and those following.

Mental disengagement is a common form of coping for individuals who suffer from PTS symptoms (Clohessy & Ehlers, 1999) and is assisted by the absence of cues that act as reminders of the trauma. The anniversary itself brought memorial services, national media coverage, and increased community dialogue and reminiscence (Harris, 2018). This heightened level of public attention could challenge coping mechanisms by cueing reminders and undermining efforts to disengage mentally. This interpretation is consistent with other findings that greater engagement with reminders of the event, such as media coverage in the case of the 9/11 terrorist attacks, resulted in higher levels of PTS symptoms (Bernstein et al., 2007). An increase in salient cues including greater media and

community attention on the anniversary may result in greater psychological distress that persists in the weeks following the anniversary.

The stronger anniversary effect after the event was limited to symptoms of PTS and depression, and not evident with anxiety. Perhaps rather than feeling on edge, worried, and irritable in the aftermath of the anniversary, feelings of loss and mourning are activated: for example, for loved ones, homes, and livelihoods (Harris, 2018). This impacts on symptoms of depression and PTS. A sense of loss has been associated with depressive symptoms (Price, Choi, & Vinokur, 2002). Indeed, individuals who experience loss are more susceptible to depression in response to life stressors (Slavich, Monroe, & Gotlib, 2011). It is also possible that anxiety was heightened before the event due to anxiety about the anniversary itself, while PTS and depression were not affected in this way.

The combination of high damage and lower SES appeared to leave individuals particularly vulnerable to PTS and depression symptoms around the third anniversary of the earthquake. The low SES, high damage and medium SES, high damage suburbs had the highest symptom severity and frequency. In contrast, high SES suburbs were largely buffered from psychological distress influenced by damage experienced during the 2011 earthquake. These findings generally support the hypothesis that individuals from suburbs with greater damage and lower financial resources experience more psychological distress. Individuals from low-income populations experience different physical and psychological impacts and greater vulnerability to disasters (Fothergill & Peek, 2004). Those in lower SES suburbs who were more physically affected are less likely to have financial resources to buffer against the impact of loss and damage, and therefore are more likely to experience distress.

The current study has particular limitations, including a number of potentially confounding variables (e.g., family issues, financial issues, and difficulties relating to insurance coverage) which might affect psychological responses to reminders of the earthquake that were not measured. Additionally, causal mechanisms of the anniversary effect such as increases in salient reminders from the media were not explored; causal explanation was not the aim of this study but presents opportunities for future research. The response rate of approximately 20% both before and after the anniversary, primarily driven by people not being home when the household was approached, potentially reduces the

representativeness of the sample. While there is no reason to expect systematic influences on non-response, future work could employ methods to increase response rate or use demographic sampling quotas to ensure that the sample is representative.

Furthermore, there was a significant difference in age for participants assessed before and after the anniversary. Studies examining psychological distress in adolescents around the time of an anniversary produced similar findings to the present study, indicating age likely does not have a meaningful effect on psychological distress experienced (Fan et al., 2011; Ye et al., 2014). To more robustly identify anniversary effects, the data in this study were compared to data on the same measures of anxiety and depression from the same suburbs 10 to 11 months after the earthquake. A more sophisticated approach could assess participants from each suburb outside the third year anniversary window (e.g., 2 months beforehand).

The extent to which the frequency of anniversaries leads to habituation over time ought to be empirically tested. Finally, because of the large number of aftershocks, some of considerable magnitude (e.g., greater than M5.0), individuals within Christchurch may have their own response to specific aftershocks that were more relevant to them. The current study focussed on the earthquake that led to fatalities and a major city-wide and national response; this was the earthquake which was likely to be the most impactful for the majority of the population. Therefore, it was considered most appropriate to assess anniversary effects within the wider community rather than screening out any participants who were more impacted by a different earthquake in the sequence.

This study shows elevations in PTSD and depression symptoms in the weeks following the third anniversary of a fatal earthquake. The findings have implications for both practice and further research. The presence of greater psychological distress after the anniversary than before suggests that community interventions, public health messaging, and resources also need to be available in the weeks following an anniversary (Lambert, 2005). Different coping strategies may be required after the anniversary, when reminders are more salient and visible, than before the anniversary. Further, attention should be paid to areas with less financial resource that have experienced higher damage to reduce the psychological distress experienced by these communities.

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The data and hypotheses in this paper have not been disseminated elsewhere. The authors have no conflicts of interest. The data that support the findings of this study are available in The Open Science Framework, <https://osf.io/njykt/>.

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Appendix 1: Non-responses by suburb and time collected

| | | Low SES | | Medium SES | | High SES | | Total |
|--------|-----------------------|-------------|------------|-------------|------------|-------------|------------|-------|
| | | High Damage | Low Damage | High Damage | Low Damage | High Damage | Low Damage | |
| Before | Refused Participation | 85 | 162 | 42 | 88 | 24 | 32 | 433 |
| | Not Home | 182 | 154 | 179 | 203 | X | X | 718 |
| | Total | 267 | 316 | 221 | 291 | 24 | 32 | 1151 |
| After | Refused Participation | 55 | 148 | 29 | 13 | 21 | 30 | 296 |
| | Not Home | 85 | 248 | 120 | 29 | 165 | 200 | 847 |
| | Total | 140 | 396 | 149 | 42 | 186 | 230 | 1143 |

Note. X indicates data missing due to a processing error

