

PTSD and Resilience in Adolescents after New Zealand Earthquakes

Timothy Heetkamp, Ian de Terte
Massey University, New Zealand

The psychological response of adolescents to several significant earthquakes in Canterbury, New Zealand was investigated. A survey questionnaire was completed by 525 adolescents at secondary schools in Christchurch 6 months after the February 22, 2011 earthquake which had a death toll of 185. Clinically significant PTSD symptoms were found amongst 24% of the sample, with females experiencing significantly greater levels of PTSD compared to males. Significant relationships were found between trauma exposure and PTSD, and fear and PTSD, whereas a significant negative relationship was found between psychological resilience and PTSD. Multiple regression analysis revealed that fear was the strongest predictor of PTSD symptoms, followed by trauma exposure. Resilience was found to moderate the relationship between fear and PTSD

Adolescent PTSD and Resilience after New Zealand Earthquakes

On September 4, 2010, New Zealand's Canterbury region was struck by a 7.1 magnitude earthquake. Widespread damage resulted, and although there were no casualties, this initial earthquake marked the beginning of a swarm of earthquakes and aftershocks. The most severe of these earthquakes occurred on February 22, 2011. The epicentre was located 6 km south-east of Christchurch's central business district at a depth of 2 km. One hundred and eighty five people were killed and over 3000 sustained injuries that required medical intervention. Thousands of aftershocks followed this earthquake and on June 13, 2011 there were two significant aftershocks that were 5.9 and 6.3 in magnitude. These aftershocks caused further damage to property, but no loss of life. Aftershocks continue at the time of writing, but their frequency and magnitude are diminishing.

It is plausible that a series of events such as these, including one where substantial loss of life and injury occurred would have a psychological impact on a proportion of people who experienced them. This assumption was tested by Norris et al. (2002a) who conducted a review of 160 studies and concluded that disasters have a

persistent psychological effect on about 10% to 50% of survivors. This was true across all life stages, including adolescence which is the developmental stage that is the focus of this study.

Posttraumatic stress disorder (PTSD) is currently the most studied mental disorder in the wake of disasters (McFarlane, Van Hoof & Goodhew, 2009), the primary reason being that the classification of PTSD clearly links an experienced trauma to resultant psychological symptoms (Neria, Nandi & Galea, 2008). In a review of 160 disaster studies, Norris, Friedman, and Watson (2002b) concluded that the prevalence of PTSD varied greatly across different disasters. They attributed this variation to factors such as disaster type, severity of trauma experienced by the sample, and variability in methodological approaches. They noted that higher levels of PTSD were consistently found amongst youth samples (children as well as adolescents) in contrast to adult samples. This has been attributed to a smaller repertoire of lifetime stress exposure and therefore less developed coping skills in youth compared with adults (Goenjian et al., 2011), as well as neuro-cognitive differences in the developing brain (Lupien, McEwan, Gunnar & Heim, 2009). Adolescence is a period of significant neuro-cognitive development and is associated with an increase of both intrinsic and extrinsic

stressors. It is therefore feasible that adolescents may be particularly vulnerable to stress following a disaster (Masten, Monn & Supkoff, 2011).

Despite conclusive evidence for the relationship between disasters and PTSD, most studies have found that only a minority of the affected population, including adolescents, develop PTSD after disasters (Norris et al., 2002a, 2002b), indicating the presence of resilience (Luther, Cicchetti & Becker, 2000). Resilience has been conceptualised in various ways, but for the purposes of this study it has been defined as the ability of individuals to cope with stress (Connor & Davidson, 2003). There have been few studies that have specifically measured resilience factors in relation to PTSD after disasters. Furthermore, no studies have been found that investigate the relationship between resilience and PTSD in an adolescent population after earthquakes.

The current study aimed to address this gap in the literature and hypothesised that:

1. Clinically significant PTSD symptoms would be present in more than 10% of the sample.
2. Resilience, trauma exposure, and fear would predict PTSD symptoms.
3. Resilience would moderate the relationship between the level of trauma exposure and PTSD symptoms.

Method

Participants

Of the 4,300 secondary school students invited to participate in the study, a total of 525 from six high schools consented and obtained parental consent. An 86 item self-report questionnaire which measured PTSD, resilience, trauma exposure, and fear, was completed by these participants. Fifty two percent of the sample was

female. The age of participants ranged from 13 to 20 years ($M = 15.2$ years; $SD = 1.48$). Seventy eight percent identified their ethnicity as New Zealand European, 6% identified as Maori, 5% as Pacific Islander, 7% as Asian, and 5% as other. Over 90% of the participants were within 25 km of the earthquake epicentre during the major earthquakes of September 4, 2010, February 22, 2011, and June 13, 2011.

Measures

Child PTSD Symptom Scale (CPSS). The CPSS (Foa, Johnson, Feeny & Treadwell, 2001) was designed to assess PTSD symptom severity in youth aged 8 to 18 years who had experienced a traumatic event. Responses were on a 4-point Likert scale, ranging from 0 (not at all), to 3 (almost always). Items were categorised into reexperiencing, avoidance, and hyperarousal subscales. Seven additional items were designed to elicit whether PTSD symptoms have affected daily functioning such as relationships with friends and general happiness with life. Foa et al. (2001) found satisfactory internal consistency, test-retest reliability, convergent and divergent validity for the CPSS. High internal consistency ($\alpha > .85$) was found for the CPSS total scale as well as each of its subscales in the current study. A cut-off value of 15 was used to determine the presence of clinically significant PTSD symptoms (Nixon et al., 2013).

Connor-Davidson Resilience Scale (CD-RISC). The 10-item Connor-Davidson Resilience Scale (CD-RISC-10; Campbell-Sills & Stein, 2007), a shortened version of the original 25-item CD-RISC (Connor & Davidson, 2003), was used to assess psychological resilience. Responses were measured on a 5-point Likert scale from not true at all (0) to true nearly all the time (4), with total scores ranging from 0 - 40. Although the CD-RISC was originally developed for adults, it has been validated in studies with children and adolescents aged 10-18 years (e.g., Fincham, Altes, Stein, & Seedat, 2009). Cronbach alphas for the CD-RISC-10 have ranged from .80 - .96 in several studies (e.g., Khoshouei, 2009). Test-retest reliability of .87 and .88 was found by Connor and Davidson (2003)

and Khoshouei (2009) respectively. Construct validity has been supported by studies that have found the CD-RISC-10 scores to uniquely moderate between trauma and PTSD (Connor & Davidson, 2003; Fincham et al., 2009). A Cronbach's alpha of .88 was found for the CD-RISC-10 in the current study.

Trauma Exposure Scale (TES). The 9 items of the TES were adapted from the 28-item Survivor Information Form (SIF; Başoğlu, Kiliç, Şalcioğlu, & Livanou, 2004), which was designed to assess trauma exposure during earthquakes. Seven of the traumatic-exposure items used in the current study required a Yes/No response. The remaining two items of the Trauma Exposure Scale elicited data regarding the participant's house. The nine items of the trauma exposure scale have face validity for the assessment of this construct. A Cronbach's alpha of .79 was found for the scale in this study.

Fear Scale (FES). The highest level of fear experienced during any of the earthquakes and the highest level of fear during the most recent aftershock were measured using two items that comprised the Fear Scale. The first item was adapted from the SIF (Başoğlu et al., 2004), and the second item was developed specifically for this study due to the volume and frequency of significant aftershocks after the initial event. The items were scored using a 5 point Likert scale ranging from 1 (no fear at all) to 5 (extreme fear/terror). The construct validity of this scale is supported by findings that fear during earthquakes accounted for a significant variation in symptoms of PTSD and other psychopathology after earthquakes (Başoğlu et al., 2004; Basoglu & Salcioglu, 2011). Reliability analysis revealed a Cronbach's alpha of .78.

Validation items. Two items were included in the questionnaire in order to detect random or erroneous responding. Questionnaires were excluded if either of these items were endorsed. A total of sixteen questionnaires (3%) were excluded due to invalid responding. Ten of these were from male respondents and six were from female respondents resulting in a final sample size of 509 participants.

Procedure

Massey University's Human Ethics Committee granted ethical approval. Nonprobability purposive sampling (Spring et al., 2003) was used to select six high schools as a representation of the adolescent population in Christchurch. All students at these schools were invited to participate in the study. The questionnaire could be completed on paper or online. Data was entered from the completed and validated questionnaires into the Statistical Package for the Social Sciences (SPSS) version 18 for statistical analysis.

Results

Descriptive Statistics

Descriptive statistics are displayed in Table 1. Independent sample t-tests revealed that the difference in male and female mean scores were statistically significant for each of the five measures. The correlations between the primary measures in this study were investigated using Pearson product-moment correlation coefficients and are displayed in Table 2.

Prevalence of PTSD Symptoms

A frequency analysis ascertained that 24% of the sample had a CPSS score above 15, 95% CI [20%, 28%], indicating clinically significant PTSD symptoms. This confirmed the first hypothesis. Only 13% percent of males scored above the cutoff in contrast to 34% of females. A chi-square goodness-of-fit test confirmed the statistical significance of this difference, $\chi^2(1, n = 513) = 9.1, p = .003$. Five percent of the sample had a PTSD score above 29, a value indicating extremely severe symptoms (Rachamim, Helpman, Foa, Aderka, Gilboa-Schechtman, 2011), of which 65% were female. Over 40% of the sample had a score of less than 6, a value associated with low to negligible PTSD symptoms. Independent-samples t-tests were conducted to compare the mean CPSS scores found by Foa et al. (2001) in their validation study sample with the mean scores found in the current study. The total mean score in the current study ($M = 10.3, SD = 9.8$) was significantly higher than that found

by Foa et al. ($M = 7.6, SD = 8.1$), $t(109) = 2.52, p = 0.01$ (two-tailed).

Relationship of Resilience, Trauma Exposure and Fear with PTSD

Pearson product-moment coefficients (see Table 2.) revealed a significant negative relationship of moderate magnitude between the CD-RISC-10 and the CPSS. Conversely, a significant positive relationship existed between the CPSS and the Trauma Exposure scale. Likewise, a significant positive correlation was found between the CPSS and the Fear scale.

Hierarchical multiple regression analysis was used to investigate the practical relevance of these correlations. Specifically, the ability of trauma exposure, fear and resilience to predict PTSD symptoms after controlling for the influence of gender and school was tested. The CPSS and Trauma Exposure variables were transformed to reduce skewness and improve the normality, linearity, and homoscedasticity of residuals (Tabachnick & Fidell, 2012). Square root transformations were found to be the most effective for both variables. With a criterion of $p < .001$ for Mahalanobis distance, no multivariate outliers among the cases were identified. Tolerance and VIF statistics indicated no violation of the multicollinearity assumption. Residual and scatter plots indicated the assumptions of normality, linearity and homoscedasticity were satisfied (Pallant, 2011).

A four step hierarchical multiple regression analysis was conducted with PTSD symptoms (square root of CPSS) as the dependant variable. Gender and school were entered at Step 1 to control for these variables. The square root of the Trauma Exposure scale was entered at Step 2, the Fear scale at Step 3, and the CD-RISC at Step 4. Variables were entered in this order since chronologically, trauma exposure precedes fear during an earthquake and resilience factors come into effect after an earthquake has occurred, possibly ameliorating the effects of the trauma (Masten, 2011).

The analysis revealed that at Step 1, gender and school contributed significantly to the regression model,

$F(2, 490) = 33.6, p < .001$, and accounted for 11% of the variation in PTSD symptoms. Introducing the trauma exposure variable explained an additional 7% of the variation in PTSD symptoms and this change in R^2 was also significant, $F(1, 489) = 32.4, p < .001$. Adding fear to the regression model explained an additional 20% of the variation in PTSD symptoms and this change in R^2 was significant, $F(1, 488) = 158.4, p < .001$. Finally, the addition of resilience to the regression model explained a further 3% of the variation in PTSD symptoms and this change in

R^2 was also significant, $F(2, 486) = 28.1, p < .001$. The strongest predictor of PTSD was fear experienced during earthquakes, which uniquely explained 17% of the variance in PTSD symptoms once all variables had been entered. Together, the six independent variables accounted for 41% of the variance in PTSD symptoms. This multiple regression analysis revealed that trauma exposure and fear were significant predictors of PTSD symptoms after differences in gender and school had been accounted for. It further found that resilience measured by the CD-RISC

Table 1. Summary of Descriptive Statistics, T-tests, and Effect sizes for Measurement Scales

Measure	N	Min-Max Score	M (SD)	t	d
Male Adolescents	245	0 - 44	7.6 (8.6)		
Female Adolescents	264	0 - 47	12.8 (10.2)		
Total Sample	509	0 - 47	10.3 (9.8)	6.6**	.57
Functional Impairment					
Male Adolescents	245	0 - 7	1.5 (2.0)		
Female Adolescents	264	0 - 7	2.0 (2.1)		
Total Sample	509	0 - 7	1.8 (2.0)	2.9*	.26
CD-RISC-10					
Male Adolescents	245	2 - 40	25.6 (7.6)		
Female Adolescents	264	1 - 40	24.1 (6.6)		
Total Sample	509	1 - 40	24.8 (7.2)	2.5*	.22
Trauma Exposure Scale					
Male Adolescents	245	0 - 5	1.2 (1.2)		
Female Adolescents	264	0 - 6	1.5 (1.3)		
Total Sample	509	0 - 6	1.4 (1.3)	3.0*	.27
Fear Scale					
Male Adolescents	245		2.6 (1.9)		
Female Adolescents	264	0 - 8	3.9 (2.0)		
Total Sample	509	0 - 8	3.3 (2.1)	7.9**	.70

Note. CPSS = Child Post-traumatic Symptom Scale; CD-RISC 10 = Connor-Davidson 10-item Resilience Scale; Min-Max Score = minimum and maximum scores obtained in this study. t = t-test statistic for difference between male and female means; * $p < .05$.

** $p < .001$. d = Cohen's d .

Table 2. Pearson Product-Moment Correlation for Primary Measurement Scales

Measure	1	2	3	4	5
1. CPSS	-				
2. Functional Impairment	.61**	-			
3. CD-RISC-10	-.31**	-.28**	-		
4. Trauma Exp.	.34**	.27**	-.18**	-	
5. Fear Scale	.57**	.28**	-.17**	.32**	-

Note. $n = 509$. CPSS = Child Post-traumatic Symptom Scale; CD-RISC 10 = Connor-Davidson 10-item Resilience Scale; READ = Resilience Scale for Adolescents. * $p < .05$ ** $p < .01$ (2-tailed).

had a modest, but significant effect on PTSD symptoms after gender, school, trauma and fear had been accounted for. These results confirmed hypothesis 2.

Hypothesis 3 stated that resilience would moderate the relationship between trauma exposure and PTSD, so that higher levels of resilience would reduce the strength of the relationship between trauma exposure and PTSD symptoms. Moderation analysis was performed using the process outlined by Aitken (1991). The transformed variables described in the multiple regression analysis were used. The required assumptions of normality, linearity and homoscedasticity were met (Tabachnick & Fidell, 2012). The centred variable for the main effect of trauma exposure was entered at Step 1, the centred variable for the main effect of resilience was entered at Step 2, and the interaction term was entered at Step 3. Results of this analysis revealed that the interaction term between trauma exposure and resilience did not explain a significant increase in the variance of PTSD symptoms, R^2 change = .001, $F(1, 494) = .34$, $p = .56$. Resilience, as measured by the CD-RISC did not moderate the relationship between trauma exposure and PTSD symptoms. Hypothesis 3 was therefore not supported.

Due to the large effect that fear during earthquakes had on the variance of PTSD symptoms, and the variance shared between this fear variable and the CD-RISC, a further moderation analysis was conducted to ascertain whether resilience, as measured by the CD-RISC, would moderate between fear and PTSD symptoms. For this analysis, the centred fear variable was entered at Step 1, the centred resilience variable at Step 2 and the interaction term of fear and resilience at Step 3. Results of the analysis showed that resilience did moderate the relationship between fear and PTSD. The resilience and fear interaction term explained a significant increase in the variance of PTSD symptoms, R^2 change = .008, $F(1, 491) = 6.78$, $p = .009$. The moderation interaction was graphed using an online computer programme (Jose, 2008) and is displayed in Figure 1. It is evident that resilience had a modest moderating effect, where each level of

resilience (low, medium, high) alters the gradient of the slope, demonstrating that when resilience is at a high level, an increase in fear during earthquakes is associated with smaller increases in PTSD symptoms than when resilience was at a medium or low level.

Discussion

Posttraumatic Stress Disorder

Findings indicate that the Christchurch earthquakes had a significant adverse psychological impact on the sample with 24% reporting clinically significant PTSD symptoms. Consistent with this, Norris et al. (2002a) reported clinically significant PTSD in 21% to 56% of young people after certain high impact disasters. It could therefore be argued that the Canterbury earthquakes were a high impact disaster for adolescents, based on the proportion with clinically significant PTSD in this sample. Endorsement of the functional impairment scale, by 42% of the sample, provided further evidence that PTSD symptoms effected the day-to-day functioning of a large percentage of this sample.

Levels of PTSD symptoms in the current study were significantly higher than those found by Foa et al. (2001) with adolescents after a U.S. earthquake of similar magnitude and peak ground acceleration. A shorter time period between the event and data collection may partially account for the higher levels of PTSD found in the current study (Goenjian et al., 2011), but it is also probable that adolescents in Christchurch experienced higher levels of PTSD symptoms due to greater trauma exposure suggested by a higher death toll, more extensive damage, and higher magnitude aftershocks (Norris et al., 2002a, 2002b).

PTSD gender differences. The higher prevalence of PTSD amongst females in this sample is consistent with previous disaster research and PTSD research in general (e.g., Nemeroff et al., 2006; Shiromani, Keane, & LeDoux, 2009). Tolin and Foa (2008) confirmed a higher prevalence of PTSD amongst females and discussed several factors that contribute to the gender difference. Of relevance to the

current study are the following factors: (a) a higher prevalence of externalised symptoms such as anger, aggression and substance use amongst males after trauma, compared to a higher prevalence of internalised symptoms such as anxiety and depression in females; (b) genetic differences between males and females which result in different emotional and cognitive reactions during the trauma, with females experiencing a more pronounced fear response; (c) higher rates of prior sexual abuse amongst females, making PTSD in response to subsequent traumatic events more probable; and (d) under-reporting of symptoms by males, influenced by socially constructed gender roles. The under-reporting of symptoms, along with greater externalised symptoms amongst males, indicate the need for alternative post-disaster measurement approaches in order to detect the needs of male adolescents.

Resilience

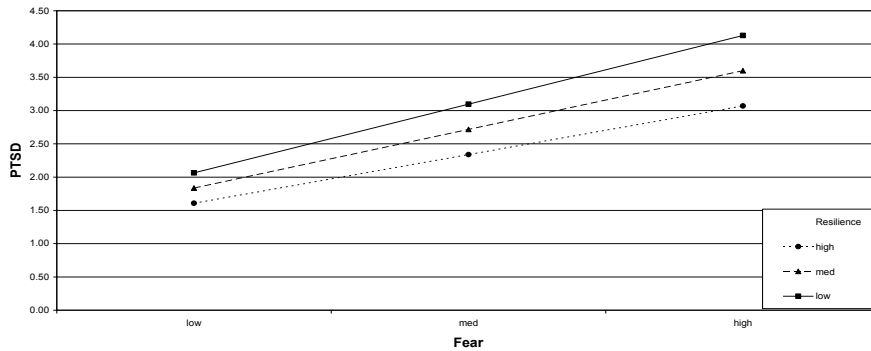
While the absence of clinically significant PTSD symptoms amongst the majority of this sample is an indication of psychological resilience (Masten, 2011), identifying specific resilience factors is important for intervention. The CD-RISC-10 items measure the respondent's perception of their ability to cope with adversity or coping self-efficacy (Benight & Bandura, 2004). The inverse relationship between resilience and PTSD, as well as its ability to predict PTSD in multiple regression analysis, signals the role of coping self-efficacy in mitigating post-disaster trauma in adolescents.

Resilience as moderation variable.

Contrary to the hypothesis, resilience did not moderate the relationship between Trauma Exposure and PTSD. This means that the effect of trauma exposure on PTSD symptoms remained constant irrespective of changes in the level of resilience, and higher resilience did not act as a buffer between trauma exposure and PTSD. This may be explained by the distribution of trauma exposure, where scores were congregated at both the low end and the high end of the scale rather than being evenly distributed. It may be that resilience did in fact protect against PTSD when trauma exposure was relatively low, but when trauma

exposure was particularly high then resilience no longer had a moderating effect. When the two extremes of trauma exposure were combined, resilience did not significantly moderate the trauma-exposure/PTSD relationship. Preliminary analysis supports this

Figure 1. Moderation of Fear and PTSD by Resilience



notion, but more targeted research is required to ascertain the variability of resilience as a moderating variable across different levels of trauma exposure.

The moderation of fear experienced and PTSD symptoms by resilience was an unexpected finding. This meant that higher resilience acted as a buffer between the level of fear experienced by the adolescent and their resulting PTSD symptoms. This can be interpreted in light of the cognitive mechanism of fear. Fear occurs as a reflexive reaction for many people during an earthquake and is largely outside the realm of conscious control (Mueller-Pfeiffer et al., 2010). Nevertheless, adaptive cognitions after trauma may mitigate the effects of the fear response, leading to more effective coping (Belus, Brown-Bowers, & Monson, 2012). The moderation of the fear/PTSD relationship by resilience supports this possibility.

Difference in resilience across gender. There was a significant difference in resilience between male and female adolescents and this difference had a small effect size. This gender difference has been found in some studies (e.g., Wrenn et al., 2011), but not others (e.g., Fincham et al., 2009). It may be that pre-disaster resilience base rates were higher for males than females in this sample. Systematic over-reporting by males due to culturally constructed gender

roles may be another explanation for the difference (Tolin & Foa 2008).

Trauma Exposure

As hypothesised, a positive relationship was found between

trauma exposure during the Canterbury earthquakes and PTSD symptoms. This relationship remained constant when individual demographics were controlled. The relationship between trauma exposure and PTSD has been well established in a wide range of studies with various age groups across diverse types of trauma. Norris et al. (2002a, 2002b) concluded that factors such as the number of lives lost, injury, threat to life, witnessing of horror, resource loss, housing issues and displacement all have significant, quantifiable effects on PTSD after disaster, which held true for the current study.

Gender differences in trauma exposure. Females had a higher mean trauma exposure score than males. The difference in trauma exposure across gender is an unexpected finding, since there is little theoretical basis to suggest that females would be exposed to higher levels of trauma than males. Two items were the primary contributors to the overall difference in male and female scores: Thirty-eight percent of females knew someone who had died, whereas only 24% of males did. Similarly, 18% of females reported that someone in their family had been injured, whereas only 10% of males did. One explanation for the differences may be that female adolescents in general have larger social networks than males (Gorrese & Ruggieri, 2012), and a greater

sensitivity to the injury or pain of others (Mestre, Samper, Frías, & Tur, 2009). A combination of these two factors could explain why females reported having more people in their families who were injured. The significant difference in reported trauma exposure across gender is an area worthy of further research.

Fear during earthquakes

A positive relationship was found between fear experienced during the earthquakes and PTSD symptoms. Two items comprised the fear scale and hierarchical multiple regression revealed that together they accounted for more variance in PTSD symptoms than any other variable in this study. This finding was consistent with Baçoğlu and Şalcioğlu (2011) who found that the level of fear experienced by an individual during an earthquake was a superior predictor of PTSD than trauma exposure. In light of these findings it is interesting that the latest *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013) has excluded the DSM-IV-TR's (2000) criterion requiring an experience of intense fear, horror or helplessness for the diagnosis of PTSD. A primary rationale for this exclusion (Friedman, Resik, Bryant & Brewin, 2011) is that not all PTSD sufferers experience intense fear, helplessness or horror in response to the original stressor (Brewin, Andrews, & Rose, 2000). This was true in the current study where a minority of adolescents who did not report intense fear reported clinically significant PTSD symptoms. Although intense fear, helplessness or horror are no longer a requirement for the diagnosis of PTSD, findings from this study suggest that adolescents who experience intense fear during a traumatic event are more likely to have higher levels of PTSD symptoms than those who do not experience such fear. The recollection of fear at the time of trauma therefore remains a relevant consideration for clinicians.

Although both items of the Fear Scale had a significant relationship with PTSD symptoms, the item that assessed the level of fear at the most recent aftershock had a stronger relationship with PTSD ($r=.61$) than the other item which assessed the highest level of

fear during a major earthquake ($r=.54$). Ongoing fear at aftershocks may be seen as a failure to habituate to the stressful stimulus (Shiromani et al., 2009) and can be viewed as a form of learned helplessness (Maier, 2001). It is likely that adolescents with more significant PTSD symptoms would have more difficulty in habituating to aftershocks (Rachmin & Levitt, 1988) which explains the strength of the relationship between these two variables.

Gender differences in fear.

Females had significantly higher fear scores than males. This finding contributes to the literature on gender differences in psychopathology after exposure to trauma (Tolin & Foa, 2008; Nemeroff et al. 2006). Higher levels of fear and PTSD symptoms amongst females suggest that fear experienced during earthquakes is a mechanism in the development of PTSD. Higher levels of fear experienced by females is most likely explained by a combination of causal factors relating to genetics and learned behaviour (Galli, Wolpe, & Otten, 2011; Lebron-Milad et al., 2012). Findings from the current study suggest that by the stage of adolescence differences in fear reactions are firmly entrenched and these are related to different psychological outcomes for male and female adolescents who experienced the Canterbury earthquakes.

Practical Application

The findings of this study can be applied to intervention planning. First, fear experienced in relation to earthquakes should be a target for intervention. This is supported by the relationship between fear experienced during earthquakes and PTSD symptoms. Cognitive-behavioural interventions that target earthquake-related fear through various forms of exposure and cognitive restructuring have been used effectively with adolescents, and hold the most promise for effective outcomes (Başoğlu & Şalcioğlu, 2011; Cohen, Mannarino, & Deblinger, 2010). Second, an adolescent's perception of their ability to cope with adversity is a worthwhile target for intervention. The relationship between resilience and PTSD symptoms, as well as the moderating effect of resilience on fear

and PTSD symptoms provide evidence of this. Since these perceptions of ability to cope have a cognitive behavioural basis (Benight & Bandura, 2004), effective intervention would use cognitive-behavioural processes in order to enhance these abilities (Cohen et al., 2010). Third, intervention should address the unique needs of male and female adolescents separately. Females have higher PTSD symptom scores, whereas males are likely to have higher externalising symptoms not detected by PTSD measures (Tolin & Foa, 2008). Interventions for males should therefore not be neglected. The difficulty in identifying male adolescents who require intervention is a challenge highlighted by this study and previous research evidence (Haen, 2011).

Study limitations

There are several limitations inherent in this study. First, a cross-sectional design was used where data was collected at a single time-point. This does not allow for conclusions to be made about the direction of relationship between variables, the causality of variables or the change in variables over time (Bowman & Hertzog, 2011) Further longitudinal study of the same population would yield worthwhile results. Second, sampling bias was likely in this study. Although an effort was made to select a sample that would be representative of the population, and some indication of its representativeness was ascertained, a non-probability sampling method was used which is vulnerable to sampling bias (Christensen, 2011). Self-selection bias may also have occurred, since for ethical reasons, adolescents could choose whether or not to participate. Third, the study relied solely on self-report data which has various inherent weaknesses (Bowman & Hertzog, 2011). In addition, retrospective fear measured in this study is subjective, and a person's memory of their fear at time of trauma may be influenced by multiple factors (Rubin, Berntsen & Johansen, 2008). It is possible that higher levels of PTSD may have influenced adolescents' recollection of the fear they experienced at the time of the earthquake, thus posing a threat to validity. Finally, no validation studies had been carried out for any of

the measures with adolescents in New Zealand and no norms exist for the New Zealand adolescent population. This could be remedied by conducting well-designed validation studies of PTSD and resilience measures with adolescents in New Zealand.

Conclusion

The findings of this study highlight the substantial psychological impact that the Christchurch earthquakes have had on the adolescents who experienced them. This is evident from the fact that 24% of the sample reported clinically significant PTSD symptoms and 42% reported some impairment in daily functioning because of these symptoms. Resilience is evident from the absence of significant PTSD symptoms in the majority of the sample, and the extent to which CD-RISC items were endorsed. The perception of ability to cope with adversity holds promise as a buffer against PTSD. The robust relationship found between fear and PTSD symptoms suggests that fear experienced during earthquakes acts as a mechanism in the development of PTSD, making it a worthy target for further research and intervention. The moderation of this relationship between fear and PTSD by resilience further emphasises the importance of resilience factors that were measured. The correlation of trauma exposure with PTSD is congruent with previous research and suggests that the degree of trauma an adolescent has been exposed to during earthquakes plays a critical role in the development of PTSD. It was clearly evident that females experienced higher levels of PTSD symptoms than males in this sample. This was also true for levels of trauma exposure and fear experienced during the earthquakes. These findings add to the extant literature on gender differences in relation to the psychological impact of trauma and the psychological impact of earthquakes on adolescence.

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Address for Correspondence

Ian de Terte
Massey University;
PO Box 756, Wellington,
New Zealand, 6140
I.deTerte@massey.ac.nz