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ORIGINAL PAPER

Community readiness for a new tsunami warning system: quasi-experimental and benchmarking evaluation of a school education component

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Abstract Youth preparedness for disasters is a growing area of research. However, studies to date have relied on cross-sectional, correlational research designs. The current study replicated aspects of the one other study to date that has used a quasi-experimental strategy to evaluate youth preparedness for disasters. This study evaluated whether children were more knowledgeable and prepared for hazards generally but also in more specific relation to the rollout of a new tsunami warning system. Using a pretest–posttest with benchmarking design, the study found that following a brief school education program, supplementing a larger community-wide effort, children reported significant gains in preparedness indicators including increased knowledge as well as increases in physical and psychosocial preparedness. Within group effect sizes compared favorably with those from the previous experimental study in this area used to benchmark current intervention-produced findings and produced hints that combining school education programs with larger community preparedness efforts can enhance preparedness. Given that this is only one of two experimentally-based studies in an area of research largely dominated by cross-sectional designs, future research should consider the use of experimental designs, including those that are pragmatic and fit with needs of the school. The current approach has limitations that need to be considered. However, it also has some real advantages, including being used more extensively in fieldwork studies that evaluate various types of interventions. Through increased use of experimental design strategies, researchers can then also have increased confidence that educational programs are the source of increases in disaster resilience in youth and their families.

Keywords Hazards education · Preparedness · Youth resilience · Hazards adjustment

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1 Introduction

Children are at an increased risk following exposure to a range of hazards. One hazard is exposure to natural and other disasters. Exposure has been found to put children at increased risk of accidents and physical injuries (e.g., Christchurch earthquake, Standring et al. 2011), along with psychological consequences (Ronan and Johnston 1999, 2005).

Most published research in relation to children and hazardous events reflects events that follow rather than precede a disaster (Chemtob et al. 2002; Giannopoulou et al. 2006; Goenjian et al. 1997; Hock et al. 2004; LaGreca et al. 1996; Ronan 1997a; Ronan and Johnston 1999, 2005; Shooshtary et al. 2008; Vernberg et al. 1996; Weems et al. 2007). However, research in recent years has also started to look at the readiness phase of the disaster cycle, including a focus on prevention through hazards education programs (Klingman and Cohen 2004; Ronan and Johnston 2005). Currently, as articulated in a recent special issue of *Children, Youth, and Environments* (e.g., Peek 2008; Ronan et al. 2008) and elsewhere (e.g., Shores et al. 2009), the literature on various aspects linked to increasing children's resilience to disasters is growing. Attention, more generally, has focused on youth's role in increasing community preparedness and resilience, including a recent national summit on youth preparedness hosted by FEMA and the Red Cross in the USA (Ronan 2010). However, research focused specifically on the effectiveness of hazards education programs is limited, particularly that which assesses gains in preparedness knowledge, skills, and preparedness indicators over time. That is, most research to date has been cross-sectional and correlational (Finnis et al. 2010, 2004; Ronan et al. 2010; Ronan and Johnston 2001, 2005; Ronan et al. 2001; Shaw et al. 2004). Thus, making causal inferences is difficult (e.g., Kazdin 2003).

One reason that prevention efforts are necessary is based on the vulnerability of children to the effects of disasters. Children are one of the most, if not the most, vulnerable demographic groups when a disaster occurs (e.g., Norris et al. 2002). Prior to a disaster occurring, it has also been established that children tend to rank hazardous events, including natural disasters, as one of their major fears (e.g., Campbell and Gilmore 2006; Ollendick et al. 1989; Muris 2002; Muris et al. 2002). Even in the case of events that do not lead to widespread damage or loss of life, research has shown that relatively benign natural hazards (e.g., volcanic eruptions in New Zealand) can lead to significant problems for some children, including younger children and children with physical conditions (e.g., asthma) (e.g., Ronan 1997a, b; Ronan and Johnston 1999). Thus, in the face of even a benign hazardous event, its occurrence may for some children bring increased risk and the realization for some children of one of their worst, and perhaps unspoken, fears.

Given this vulnerability, prevention is one obvious strategy for reducing risk. Overall, preliminary research that has evaluated prevention and preparedness education programs with children (Finnis et al. 2004, 2010; Ronan et al. 2001, 2010; Ronan and Johnston 2001, 2003; Shaw et al. 2004) and adults (Karanci et al. 2005; Mishra and Suar 2007; Whitney et al. 2004) has demonstrated that they can produce a number of benefits. These include increased engagement in specific preparedness activities, including those done at home and within families, designed to reduce vulnerability to accidents and injuries directly or secondarily related to a disaster's occurrence (e.g., Ronan and Johnston 2003, 2005).

These are important findings given that other research shows clearly that low levels of preparedness in communities are the norm, including in high-hazard areas (Cuny 1983; Eisenman et al. 2006; Karanci et al. 2005; Lindell 2000; Lindell and Whitney 2000; Paton and Johnston 2001; Peek and Mileti 2002; Tierney et al. 2001; Whitney et al. 2004). This fact has contributed to a line of research that examines predictors of increased preparedness

activities as well as increased risk of an adverse reaction in the face of a hazardous event. These include both static factors and non-static, and therefore modifiable factors (see Ronan et al. 2010). Taking these factors into account, then, educational interventions should seek to incorporate these findings both to reduce risk and to increase resilience. This would include increasing knowledge, skills, and preparedness itself including a sense of physical and emotional resilience (e.g., Peek 2008; Ronan et al. 2008).

Studies to date evaluating the role of hazards education programs for youth have been supportive. However, almost all of them have been correlational studies (e.g., Ronan et al. 2001, 2008; Ronan and Johnston 2001; Shaw et al. 2004). In fact, only one published study to date has used a quasi-experimental methodology (Ronan and Johnston 2003). That study found that hazards education programs led to changes in knowledge, preparedness, and indicators of emotional resilience. In that study, the more effective program was one that incorporated emergency management guidelines and led to increases in home-based preparedness, hazards-related knowledge, and reduced fear of hazards.

The current research also used a quasi-experimental methodology, conducting tests both before and after a hazards education program, and was designed to replicate aspects of that one other study that used a pre–post methodology (Ronan and Johnston 2003). Similar to both studies, the current hazards education program taught children basic, and all hazards, emergency management (EM) principles. The major difference was that this study did it within a specific context, in advance of the introduction of a new tsunami warning system. The two programs (emergency management vs. reading and discussion) evaluated in the earlier study (Ronan and Johnston 2003) were conducted without this contextual element but, rather, as a feature of a disasters education module that was considered part of the standard curricula. Another difference between the 2003 study and the current one was that the education program in the previous study was conducted over 6 weeks whereas this program was much briefer (see Method). As a consequence, the main aim of the current study then was to evaluate whether a brief education program designed to help children anticipate and know how to respond to a new warning system was also capable of helping them acquire additional EM knowledge, prepare more effectively, and improve physical and emotional resiliency.

While this study did not have the advantage of using a comparison/control condition as in our previous quasi-experimental study (i.e., a reading and discussion condition, Ronan and Johnston 2003), this study did use another comparative strategy. Given that this study was not able to use a true experimental design (i.e., randomization to experimental vs. control/comparison conditions), one issue that needs to be addressed is various threats to internal validity (Cooke and Campbell 1979). One manner for dealing with these issues, notwithstanding some limitations, is through the use of benchmarking procedures (e.g., Hunsley and Lee 2007), designed to increase confidence that any positive changes are not simply the result of maturation, history, retesting, regression to the mean or other threats to internal validity (Cooke and Campbell 1979). Following an increasingly used methodology in psychological intervention evaluation research, particularly "effectiveness" (fieldwork) research (e.g., Curtis et al. 2009), this study used previous findings to "benchmark" current findings in an attempt to raise confidence that changes were due to the education program itself and not some extraneous factors. In fieldwork studies, where comparison or control conditions can be difficult to find (or get approved), benchmarking is an increasingly common strategy used in fieldwork evaluations of educational or psychological interventions (Hunsley and Lee 2007).

In this particular fieldwork study, getting a comparison condition from the same community was not considered feasible in light of the fact that the preparedness

educational materials were disseminated both through schools and through public channels. That is, even if school educational material were restricted, children were likely to have been exposed to some educational material disseminated through community-level sources (e.g., local radio) or from classmates in the experimental condition. In addition, it was deemed difficult to do a comparison group strategy where additional work would be required from the schools. One of the reasons here, and a quite sensible one also from a methodological perspective, is that the brief length of time for the educational intervention would make it difficult to coordinate, and carry out, additional tasks, including doing more than two testings (i.e., a "waitlist control" condition requires 3 testings, precontrol, postcontrol, postintervention) and, more importantly, carrying out two separate deliveries of the educational material. Given issues such as these, benchmarking becomes possible as an alternative strategy when data are available for comparison from previous research (Hunsley and Lee 2007). Thus, in addition to pre–post findings assessing whether children gained in knowledge and overall preparedness, current findings also were able to be compared to previous research findings as another gauge of effectiveness and as a way of controlling for some threats to internal validity.

2 Methods

2.1 Overview of the design

The current study was intended to replicate features of an earlier study using a quasi-experimental design, expanding the scope of a pre–post design to an education program that had a specific target, an early warning tsunami system (Ronan and Johnston 2003). In this context, the study examined the direct effect a hazards education program had on a number of dependent variables, including risk perceptions, emotion-focused factors (e.g., hazard-related fear in children, perceived parental upset, and perceived emotion-focused coping ability in the event of a hazard), knowledge surrounding protective behaviors in the event of a hazard, readiness behaviors including both risk mitigation and preparedness activities, including home-based hazard adjustments. This included assessment of specific factors linked to readiness for tsunami and awareness of the early warning system and protective behaviors that are recommended to reduce risk for accidents and injuries.

Unlike Ronan and Johnston (2003), who used a comparison group strategy, this study used a one-group pretest–posttest design. That is, all participants were asked to complete a questionnaire both before and after the administration of a hazards education program (discussed in further detail below). As the design of this study did not allow the results to be distinguished from time and/or placebo effects, this study incorporated a benchmarking procedure. Specifically, the intervention-produced effect sizes (i.e., within group effect sizes) of the current study were compared to the intervention-produced effect sizes from our earlier study, which did use a group comparison approach (Ronan and Johnston 2003).

2.2 Participants

Participants within this study were 213 primary and intermediate school students recruited from the Napier, New Zealand region. Overall, there were 112 female (52.6%) and 101 male (47.4%) participants. The age of the participants ranged from 8 to 17 years, with a mean age of 11.15 years (SD = 2.44). Children came from a variety of ethnic and cultural backgrounds: Caucasian/European descent ("Pakeha") ($n = 139$, 65.3%), Maori ($n = 21$,

9.9%), Maori/Pakeha ($n = 20$, 9.4%), Asian ($n = 5$, 2.3%), Pacific Islander ($n = 5$, 2.3%), Pacific Islander/Pakeha ($n = 4$, 1.9%), Maori/Pakeha/Other ($n = 2$, .9%), Pakeha/Other ($n = 1$, .5%), Pakeha/New Guinean ($n = 1$, .5%), Maori/Pakeha/Pacific Islander ($n = 1$, .5%), Dutch ($n = 1$, .5%), German ($n = 1$, .5%), Australian/European ($n = 1$, .5%), Croatian ($n = 1$, .5%), Pacific Islander/Other ($n = 1$, .5%), Pakeha/Polish ($n = 1$, .5%), and Other ($n = 4$, 1.9%).[1]

2.3 Measures

The measures used within this study were adapted from Ronan and Johnston (2001, 2003) and Ronan et al. (2001).

2.3.1 Readiness: knowledge of response-related protective and risk mitigation behaviors

This section of the questionnaire assessed the knowledge children possessed in relation to hazards and the best course of action to take in the event of a hazard. Three to six answers for each hazard (floods, storms with high winds, fires, earthquakes, volcanic eruptions, tsunamis, chemical spills, and tornados) were presented. For each hazard, children were asked to indicate which behavior or behaviors they would endorse in the event of a certain hazard (e.g., moving one kilometer inland in the event of a tsunami). The inclusion of possible behaviors was based on issues that are often highlighted in hazards education programs and emergency management recommendations (Ronan et al. 2001). Overall, there were a total of 15 incorrect responses and 14 correct responses. Of the 14 correct responses, nine were identified to be of vital importance (e.g., move to an area higher than flood level in the event of a flood).

2.3.1.1 Emergency management alarm system The city in which the study took place currently has a civil defense alarm in place that was upgraded in recent years. One aim of the education program, and this study, was to examine whether or not children had knowledge of the alarm and secondly to assist them to learn what to do if they heard the alarm. In order to examine this, children were asked if they were aware of the alarm on a 3-point scale (*1* = yes, *2* = not sure, *3* = no). Second, children were asked to select from five options what they would do if they were at home and heard the alarm. Of the five available responses, two were correct (listen to radio; go and ask a parent or caregiver what to do) and three were incorrect (do nothing; go outside and look around; evacuate immediately).

2.3.2 Readiness: hazard adjustments

In order to assess what protective behaviors and risk mitigation strategies the children's families employed, children were asked to identify which if any range of hazard adjustments their family had employed. Overall, 23 specific hazard adjustments were assessed including having a torch (flashlight), rearranging breakable items, putting strong latches on cabinet doors, storing hazardous materials safely, adding lips to shelves, strapping the water heater, installing flexible piping, bracing house walls, securing the house foundation (two items here: bolting house to foundation and bracing the pile foundation), having a radio with spare batteries, having a first aid kit, having water and food provisions for

[1] Totals do not add up to 213 here and regarding other demographics owing to missing data.

3 days, having a fire extinguisher, having a smoke detector, storing emergency equipment, placing a wrench (spanner) near turn-off valves, picking a contact person, someone in the family learning how to put out fires, someone in family learning how to administer first aid, finding out which hazard are more likely in their area, and having the home inspected for resistance to earthquakes.

2.3.3 Hazard awareness and risk perceptions

Children were asked a series of questions that addressed their knowledge of a number of issues including (a) the two hazards that are most likely to affect them, (b) the likelihood of occurrence of each of the eight hazards on a 3-point scale (*1* = likely, *2* = a chance, *3* = unlikely), and (c) the child's perception of the likelihood that they would be injured in the event of each of the eight hazards on a 3-point scale (*1* = likely, *2* = a chance, *3* = unlikely). The alpha reliabilities for each of the eight-item measures were .64 and .72, respectively.

2.3.4 Emotional coping and resilience

With regard to psychological issues, children were asked a series of questions that addressed the following: (a) their level of overall fear or upset experienced when discussing hazards on a 3-point scale (*1* = not at all, *2* = sometimes, *3* = often), (b) their perception of any parental upset when discussing hazards on a 3-point scale (*1* = yes, *2* = not sure, *3* = no), and (c) the children's perception of their emotional coping ability in the event of a hazard on a 7-point scale (*1* = not at all able, *4* = somewhat able, *7* = completely able "to help self feel comfortable/less upset").

2.4 Procedure

The questionnaire was administered to participants before participation in a 2005 hazards education program that reinforced messages from a public education program aimed at assisting residents their awareness of a new tsunami alert system as well as instructing them on what to do to prepare and respond for a tsunami and other local hazards. The public education program had the following key messages:

- When residents hear the siren, they should turn on their radio and tune to a local radio station, and when the siren stops, listen for a public announcement
- A local Hawke's Bay radio station is one that has local news bulletins or local announcers
- It is possible that some residents may not be able to hear the sirens due to location or ambient noise
- Residents with special needs (like those with hearing or intellectual difficulties) should ensure that they have a support network who can keep them informed
- Care givers and neighbours of residents with special needs—upon hearing the sirens, you should listen for the public announcement on the radio, check your own families, then convey the information to those with special needs
- Residents should maintain a transistor radio and spare batteries at all times
- Everyone should have a household and workplace emergency plan
- Every household should maintain 3 days supply of food, water, and medical supplies

In addition to these messages, and immediately following the pretest, teachers discussed with children these key messages, but also discussed preparing for a wider range of hazardous events. This included providing information on personal safety as well as how to prepare in the home setting and followed both a public flyer as well as a longer document called "Background Question and Answer Document—CD Siren Warning System," a 9 page document that gave quite specific information on the siren warning system but also the need to be prepared for a wider range of local hazardous events, including earthquakes, cyclones, and floods. Following this class time discussion, children were also alerted to the public education campaign that was to play out prior to the test of the alert system. Discussions focused on these topics then happened daily during class time over the next week and prior to the post-test.

One week later, participants were then again asked to complete the questionnaire again. The questionnaire was administered to participants within each school by classroom teachers. After the instructions were read aloud, children were asked to complete the questionnaires by reading to themselves. If children had difficulty understanding a particular item, they were encouraged to ask questions. Overall, the time necessary for completion of each survey was approximately 25–35 min.

2.5 Plan of analysis

Following data collection, a number of statistical analyses were carried out to examine the aims and hypotheses of this study, including a series of paired *t* tests to examine the effect the hazards education program had on a number of dependent variables between pre- and posttest including hazard adjustments, emergency management knowledge, emotion-focused coping ability, risk perceptions, discussions with parents and teachers, and factors related to Napier and the civil defense alarm.

3 Results

3.1 Hazard adjustment

The possible score on the hazard adjustment index ranged from zero to 23. As expected, the presentation of a hazards education program did lead to a significant increase in the number of hazard adjustments reported as well as other factors (see Table 1).

3.2 Emergency management knowledge, protective, and risk mitigation behaviors

In order to examine whether the presentation of a hazards education program decreased incorrect knowledge and increased children's knowledge of protective behaviors, a number of analyses were carried out. In terms of the most vital knowledge ($N = 9$ correct responses), the presentation of a hazards education program did lead to a significant increase in the number of vitally correct responses (see Table 1). Additionally, the presentation of a hazards education program led to a significant increase in the number of overall correct responses ($N = 14$ correct responses) (see Table 1). Finally, the presentation of a hazards education program led to a significant decrease in the number of incorrect responses ($N = 15$ incorrect responses) (see Table 1).

Table 1 Problem- and emotion-focused factors: means, standard deviations, and *t* scores

Hazard	Pre		Post		
	M	SD	M	SD	
Knowledge: vital	6.06	1.58	6.39	1.60	$t\ (212) = -3.38$***
Knowledge: total	8.26	2.33	9.02	2.50	$t\ (212) = -5.42$***
Knowledge: incorrect	2.20	1.76	1.99	1.89	$t\ (212) = -2.01$*
Hazard adjustment	10.68	4.76	13.15	5.48	$t\ (212) = -15.65$***
Hazard-related fear	1.78	.63	1.69	.59	$t\ (201) = 2.31$**
Parent fear	2.11	.50	2.17	.50	$t\ (209) = -1.58^{+}$
Emotional coping	4.77	1.77	4.67	1.76	$t\ (208) = .92$

M mean, *SD* standard deviation

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$. One tailed

$^{+}$ $P \leq 0.1$

3.3 Napier and the civil defense alarm

Prior to participation in the current hazards education program, a total of 120 (56.3%) children reported having knowledge of the civil defense alert in place within Napier. Following the hazards education program, a total of 163 (76.5%) children reported having knowledge of the civil defense alert. This represented a significant difference, such that following the education program, significantly more children were aware of the alert, $\chi^2\ (2) = 23.08$, $P < .001$ (see also Table 2).

Following participation in the hazards education program, children's knowledge regarding what to do in the event that they heard the civil defense alert while at home changed in desired ways. Following the program, two incorrect answers, (a) go outside and (b) evacuate immediately, were both significantly reduced (see Table 2). Additionally, the correct answer considered vitally correct by local emergency management, listen to the

Table 2 Knowledge surrounding the civil defense alert before and after intervention: means and standard deviations

Hazard	Pre		Post		
	M	SD	M	SD	
Knowledge: alert[a]	1.60	.75	1.27	.57	$t\ (203) = 5.76$***
Go outside[b]	.24	.43	.17	.38	$t\ (212) = 2.37$**
Evacuate	.46	.50	.37	.48	$t\ (212) = 2.39$**
Nothing	.15	.36	.16	.37	$t\ (212) = -.15$
Ask caregiver	.63	.48	.60	.49	$t\ (212) = .74$
Listen to the radio	.42	.49	.68	.46	$t\ (212) = -6.62$***

M mean, *SD* standard deviation

** $P \leq 0.01$; *** $P \leq 0.001$. One tailed

[a] Given the nature of the scale used for this versus the other items in this table, the change from pre- to posttest was in the desired direction. Similarly, for the other items found to change significantly, these too were all in the desired directions

[b] The item here asked "If you were at home and you heard the siren, what would you do?"

radio, increased significantly (see Table 2). The other items did not change significantly (see Table 2).

3.4 Emotion-focused coping

In order to examine whether the presentation of a hazards education program had an effect on psychological factors, a number of analyses were carried out. With regard to children's overall hazard-related fears, following the education program, children reported a significantly reduced level of fear (see Table 1). In relation to specific hazards, the hazards education program led to a significant decrease in the fear associated with a number of specific hazards (see Table 3). In fact, fears decreased from pre- to posttests across all individual hazards with some of them reaching significance or trending toward significance (see Table 3). Secondly, following the hazards education program, children reported perceiving a decrease in parental fear, which trended toward significance (see Table 1). Finally, with respect to emotion-focused coping ability, the presentation of a hazards education program did not have a significant effect on children's perception of their emotional coping ability in the event of a hazard (see Table 1).

3.5 Risk perceptions

The presentation of a hazards education program led children to believe that the following Hazards—floods, fires, volcanic eruptions, tsunamis, and tornados—were significantly more likely to occur within their area than they had previously believed (Table 4). The presentation of a hazards education program did not have a significant effect on children's perception of the likelihood of chemical spills, storms with high winds, or earthquakes (see Table 4). Here, it is noted that likelihood perceptions of storms with high winds and earthquakes, while the changes were nonsignificant, were already at a higher level relative to others at pretest, perhaps as a function of the former being relatively common in this area and the latter risk being well known as a function of the most well-known earthquake

Table 3 Fear level surrounding specific hazards before and after intervention: means and standard deviations

Hazard	Pre		Post		
	M	SD	M	SD	
Flood	.20	.40	.19	.39	$t\ (212) = .29$
Fire	.50	.50	.44	.50	$t\ (212) = 1.53^{+}$
Volcanic eruption	.33	.47	.30	.46	$t\ (212) = .94$
Chemical spill/gas leak	.16	.37	.12	.32	$t\ (212) = 1.53^{+}$
Storm with high winds	.20	.40	.15	.36	$t\ (212) = 1.53^{+}$
Earthquake	.43	.50	.36	.48	$t\ (212) = 1.95^{*}$
Tsunami	.46	.50	.45	.50	$t\ (212) = .27$
Tornado	.44	.50	.33	.47	$t\ (212) = 3.16^{***}$

M mean, *SD* standard deviation

* $P \leq 0.05$; *** $P \leq 0.001$. One tailed

$^{+}$ $P \leq 0.1$

Table 4 Risk perceptions before and after intervention: means and standard deviations

Hazard	Pre		Post		
	M	SD	M	SD	
Risk perceptions: future likelihood of occurrence					
Flood	1.79	.63	1.68	.58	T (210) = 2.56**
Fire	1.75	.65	1.66	.58	T (211) = 1.95*
Volcanic eruption	2.74	.54	2.64	.59	T (209) = 2.25**
Chemical spill/gas leak	2.13	.61	2.13	.53	T (208) = .11
Storm with high winds	1.57	.57	1.52	.54	T (208) = 1.11
Earthquake	1.44	.57	1.39	.53	T (207) = 1.22
Tsunami	2.33	.64	2.24	.66	T (208) = 2.01*
Tornado	2.60	.56	2.51	.58	T (208) = 2.16*
Risk perception: likelihood of injury					
Flood	2.13	.70	1.98	.66	t (206) = 3.09***
Fire	1.39	.52	1.40	.56	t (205) = -.11
Volcanic eruption	1.78	.82	1.98	.86	t (208) = -3.13***
Chemical spill/gas leak	1.87	.67	1.87	.64	t (206) = .00
Storm with high winds	1.86	.65	1.80	.66	t (206) = 1.14
Earthquake	1.58	.59	1.54	.59	t (205) = .77
Tsunami	1.59	.76	1.71	.74	t (210) = -2.20**
Tornado	1.72	.77	1.85	.77	t (206) = -2.11*

M mean, *SD* standard deviation. The scale for the above data: *1* = likely, *2* = a chance, = unlikely

* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$. One tailed

in New Zealand in the twentieth century (i.e., in 1931) and represented by a prominent local museum and many other local reminders.

In terms of perceptions of injury risk, following the education program, children increased their perceptions of injury potential in the event of a flood (see Table 4). The presentation of a hazards education program led children to believe that should a volcanic eruption or tsunami occur, they were less likely than at pretest to believe that they could be injured (see Table 4). No significant effects were seen on children's perceptions with respect to fires, chemical spills, storms with high winds, earthquakes, or tornadoes (see Table 4).

3.6 Benchmarking results

The main findings of the current study are comparable to that of the previous study that used a quasi-experimental methodology (Ronan and Johnston 2003). As seen in Table 5, the eta-squared effect sizes for hazard adjustment and emergency management knowledge were slightly larger in the current study. The emotion-focused factors (hazard-related fear, perception of parental distress, and perceived emotional coping) varied slightly, but on average were similar. As can be seen in the table, the magnitude of effect sizes across constructs was also similar: large effects for home-based hazard adjustments; medium effects for child knowledge; small effects for emotional factors.

Table 5 Benchmarking

Variable	Eta squared	
	Current study	Ronan and Johnston (2003)
Hazard adjustment	.54	.46
Emergency management knowledge	.11	.05
Hazard-related fears	.03	.03
Perceptions of parental distress	.01	.03
Perceived emotional coping	<.01	<.01

Eta-squared ranges: small effect, .01–.06; medium effect, .06–.14; large effect, ≥.14. Effect sizes from Ronan and Johnston were based on the pretest–posttest ANOVA across groups (i.e., trials effect)

4 Discussion

Taken together, the findings of the current study provide quasi-experimental support for a brief school and public education program in assisting children to become more aware of a specific new warning system as well as more general emergency management principles. In addition to increased awareness and knowledge, children also reported more preparedness at home, including protective and risk mitigation behaviors designed to reduce risk for accidents and injuries and other consequences of exposure to a tsunami or other disasters. Participants also reported reduced fears in relation to hazards. Moreover, benchmarking comparisons indicated that findings here were similar to those from a previous quasi-experimental study (Ronan and Johnston 2003). Thus, this study adds a second set of experimentally-based findings to the cross-sectionally-based literature that hazards education for youth can lead directly to increases in readiness and resilience in relation to disasters (e.g., Finnis et al. 2004, 2010; Ronan et al. 2001, 2010; Ronan and Johnston 2001, 2003; Shaw et al. 2004).

In terms of the major variables addressed, all but two were seen to change following the education program. One of these two, perception of parent fears, demonstrated a trend toward significance in the expected direction. Thus, in terms of the major variables addressed, knowledge, preparedness, emotional indicators, this program could be considered successful in improving resilience overall. However, we would add that there are indications from previous research (Ronan et al. 2001; see also Ronan and Johnston 2001) that hazards education programs have a "half life" with benefits reduced as a function of the number of programs in which children engage. In other words, the effects of a singular program would be expected to recede with time and, conversely, to be enhanced through repetition. In fact, earlier research reported that children who were involved in two or more hazards education programs had much more knowledge retention than those children who were involved in only one program (Ronan et al. 2001). Another study found that program recency was linked to increased benefits compared with programs carried out at more distal timeframes (Ronan and Johnston 2001). Thus, while this program demonstrated effectiveness, a program like this should really be part of a sequence of programs that are provided for children over time, that both teach them and encourage them to interact with parents and caregivers to encourage transfer of benefits into the home setting (Ronan and Johnston 2003). In addition, as found by Shaw et al. (2004), the more school education programs can be integrated within whole of community programs, the more benefits may accrue for children and families and for the larger community. While this latter aspect was not able to be tested directly in the current study, the community in this study did use both public and school education campaigns that were intended to build on and reinforce each

other. In this context, it is worth noting that the pre–post effect sizes for both (1) home-based hazards adjustments and (2) emergency management knowledge were higher than in the previous, and benchmarking, study that only focused on school education (Ronan and Johnston 2003). At the same time, while this reflects favorably on a combined approach, future research needs to test more directly the proposition that combining various modalities increases effectiveness.

Additionally, while the program overall demonstrated indicators of effectiveness, it was not universally effective. Even though the impetus for the program itself was centered on the introduction of a new tsunami warning system, many fewer than 100% of child participants reported having knowledge of the warning system at posttest. Thus, while there was a significant increase in awareness as well as an increase in knowledge about what to do when hearing the warning, the fact is that one would expect more than roughly three quarters of children to report having knowledge of the new warning system at posttest. In addition, perceived emotional coping ability did not change between pretest and posttest, a finding also reflected in our earlier experimental study (Ronan and Johnston 2003).

Reasons for a lack of change on this index across both of these studies include the possibility that these programs do not instill an increased perception of emotion-focused coping ability. This program, and the program in Ronan and Johnston (2003), focused on standard hazards education, including providing information on knowledge and physical preparedness, but not on emotional preparedness. Thus, future studies might address this issue by an enhanced education program that is then monitored by a measure of intervention fidelity. Doing so would allow for a better documentation of the specifics of the program as well as linking the components of the program more specifically to the benefits derived.

However, apart from changes in an independent variable, another reason that measures do not change can also be a function of the dependent variables themselves, including a lack of intervention sensitivity and other reasons. In terms of another possibility, the perceived emotion coping item used a 7-point Likert scale and may have more differentiation than is optimal for children at this developmental level. Thus, a reduced Likert scale (e.g., 3-point scale) might be useful. On the other hand, this type of coping item, and 7-point Likert scale, has been used in various psychological intervention studies and has demonstrated intervention sensitivity (e.g., Girling-Butcher and Ronan 2009). However, the difference between these previous studies and the current one is that coping items are individualized to the young person and reflect issues that are central to their lives whereas the item used here is more general and may not either be understood or processed sufficiently in such a way that it is then rated in a way that reflects changes. Finally, the index used here was a one-item measure. A measure that uses an increased number of focused items might have more potential to reflect changes. As a result, future studies might focus on enhancing the individual variable (i.e., adding a psychological resilience component to the program) as well as changes to the dependent variable.

Study limitations include issues related to independent and dependent variables as just articulated. However, another limitation was the use of a single-group pretest–posttest design. While the use of benchmarking helps to increase confidence, the fact is that single group designs do not mitigate all known threats to validity. Thus, other factors could account for findings, including maturation, history, retesting, regression to the mean, and so forth (Cook and Campbell 1979). In addition, children were the sole reporters in this study. It would have been preferable to have parents involved as in previous studies (Ronan and Johnston 2001, 2003), but was not possible within the confines of this school program. Thus, while children's knowledge increase is unlikely to be solely a function of maturation,

retesting, or regression to the mean, the fact is that history cannot be ruled out (e.g., acquiring knowledge through means other than education campaigns). Relatedly, we do not know the relative effects of the school versus the public components of the community education campaign. Would the children have had the same increases in reports of adjustments and in knowledge with only school education or only with public education? Or, did one add more value than the other? Future research should try to isolate the effects of multimodal campaigns in the future to enhance our knowledge about what works in communities and with specific subgroups of those communities.

In addition, while previous research has demonstrated a correlation between child and parent report of home-based preparedness (Ronan and Johnston 2001, 2003), the fact is that having parents involved would allow for multi-method comparison, particularly in relation to home preparedness. Our previous research has some indication that children may overestimate preparedness activities compared with parent reports. However, in saying that, given the significant correlation between child and parent report (Ronan and Johnston 2001), the trend between pretest and posttest in relation to an education program is also quite similar in terms of increases in child and adult reports of home preparedness behaviors following an education program (Ronan and Johnston 2003). Thus, both of these factors increase confidence. Nevertheless, future research might try to use more pure experimental strategies, multi-method assessment across expanded constructs, and provide more differentiated evaluation of enhanced education programs, whether a sequence or contemporaneous combination of programs, within a larger community context (Shaw et al. 2004). Having said all of this, the logistics involved in doing pure experimental research in school settings can be quite difficult based on our experience. Schools and their teachers tend to be very busy, with many interest groups wanting access to school children. Thus, adopting research strategies that are seen as relatively easy to use, while also fitting in with a school's mission (e.g., help children and their families in disaster-prone areas; help children be good risk evaluators), might then have a better chance of being acceptable to a school system.

Thus, despite some limitations, this is one of very few published studies that uses a before-and-after strategy to help increase confidence in findings. As well, through additional benchmarking, the study does provide findings that do add to and extend the literature in this area. The challenge for researchers now is to link these preparedness programs with sustained change across time, links to community efforts, and, importantly, to document their ability to help children and families actually respond and recover effectively when a hazardous event does occur.

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