

Resilience in Youth with Type 1 Diabetes Following an Earthquake

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URL: http://trauma.massey.ac.nz/issues/2016-2/AJDTS_20-2_Su.pdf

Abstract

Disastrous natural hazard events impact negatively on diabetes self-care, with potentially catastrophic consequences for patients with type 1 diabetes mellitus. Insulin may be inaccessible or spoiled due to inadequate storage conditions, self-care apparatus may be misplaced or damaged, food security may be compromised and physical and psychological stress may contribute to unstable diabetes. However, following the 2011 Christchurch earthquake, there was no increase in hospital admissions for metabolic decompensation observed. To better understand this apparent case of diabetes-related resilience, Youth aged 16-25 years, identified from a type 1 diabetes database, were asked complete an online questionnaire a year after the earthquake. This questionnaire asked about the physical and psychological consequences of the earthquake on diabetes self-management. Of the 63 respondents, 42 experienced major physical disruptions in their living conditions. Eighteen reported immediate changes in insulin requirements which settled after 4 to 210 days. Professional psychological support was obtained by 12 respondents and support from family was also considered important. Some changes were positive, for example one respondent commented on eating healthier, with less availability of junk food. Surprisingly, glycated haemoglobin, a measure of overall diabetes control showed only minimal change

following the 2011 earthquake. In conclusion, while acknowledging that questionnaire respondents represent only a minority of local residents with type 1 diabetes, the metabolic impact of the earthquake on respondents was minimal in this patient subgroup. Awareness of disaster planning is likely to have been influenced positively by an earlier, September 2010 local earthquake and its aftershocks. Personal disaster planning should form part of the education curriculum for patients with type 1 diabetes mellitus.

Keywords: *disaster medicine; type 1 diabetes, resilience*

Previous research has shown that natural disasters have a negative impact on diabetes self-management, especially for those taking insulin (Fonseca et al. 2009; Ng, Atkin, Rigby, Walton & Kilpatrick, 2011). There are multiple reasons for this observation, including loss of diabetes medications either through direct damage or through spoiling due to inadequate storage conditions. Also, considering that dietary modification is a cornerstone of diabetes self-management, food security may be particularly problematic after a disaster. The September 2010 Canterbury earthquake caused physical damage and psychosocial distress, however the 2011 Canterbury earthquakes caused huge disruption to local infrastructure, including loss of domestic electricity and water supplies (Stevenson et al, 2011; Potter, Becker, Johnston, & Rossiter, 2015). They also caused disruptions for both primary and secondary care services responding to acute medical problems (Ceismic, 2016).

The disruption of housing and other infrastructure affected insulin users' ability to undertake the following: keep their stocks of insulin cool; ensure hands are clean prior to capillary glucose monitoring; ensure apparatus such as glucagon and test strips are stored in optimal conditions. In type 1 diabetes mellitus (T1DM), insufficient insulin, administered by injection or with an insulin pump, predisposes individuals to metabolic de-compensation. If insulin insufficiency is severe, this results in diabetic ketoacidosis (DKA) and eventually in death. Although local diabetes services anticipated an increase in diabetes related admissions, there was no obvious increase in DKA presentations observed

by service providers, following either the 2010 or 2011 earthquakes.

This study aims to explore the impact of these earthquakes, with a focus on the February 2011 earthquake, on diabetes self-care for those with T1DM while gaining some insight concerning their coping mechanisms. For this purpose, DKA admissions were used as one, negative, proxy for self-care. Admission rates for those aged 15 years or more, representing youth and adult populations, were reviewed before and after the two major Canterbury earthquakes, in September 2010 and February 2011.

Youth with T1DM are especially vulnerable to metabolic de-compensation, when compared with older adults. The second part of the study therefore aimed to gain a better understanding of self-management strategies employed by Youth under stress. This was achieved by surveying how they had coped with their diabetes self-management in the months immediately following the main February 2011 earthquake.

Methods

For the first part of the study, data concerning Youth and adult DKA admissions were obtained for the greater Christchurch region, through the Canterbury District Health Board's Decision Support services. These data specifically concerned the absolute number of DKA admissions by month for the total population aged 15 years and over. Christchurch is relatively isolated geographically. This means these data are likely to reflect DKA rates amongst the resident population in Christchurch at the time.

For the second part of the study, contact details of Youth aged 16-25 years with T1DM and thought to be resident in Christchurch in February 2011 were obtained from Diabetes Youth Canterbury, a lay support organisation. For the purpose of the current study, a minimum age of 16 years was chosen as it was considered that these participants would be able to consent to and complete the questionnaire, without parental or caregiver support. A postal questionnaire was considered problematic in a post-quake environment marked by a lot of residential mobility. The current questionnaire was conducted using an email-weblink approach instead. Eligible young people were initially contacted by mail, phone or in person, asking if they wanted to participate in the questionnaire. For those interested in participating, the questionnaire link was e-mailed to them. Although all

responses were de-identified, participants were asked for permission to link their unique national health identifier with their glycated haemoglobin (HbA1c) results. HbA1c is a blood test that measures glucose control over the preceding three months and was included because the study aimed to incorporate how HbA1c trended over the year following the 2011 earthquake. This meant that HbA1c results that were closest to the 3 and 12 month post-quake time period were selected. The study as a whole was approved by the Upper South B Regional Ethics Committee - reference URB/11/EXP/047.

Statistical analysis

DKA admissions are usually reported by number of admissions per 100,000 population. This approach was inappropriate in the post-earthquake environment, because of the lack of reliable data concerning such a mobile population. DKA admission data were therefore collected as absolute numbers of admissions. The average number of monthly admissions before and after the 2010 and 2011 earthquakes was then compared using non-parametric tests: The Wilcoxon Rank Sum test was used for two-sample comparisons and the Kruskal-Wallis test for three-sample comparisons. Comparisons of HbA1c results were also undertaken, using paired t-tests comparing the following time points: 1. comparing before the 2011 earthquake with three months following the earthquake; 2. comparing before the 2011 earthquake with one year following the earthquake.

Results

Figure 1 shows monthly DKA admissions across the total population aged 15 years or more, in relation to either the 2010 or the 2011 earthquakes. Visual inspection of figure 1 shows no obvious increase in monthly admissions following either the September 2010 or the February 2011 earthquakes. The apparent lack of increase was nonetheless tested using statistical analysis. The number of monthly admissions was divided into three unequal blocks: i. before September 2010; ii. between September 2010 and February 2011; and iii. after February 2011. There was no statistically significant difference in admission numbers between these three time periods using the Kruskal-Wallis test ($\chi^2(2, N = 96) = 0.89, p = 0.26$). The number of monthly admissions was also considered in two blocks: before and also after February 2011. There continued to be no statistically significant difference in admission numbers using the Wilcoxon Rank Sum test ($z=0.07, p = 0.94$).

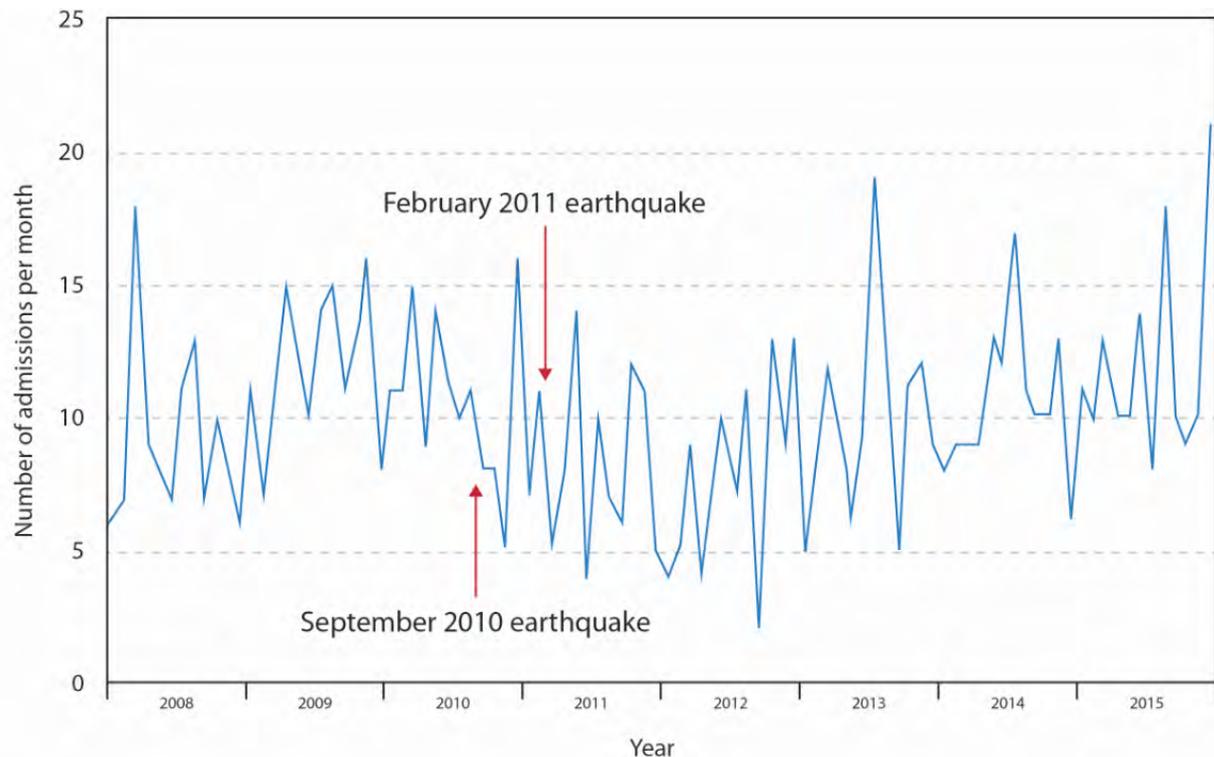


Figure 1. Absolute number of diabetic ketoacidosis admissions by month to Christchurch hospitals, for youth and adults aged 15 years or more.

The absolute numbers of admissions for DKA in the 16-25 year, youth, age group were too small for meaningful statistical analysis. Admission rates in this age group did not however show any obvious increase in the post-quake period: The average monthly Youth admission rate from January 2008 to September 2010 was 4.2. From September 2011 to February 2012, from the first earthquake up until the anniversary of the most devastating earthquakes, it had fallen to 2.8 and from April 2012 to December 2015 it had increased back to 4.6.

Regarding the online questionnaire, 23 percent (63 of 278) of the estimated eligible population responded. The average age of responders was 20 years. Fifty-four percent were female and 90 percent were of New Zealand European ethnicity, reflecting the fact that T1DM is most prevalent in European New Zealanders. At the time of the earthquake, 83 percent of respondents were studying or working.

Of the 63 respondents, 42 participants (67%) experienced major physical disruptions in their living conditions, as detailed below. Eighteen of 63 participants (29%) reported immediate changes in insulin requirements which settled after 4 to 210 days. Professional psychological support was obtained by 12 (19%) of respondents and support from family was also

considered important. Some changes were positive, such as the qualitative response from one participant: "Began to eat healthier; junk food less available". Other responses to specific questions are outlined in table 1.

Glycated haemoglobin (HbA1c)

Eighty four percent of participants ($n = 53$) consented to linking of their unique national health identifier with their HbA1c data. This high level of consent to data linkage suggests that there was a high level of what Moore & Niemi (2016) called *social licence*. In other words, within the context in of the current research, community members appeared to readily approve of our use of their personal data. Two or more HbA1c data points were available from 50 participants within the study time frame. These participants' data was therefore able to be analysed by paired t test, comparing values before and approximately three months after the 2011 earthquake, and/or comparing values before and approximately twelve months after the same earthquake. Mean HbA1c values (mmol/mol) were as follows: pre-quake 77 ($N = 50$), three months post-quake 79 ($N = 44$), twelve months post-quake 75 ($N = 47$). The paired t test results before and three months post-quake were $t(43) = 0.88$ ($p = 0.39$). The corresponding values for before and 12 months post-quake were $t(46) = 0.42$ ($p = 0.67$), thus there were no statistically significant or clinically

significant changes in HbA1c seen post-quake in the study participants.

Table 1. *Participant Responses to Specific Questions about Post-Earthquake Situation*

Type of Disturbance	Percentage of Participants Giving a Positive Response
Domestic infrastructure	
Had damage to their home	30%
Lost domestic power	73%
Lost domestic water	54%
Lost domestic sewerage	43%
Lost time from school/tertiary study/work	81%
Psychological disturbance	
Sleep disturbance	56% ^a
Changes in appetite	30% ^b
Reduced energy levels and fatigue	48%
Reduced mood and or increased irritability	49%
Increased stress levels	62%
Insulin requirements	
Changes in insulin requirement	29% ^c

^aParticipants describing sleep disturbance reported that it was often of many months duration and it was related to aftershocks and anxiety.

^bParticipants describing a change in appetite reported a mix of eating healthy due to lack of choice of "junk" food, but also some "comfort eating", usually with suboptimal food choices.

^cParticipants reporting changes in insulin requirements typically said requirements were "now all over the place". The majority found this change in insulin requirement settled, several months after the February 2011 earthquake.

Discussion

Youth with T1DM showed considerable resilience after the February 2011 earthquake. They tended to be living under adverse physical and psychological conditions and had reduced clinical support. However they showed no increase in presentation to the local health services with DKA. Also, patients who allowed us to review their HbA1c results showed no metabolic deterioration over one year. Circumstances seemed difficult but not impossible for most, and this may have contrasted with other disaster-affected populations suffering a much larger magnitude of devastation.

The local experiences documented by the current research suggest that for T1DM, personal diabetes self-care responses to a disaster are an extension of general preparedness for difficult medical situations,

including sick day management. Patients need to trouble shoot problems using the resources available. While we endorse the standard recommendations of having several days of medical and general supplies available at home, some disasters such as earthquakes occur without warning. This means that many patients may not have access to their home supplies. We consider that diabetes disaster preparedness advice around availability of domestic medical supplies should be extended to carrying around some personal supplies at all times. This applies to patients reliant on insulin and blood glucose self-monitoring in particular.

It is difficult to undertake research in a post disaster environment without encountering methodological limitations. The 2010 earthquake and subsequent aftershocks are likely to have primed individuals' disaster preparedness, so individual's responses to the 2011 earthquake may not represent responsiveness in a setting where a disaster is less anticipated. Another limitation was the low questionnaire response rate, of 23 percent. Responses are likely to have been subject to individual biases, although it is difficult to know in which direction such biases were operating, towards over-reporting or under-reporting earthquake impacts for example. It is nonetheless reassuring that individual questionnaire responses generally align with commentary provided to the authors, by older T1DM patients in a clinical setting.

There were many anecdotal stories from around New Zealand, of T1DM patients arriving into other health districts with significant psychological and metabolic distress shortly after the February 2011 earthquake. One study, by Newell, Beaven, & Johnston (2012), analysed cell phone usage among the general population. This usage data indicated that around 15 percent of the usual population of Christchurch probably left the city over the first week after the 2011 earthquake. It is not known whether those with high health needs such as T1DM were more likely to self-evacuate and were therefore under-represented in the current questionnaire of Youth still based in Canterbury. Also, self-evacuation may have influenced the number of Youth presenting to local services with DKA.

The resilience shown by the respondents with T1DM in the immediate post-quake period largely reflects use of their own resources and support systems. This is because the local health system was severely strained and could only offer limited diabetes-specific support. The diabetes community, as with many other

local communities, self-organised their own immediate disaster response. This included micro-distribution of diabetes supplies including insulin (Ceismic, 2016). Access to diabetes supplies was difficult at times but there appeared to be no prolonged barriers to access.

We consider that the future focus of disaster preparedness should move beyond generalised health system support to specific national, regional and local preparedness that includes those with chronic medical conditions, as outlined in the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations Office for Disaster Risk Reduction, 2016). This approach encompasses the potential to provide rapid, co-ordinated support for patients whose life depends on continuous treatments.

In conclusion, a disaster event typically produces a hostile, life threatening environment for those with T1DM. However, Youth with T1DM, participating in the current study, showed adaptive diabetes self-management skills following the Canterbury earthquakes. These skills allowed them to cope, at least from a metabolic perspective. For individual, insulin-dependent patients, education concerning disaster preparedness should be an extension of sick day management and an extension of how to manage everyday diabetes emergencies. We also welcome any co-ordinated initiatives that extend general population disaster preparedness into preparedness for those with chronic diseases.

Acknowledgements

We thank the following for their help with this study: Ma Yi, Canterbury District Health Board Biostatistician, for her help with data analysis; and Diabetes Youth Canterbury for helping to identify Youth with T1DM residing in Christchurch. We are also grateful to previous researchers who have published details of local responses to managing diabetes following a disaster. Their shared insights and experiences helped us plan our own local emergency response.

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