Article

Massacre, Earthquake, Flood

Translational Science Evidence That the Use of Micronutrients Postdisaster Reduces the Risk of Post-Traumatic Stress in Survivors of Disasters

Julia J. Rucklidge[1], M. Usman Afzali[1], Bonnie J. Kaplan[2], Oindrila Bhattacharya[1], F. Meredith Blampied[1], Roger T. Mulder[3], and Neville M. Blampied[1]

[1]University of Canterbury, Christchurch, New Zealand
[2]Cumming School of Medicine, University of Calgary, Calgary, AB, Canada
[3]School of Medicine, University of Otago, Christchurch, New Zealand

Abstract. Natural (e.g., earthquake, flood, wildfires) and human-made (e.g., terrorism, civil strife) disasters are inevitable, can cause extensive disruption, and produce chronic and disabling psychological injuries leading to formal diagnoses (e.g., post-traumatic stress disorder [PTSD]). Following natural disasters of earthquake (Christchurch, Aotearoa/New Zealand, 2010–11) and flood (Calgary, Canada, 2013), controlled research showed statistically and clinically significant reductions in psychological distress for survivors who consumed minerals and vitamins (micronutrients) in the following months. Following a mass shooting in Christchurch (March 15, 2019), where a gunman entered mosques during Friday prayers and killed and injured many people, micronutrients were offered to survivors as a clinical service based on translational science principles and adapted to be culturally appropriate. In this first translational science study in the area of nutrition and disasters, clinical results were reported for 24 clients who completed the Impact of Event Scale – Revised (IES-R), the Depression Anxiety Stress Scales (DASS), and the Modified-Clinical Global Impression (M-CGI-I). The findings clearly replicated prior controlled research. The IES-R Cohen's *d* ESs were 1.1 (earthquake), 1.2 (flood), and 1.13 (massacre). Effect sizes (ESs) for the DASS subscales were also consistently positive across all three events. The M-CGI-I identified 58% of the survivors as "responders" (i.e., self-reported as "much" to "very much" improved), in line with those reported in the earthquake (42%) and flood (57%) randomized controlled trials, and PTSD risk reduced from 75% to 17%. Given ease of use and large ESs, this evidence supports the routine use of micronutrients by disaster survivors as part of governmental response.

Keywords: disasters, psychological injuries, micronutrients, earthquake, flood, mass shooting

Impact and Implications. Disasters, both natural (e.g., earthquakes, floods) and human-made (e.g., terrorism, civil strife), affect communities worldwide, often causing immense disruption and suffering, and lasting psychological injuries.

Following the mass shooting in mosques in Christchurch, NZ, in March 2019, micronutrients (vitamins and minerals) were offered to survivors as a clinical service, and results replicated controlled research in the aftermath of an earthquake and a flood that showed that providing survivors with micronutrients reduced psychological distress, to a clinically significant degree, immediately and at one-year follow-up.

This research promotes the achievement of the United Nations Sustainable Development Goals number 2 (improve nutrition) and number 3 (ensure healthy lives and promote well-being).

Disasters, both natural and human-made, have been experienced by humankind throughout history. However, despite our collective understanding of the inevitability of such events, when disasters do occur, they always cause distress, and the trauma may be severe for some individuals in the affected population. A sudden disaster that brings threats to well-being and survival evokes an array of defensive responses, often described as the fight/flight response (Rego et al., 2009), with associated physiological, cognitive, and emotional reactions that prepare survivors to evaluate the threat and organize themselves for avoidance, confrontation, or escape; these responses are accompanied by emotions such as fear and anxiety (Baldwin, 2013; Craske et al., 2006; Sherin & Nemeroff, 2011). The immediate and longer-term psychological distress individuals feel following a disaster can include prolonged and/or intense anxiety and fear, depression, dissociation, hypervigilance, flashbacks, and extreme irritability (Baldwin, 2013), although there is great individual variability (Bonanno et al., 2010, 2011; Dickstein et al., 2010).

When symptoms of distress become severe and prolonged, individuals may develop diagnosable disorders such as acute stress disorder, post-traumatic stress

disorder (PTSD), major depressive disorder, and general symptoms of post-trauma stress (American Psychiatric Association, 2013). Following a disaster, rates of PTSD can range from 30% to 60% of those exposed and can persist for up to one-third of those affected 2 years postevent (Galea et al., 2005); some may continue to experience symptoms for years, even decades. This is much higher than the general lifetime prevalence of PTSD of ~7% (Kessler et al., 2012). Thus, whatever the nature, scale, and duration of a disaster, psychological injuries will be among the many serious challenges facing individuals, communities, and health systems. Indeed, O'Connor et al. (2011) observed that "*Of all the many physical, social, environmental, and economic aspects of natural disasters, the psychological dimension is arguably the most important to humans*." (p. 2). While in the immediate disaster aftermath the treatment of physical injuries will likely dominate the health response, psychological distress and its chronic sequelae will become more important as time goes on (Deely & Ardagh, 2018).

While distress is an expected consequence of disasters, it is difficult to predict who will be individually vulnerable to it, especially in the form of PTSD and other diagnoses, and who will be resilient. Factors known to increase the risk of prolonged distress include severity of any injuries to self and important others, level of social support, age, personality factors, emotional states, early life experiences, level of destruction of homes and other places of personal, economic and social importance, and general loss of resources (Bonanno et al., 2010, 2011; Orcutt et al., 2014). However, given that these predictors are neither highly reliable nor necessarily easy to determine case by case in the immediate event aftermath, any postdisaster intervention that can be delivered safely and immediately to a wide range of survivors will likely produce substantial benefits in reducing distress and preventing serious disorders such as PTSD.

Triage Theory and the Role of Nutrition Postdisaster

A factor that has been largely overlooked in extant disaster/trauma research is the adequacy of the postdisaster food and nutritional environment to meet the nutritional needs of highly stressed survivors. There are several factors that are relevant here. First, the disaster may disrupt food supplies and make access to food in general, and especially food of high nutritional quality, difficult. Second, dietary choices tend to change in the wake of a disaster toward selection of "comfort foods" (Kuijer & Boyce, 2012), so even those with access to high-quality food may experience a reduction in the nutritional quality of their diet as a function of their individual choices. Third, there are individual differences in metabolic needs for various dietary components (Kaplan, Rucklidge, Romijn, & McLeod, 2015), making some individuals especially vulnerable to postdisaster nutritional insufficiency, irrespective of general food supply adequacy and individual food choice.

Of particular concern are the food components, vitamins and minerals (collectively, micronutrients), since these are essential for the daily operation of biochemical reactions that occur throughout the body, including the brain. Among other functions, micronutrients provide the essential cofactors/catalysts required to synthesize neurotransmitters, support the function of the citric acid cycle (which is essential for the production of energy), assist with modulating inflammatory responses, and are essential for ensuring that methylation occurs, a process which ensures the regulation of the cardiovascular, neurological, reproductive, and detoxification systems (Kaplan, Rucklidge, Romijn, & McLeod, 2015). All of these key metabolic activities require that the food individuals consume reliably supplies the necessary micronutrients. It follows from this that any impairment of the postdisaster diet, for whatever reason (see above), may weaken the capacity of individuals to cope with and adapt to the prolonged stress characteristic of such situations. This is highlighted by triage theory (McCann & Ames, 2009).

Triage theory identifies how intrinsic internal systems ensure that the micronutrient-dependent physiological functions required for short-term survival (like the fight/flight response) are metabolically protected at the expense of longer-term functions (such as cognitive processing and emotion regulation). In coping with immediate threats, the body diverts resources from homeostatic physiological processes (such as gut function) to meet urgent survival needs (such as increased cardiac and adrenal output), thereby prioritizing short-term survival over long-term adaptive coping. Triage theory thus predicts that, during and after a disaster, nutrients are redirected to the individual's stress response, leaving limited nutritional resources to be shared with other functions. Over time, and given persisting stress, this prioritization in favor of short-term survival may reduce or impair methylation processes that in turn may damage DNA and contribute to mitochondrial decay (Ames, 2010), all processes identified as important to mental health.

Thus, as an individual's nutritional reserves that support the flight/flight response are depleted – because available foods are less nutritious, or because of ongoing choice of less nutritious food, and/or because of individual metabolic differences in nutrient needs – triage theory suggests that the person may experience a nutritional deficit that

could compromise other adaptive functioning such as emotion regulation, cognition, and social functioning (Kaplan, Rucklidge, Romijn, & McLeod, 2015). Note that triage theory does not require nutritional deficiencies to reach the point of causing overt physical symptoms (e.g., scurvy); Ames (2010) has hypothesized that even small or subtle deficiencies in one or more nutrients may lead to significantly poorer long-term outcomes if the stress experienced is chronic in nature.

Evidence for B Vitamins in Alleviating Stress

Triage theory predicts that increasing the supply of essential nutrients during a time of high stress should have a positive effect on coping and resilience, a prediction based, in part, on the known biochemical roles that B vitamins play in moderating the stress response. B vitamins are known to play a prominent role in methylation, neurotransmitter synthesis, energy production, glucose metabolism, and inflammation reduction (Kennedy, 2016). Furthermore, there is now research, including randomized placebo-controlled trials, in settings such as workplaces and among healthy community volunteers, which has consistently shown that increasing B vitamin intake improves resilience as shown by greater reductions in reported stress in the B vitamin groups compared with placebo groups (Schlebusch et al., 2000; Stough et al., 2011; White et al., 2015). Two meta-analyses have confirmed the stress-reduction benefits of B vitamins (compared with placebo); reported between-group effect sizes (ESs) range from 0.23 to 0.35 (Long & Benton, 2013; Young et al., 2019).

Based on the Chambless and Hollon (1998) criteria for a well-established treatment, B vitamins, as treatment for reducing stress, meet those criteria. While these ESs are small, the majority of the samples were healthy volunteers; effects tend to be larger when targeting clinical samples (Blampied, Bell et al., 2020). As additional evidence of the effect of B vitamins on stress, biological markers, such as nutrient concentrations (Armborst et al., 2018; Camfield et al., 2013), have been shown to increase significantly in line with reduction in reported stress levels, supporting the biochemical role these nutrients play in improving mental health.

Postdisaster Nutrition Research

The fight/flight response as a reaction to stressful events outlined above is known to be largely independent of the particular kind of event inducing the stress (Chrousos, 2009). Consistent with this, research by the Mental Health and Nutrition Research Laboratory (University of Canterbury) has identified broad-spectrum micronutrients (vitamins and minerals, including but not limited to B vitamins) as an aid in recovery from the stress associated with natural disasters. This research was initiated in the aftermath of a severe earthquake sequence that began in September 2010 in the Canterbury (Aotearoa/New Zealand) region, ultimately destroying much of the city of Christchurch. After the initial earthquake, Rucklidge and Blampied (2011), exploiting a natural experiment where the timing of the earthquake relative to participation in a clinical trial fortuitously created control and treatment groups, reported that trial participants who happened to be taking micronutrients at the time of the September 4, 2010, earthquake (magnitude 7.1) recovered more quickly in the first two weeks postearthquake than the people who were not taking the nutrients.

Following a severe aftershock (magnitude 6.3) in this sequence in February 2011, which killed 185 people and caused further major damage to the city, 91 adults volunteered for a randomized controlled trial (RCT) and were randomized to receive either B vitamins or a low or high dose of broad-spectrum micronutrients, and there was also a nonrandomized treatment-as-usual (TAU) group (n = 25) who were identified as being similar in demographic characteristics and symptom severity at baseline as the treated groups (Rucklidge et al., 2012). Relative to the TAU group, all three nutrient treatments resulted in a clinically and statistically significant reduction in reported stress and anxiety (d_s ES relative to TAU ranged from 0.4 to 0.88) and improved mood, with mean scores changing from moderate–severe baseline levels into the normal/nonclinical range. For the TAU group, in contrast, there was very little change over time (e.g., d_{av} for change in post-trauma stress pre–post = 0.14). The higher dose of micronutrients (eight capsules per day) showed the most benefit relative to the comparison supplements, in that more people taking the high dose reported greater improvement in mood, anxiety, and energy, with twice as many reporting being "much" to "very much" improved compared with the B-vitamin group. Those taking the micronutrients also reported fewer intrusive thoughts related to the trauma than did the B-vitamin recipients. In addition, rates of probable PTSD in the nutrient groups (identified by a score ≥33 on the Impact of Event Scale – Revised (IES-R; Weiss & Marmar, 1997) dropped from 65% to 19% compared with no change in the TAU group (which stayed at about 48%). These clinical advantages for the treated groups were maintained at a 1-year follow-up (Rucklidge, Blampied et al., 2014).

Following the same earthquake, beneficial effects of micronutrients were also observed for 14 children aged 8–11 years with pre-existing anxiety disorders which were exacerbated by the disaster. They showed large reductions in anxiety and emotional distress (ESs > 1) following 8 weeks consumption of the same micronutrient formula as used in the adult RCT (Sole et al., 2017), in a multiple-baseline across participants design.

These positive effects of nutrients on stress were replicated in a further RCT following a flood in Alberta, Canada, in June 2013, which resulted in five deaths, the evacuation of over 70,000 people, and extensive damage to the city of Calgary and adjacent communities (https://en.wikipedia.org/wiki/2013_Alberta_floods). Kaplan, Rucklidge, Romijn, and Dolph (2015) recruited 56 flood-affected adults in Alberta who were suffering from heightened depression, anxiety, and/or stress following the flood, and who had no prior history of mental disorders. They were randomized to receive B vitamins, the same micronutrient formula used in the earthquake RCT, or 1,000 IU of vitamin D (an active comparator treatment). The B vitamins and micronutrients both resulted in significant improvements in reported psychological distress compared to the modest improvements following vitamin D (between-group d_s > 0.8; a conventionally large ES; Lakens, 2013).

The conclusion that can be drawn with at least modest confidence from this series of controlled studies, involving different natural disasters in different countries, and examining the effects of a range of nutrient treatments for both adults and children suffering psychological distress following the disaster, is that micronutrient supplementation delivers observable clinical benefits through reduction in symptoms of psychological distress.

The Translation of Research to Practice Following a Massacre

On March 15, 2019, a gunman (a self-proclaimed white supremacist) successively entered two mosques in Christchurch (Aotearoa New Zealand) while worshipers were engaged in Friday prayers and killed 51 people and injured 40. The attack was live-streamed by the gunman on Facebook; an unknown but very large number of people worldwide, including children, viewed it despite attempts to remove it from the internet (see https://www.classificationoffice.govt.nz/news/featured-classification-decisions/christchurch-mosque-attack-livestream/). This was a disaster that very seriously impacted the local Muslim community, the entire citizenry of Christchurch, and many people in the wider nation, and, because many members of the community were immigrants and refugees, had negative effects across the world (see https://theconversation.com/nz/topics/christchurch-mosque-shootings-67899).

The causes and consequences of this event were of great concern to psychologists nationally (and, indeed, elsewhere; see the special issue of the *New Zealand Journal of Psychology*, *48*(1), April, 2019). Locally, in the immediate aftermath of the shootings, the researchers in the Mental Health and Nutrition Research Laboratory faced a compelling scientific and ethical dilemma: How best to use the knowledge reviewed above, about nutritional supplementation gained from previous studies on disasters, to help the survivors of this latest catastrophe? The research group chose to implement the research findings as a minimally sufficient clinical service (Blampied, Mulder et al., 2020) as an example of translational science (Reich, 2008); that is, turning research into practice so that new treatments based on research knowledge reach those who need the treatment (Woolf, 2008). This clinical work was facilitated through senior university students who were able to work in a culturally appropriate way with members of the affected community (authors M.U.A. and O.B.; see Electronic Supplementary Material, ESM 1, for more information on their role) and was conducted in accordance with the Declaration of Helsinki and the ethical standards applying in Aotearoa New Zealand to physicians and psychologists. Relevant university and health system ethics committees later granted clearance to publish our clinical observations. We report these here while also providing context by presenting reanalyses of relevant data from the earthquake and flood RCTs using the measures common across all three events, namely, the IES-R (Weiss & Marmar, 1997), the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995) and the Modified-Clinical Global Impression scale (M-CGI-I; Spearing et al., 1997).

We were aware that the use of psychological measures such as these across different national communities and cultural and religious groups raises issues regarding the cultural generality of such measures (Byrne, 2016). We used the IES-R, the DASS-21, and the M-CGI-I because they permitted direct comparisons with our prior research, but considerable research has established that the IES-R and the DASS, both in English and in translation into languages used in Islamic-majority countries, retain their psychometric structure (e.g., the three-factor solution for the DASS; Asghari et al., 2008; Sariçam, 2018) and validity (e.g., the diagnostic domains of PTSD; Othman et al., 2016; Smith et al., 2003; Weiss, 2007), although there may be variation in the weighting given to specific components across cultures (King et al., 2009;

Zanon et al., 2020). The M-CGI-I is a self-rating of perceived improvement, thus permitting respondents to report their own judgment of any change in their state relative to their own cultural viewpoint.

The approach deployed in our work entailed three logical steps: First, we drew on the data from the B-vitamin literature as well as the earthquake and flood RCTs to identify the treatment condition that was clearly superior to the placebo and/or active control and comparison conditions in those studies. This gave us substantive evidence for recommending a particular micronutrient formulation to massacre survivors. Second, we used inductive generalization to predict that what had benefited the survivors of the prior disasters would benefit the massacre survivors. Third, we gathered clinical data that might (or might not) confirm our inductive generalization when it was directly compared with that obtained in the prior RCT research (Barlow et al., 1984; Haig, 2014), and which also permitted us, clinically, to monitor response to treatment and any adverse effects and to respond to any such events appropriately.

For ethical reasons, there was no direct control possible for the mosque shootings, but the results were compared with the findings from controlled research, where the evidence is that the micronutrients were beneficial. If the prediction is confirmed that the survivors of the shootings would experience benefit similar to that shown in the RCTs, there is support for the conclusion that the nutrients were the common source responsible for the benefit. As a matter of further generality, the data relating to the massacre are also the first observations of the effect of a nutritional intervention on a human-perpetrated disaster as compared to natural disasters (Galea et al., 2005), as well as being the first instance of a translational science approach to the deployment of a nutritional intervention postdisaster.

Method

Clients

Twenty-six adult clients began treatment between April 15 and May 27, 2019 (i.e., within 1–2.5 months of the massacre). They sought treatment through the liaison team members, having learned via word of mouth in the community or various services (e.g., Christchurch Resettlement Services, Muslim Association of Canterbury, and Anxiety Disorders Service) that donated micronutrients were available for anyone who was either directly (present in one of the mosques) or indirectly (a family member had been injured or killed) involved in the mass shooting. A majority were male (N = 17 of 26; 65%), aged 19–58 years old (M = 39, SD = 10.6 years), and nine were present in one of the two affected mosques at the time of the shootings. There was a broad range of nationalities/ethnicities represented, including people identifying as Pakistani, Indian, Afghan, Ethiopian, and Somali as well as New Zealand European.

Treatment

Clients were provided with micronutrients in the form of Optimal Balance (Hardy Nutritionals) capsules by one of the authors (M.U.A. or O.B.). This is a broad-spectrum micronutrient formula (see Table 1 for the ingredient list) very similar to EMPowerplus (EMP+) used in the prior RCTs. It was classified as halal and could be taken outside of the Ramadan fasting (which fell during the clinical observation period). The manufacturer recommends three capsules be taken twice per day with food and ample water.

Clinical Procedures

For the massacre clients, as is consistent with clinical practice, there was no randomization to any treatment condition, there was no control condition, there were no selection or exclusion criteria imposed (beyond those noted above), and neither the daily dose nor the duration for which the capsules were consumed was prescribed. Clients were recommended to follow the manufacturer recommended dose, but some people took more, some less, and those concurrently taking other treatments, including medication, were advised to discuss their micronutrient consumption with their physician/health provider. All clients were given information about possible side effects of micronutrients and about other treatment options, and they gave full informed consent to treatment (and any later dissemination of anonymized information). A physician (R.M., a psychiatrist) provided medical oversight as required.

Informed consent was obtained when the capsules were delivered and when clients completed the online questionnaire. Completing the questionnaire provided a record of consent, some demographic information, and baseline and subsequent information about the clients' psychological state, as the clients were asked to revisit the website and complete the psychological measures and report any side effects every 2 weeks. Reports were monitored to detect any response to treatment and any adverse side effects. When clients contacted the team and asked for more Optimal Balance, they were asked to continue completing the online questionnaire at 2-week intervals

Table 1. Ingredients in Optimal Balance

Ingredients in Optimal Balance	Amount/serving (three capsules)	Amount/day (six capsules)
Vitamin A (as retinyl palmitate)	2,000.0 IU	4,000.0 IU
Vitamin C (as ascorbic acid)	150.0 mg	300.0 mg
Vitamin D (as cholecalciferol)	1,500.0 IU	3,000.0 IU
Vitamin E (as D-alpha tocopheryl succinate)	35.0 IU	70 IU
Vitamin K_1 (as phylloquinone and menaquinone-7)	60.0 mcg	120.0 mcg
Thiamin (as thiamin mononitrate)	27.0 mg	54.0 mg
Riboflavin	8.0 mg	16.0 mg
Niacin (as niacinamide)	26.0 mg	52.0 mg
Vitamin B_6 (as pyridoxine hydrochloride)	24 mg	48.0 mg
Folate (as folic acid and L-methylfolate calcium)	400.0 mcg	800.0 mcg
Vitamin B_{12} (as methylcobalamin)	168.0 mcg	336.0 mcg
Biotin	318.0 mcg	636.0 mcg
Pantothenic acid (as D-calcium pantothenate)	14.0 mg	28.0 mg
Calcium (as chelate)	303.0 mg	606.0 mg
Iron (as chelate) – for women	13.5 mg	27.0 mg
Iron (as chelate) – for men	4.0 mg	8.0 mg
Phosphorus (as chelate)	193.0 mg	386.0 mg
Iodine (as chelate)	120.0 mcg	240.0 mcg
Magnesium (as chelate)	137 mg	274.0 mg
Zinc (as chelate)	11 mg	22 mg
Selenium (as chelate)	46 mcg	92.0 mcg
Copper (as chelate)	1.6 mg	3.2 mg
Manganese (as chelate)	2.2 mg	4.4 mg
Chromium (as chelate)	143.0 mcg	286 mcg
Molybdenum (as chelate)	33.0 mcg	66.0 mcg
Potassium (as chelate)	55.0 mcg	110.0 mg

Other ingredients: choline, coenzyme Q10, β-sitosterol, tocopherol, mineral wax, spirulina, larch arabinogalactan, inositol, *Rhodiola rosea* root extract, alpha lipoic extract, bamboo shoot extract, *Astragalus* root extract, royal jelly, grape seed extract, *Ginkgo biloba* leaf extract, boron (as chelate), vanadium (as chelate), lithium orotate (as chelate), nickel (as chelate) vegetarian capsule, microcrystalline cellulose, magnesium stearate, and silicon dioxide.

and another supply was delivered personally or mailed. Clients decided when they ceased treatment and when they stopped providing information online. Further detail of the clinical service work is provided in ESM 1.

Measures

The measures completed online were

1. *The IES-R* (Weiss & Marmar, 1997): The IES-R is a 22-item measure of commonly experienced symptoms following a distressing event. This scale is widely used in different cultures and following exposure to various traumatic events including, but not limited, to natural disasters like hurricanes (Dougall et al., 1999; Ironson et al., 1997), and earthquakes (Asukai et al., 2002; Wang et al., 2010). There are three IES-R subscales, namely, intrusion (eight items), avoidance (eight items), and hyperarousal (six items), but these have not consistently emerged as factors in psychometric research (Creamer et al., 2003) and we only used the total score. A total score of ≥33 has been identified as a cutoff for probable PTSD, while a score of ≥24 indicates a basis for clinical concern.
2. *The DASS – Short Form* (DASS-21; Henry & Crawford, 2005; Lovibond & Lovibond, 1995): The DASS is a 21-item questionnaire that assesses an individual's current severity of symptoms relating to depression, anxiety, and stress; scores are doubled to match the long form. Cutoff scores indicative of at least mild symptom levels are >9 for depression, >7 for anxiety, and >14 for stress; for moderate severity, these scores are >12, >9, and >18, respectively (see www.psy.unsw.edu.au/groups/dass).
3. *The M-CGI-I scale* (Spearing et al., 1997): The M-CGI-I asks individuals to rate their condition from 1 (*very*

much improved) to 7 (*very much worse*) and how much better/worse they were feeling since taking the micronutrients. Standard practice identifies those who endorse "much to very much improved" as "responders." It was not completed before treatment.

4. *Side effects:* All individuals were asked to identify whether they had experienced any commonly reported symptoms (e.g., dry mouth, nausea, and constipation) from a list of possible side effects. They were also asked to comment whether they had noted any other adverse effects from taking the capsules.

Results

In comparing data from these events, it is worth recalling that the mosque shooting was one brief event, the flood was one event lasting some days, and the earthquake involved a sequence of severe shocks and aftershocks over many months; of course, all had long-term impacts. Summary data from the three disasters are presented in Table 2. Individual responses are presented in modified Brinley plots (Blampied, 2017). These plots are a form of scatterplot, where each individual's score at a later time is plotted against their score at an initial time, generally baseline. If there is little or no change over time, all data points will lie on or near the solid 45° diagonal (the line of no effect); treatment effects are shown as systematic deviations of the data points above and below this line. A second (dashed-dotted) line at 45° below the no-effect line shows the lower limit of the Reliable Change Index (RCI; Jacobson & Truax, 1991); points at or below this line are unlikely ($p < .05$) due to measurement error alone. The RCI for the IES-R was calculated from data in Creamer et al. (2003; Cronbach's $\alpha = .96$) and those for the DASS from Henry and Crawford (2005; $\alpha = .88$, .82, and .90 for Depression, Anxiety, and Stress, respectively). The plots also show relevant clinical cutoffs (see Measures) as vertical and horizontal lines. The figures show additional information by way of the number of cases (N[1]) and the ES Cohen's d and its 95% CI[2] (calculated for pre-to-post data using software provided by Cumming [2012]; see also Lakens [2013]). A second ES is also reported, the percent superiority (PS) ES, which gives the probability that any randomly selected case has a clinically better score post-treatment than at baseline (Lakens, 2013). These two ES measures complement each other in that one (d) is a standardized mean difference, and the other (PS) an estimate of likelihood of change for any case. The data are shown separately for men and women, due to likely interest in any gender effects, both on initial trauma symptom response and in response to treatment, although this gender split does not yield subgroup Ns large enough for further statistical analysis.

Of the 26 individuals who experienced the 2019 mass shooting and sought our clinical service, 24 completed at least two questionnaires, one before treatment and one between 2 and 8 weeks after beginning the treatment. Most took about six capsules per day (the recommended dose; average dose was ~five capsules per day, a dose comparable to the dose used in the RCTs), and side effects were reported infrequently if at all and were mild (e.g., dry mouth, headache, and constipation), all of which were resolved by taking the capsules with ample food and water or reducing the dose. Two people chose to discontinue treatment because of trouble swallowing the capsules. Three people reported to us that they also sought help from a counselor while taking the capsules.

Mosque Client Trauma Results

Figure 1 shows IES-R data for the 24 mosque clients. In contrast to the earthquake and flood data (see below), there were substantially more men than women consuming the supplement after this event. What Figure 1 shows most conspicuously is that at baseline (i.e., after the experience of the massacre but before nutritional supplements were consumed), the IES-R scores of the clients fell into two clear groups. Six cases (one a woman) had low scores, all below the threshold of clinical concern. The rest all had scores to the right of the vertical clinical cutoff line indicative of possible PTSD. At the last observation (at which point, clients had taken different doses for varying durations of consumption, but for a minimum of 2 weeks), the six cases in the low IES-R score group at baseline showed little change. However, for those above the likely PTSD threshold pretreatment, all but three (all men) showed a reduction in scores to be at or below that threshold (shown as the solid horizontal line), with 10 cases being even below the lower cutoff for clinical

[1] This N is generally smaller than the total N reported for the respective study because only those cases with data at both specific time points can be plotted.

[2] Note that if the 95% CI on d does not cross zero, then a t-test on the corresponding means would be statistically significant, $p < .05$. d may also be said to be "statistically significant," meaning that the null hypothesis that $d = 0$ can be rejected at the stated alpha level ($p < .05$).

Table 2. *M*, ranges, and *SD* at baseline and last observation for the Impact of Event Scale – Revised, and Depression, Anxiety, and Stress from the Depression Anxiety Stress Scales

		Range				95% CI		
	M	Lowest	Highest	*SD*	d_{av}	Lower	Upper	Percent superiority
Impact of Event Scale – Revised Total Score								
Massacre *N* = 24								
Baseline	41.2	4	77	20.13				
					−1.13	−1.7	−0.52	81%
Last observation	21.2	0	60	14.93				
Flood *N* = 14								
Baseline	31.1	6	54	11.88				
					−1.2	−1.88	−0.53	90%
Last observation	16.4	3	47	12.24				
Earthquake *N* = 26								
Baseline	39.95	9	68	15.66				
					−1.1	−1.6	−0.57	84%
Last observation	21.62	0	69	17.89				
Depression Anxiety Stress Scales – Depression								
Massacre *N* = 24								
Baseline	17.1	0	42	12.44				
					−1.2	−1.8	−0.56	82%
Last observation	5.6	0	22	5.37				
Flood *N* = 18								
Baseline	20	1	30	2.6				
					−1.05	−1.7	−0.36	81%
Last observation	8.3	0	18	3.2				
Earthquake *N* = 26								
Baseline	16.12	0	29	8.69				
					−0.83	−1.3	−0.34	77.5%
Last observation	9.04	0	28	8.44				
Depression Anxiety Stress Scales – Anxiety								
Massacre *N* = 24								
Baseline	15.08	0	38	11.17				
					−1.12	−1.73	−0.5	79%
Last observation	5.33	0	18	5.13				
Flood *N* = 18								
Baseline	8.67	0	27	7.2				
					−1.05	−1.7	−0.38	79%
Last observation	2.6	0	11	3.2				
Earthquake *N* = 26								
Baseline	11.15	1	33	7.54				
					−0.88	−1.275	−0.48	86%
Last observation	4.62	0	31	7.28				

(Continued on next page)

Table 2. (Continued)

		Range				95% CI		
	M	Lowest	Highest	*SD*	d_{av}	Lower	Upper	Percent superiority
				Depression Anxiety Stress Scales – Stress				
Massacre *N* = 24								
Baseline	19	0	42	13.2				
					−1.1	−1.7	−0.51	82%
Last observation	7.1	0	32	7.97				
Flood *N* = 18								
Baseline	20	4	36	9.9				
					−1.37	−2.1	−0.65	88%
Last observation	8.3	0	25	6.99				
Earthquake *N* = 26								
Baseline	22.1	5	37	8.9				
					−1.2	−1.7	−0.67	87%
Last observation	11.2	0	38	9.1				

Note. Also shown is Cohen's d_{av} ES (for within-subjects data), the 95% CI on *d*, and the percent superiority ES. CI = confidence interval, ES = effect size.

concern and with 12 of 18 cases showing reliable change (i.e., below the dashed-dotted line). The *d* ES is conventionally large (> 0.8; Lakens, 2013) and indicates that the mean difference is statistically significantly different pre to post. The PS ES also indicates a high probability of benefit post-treatment.

In absolute terms, the *d* ES represents a reduction of 17.5 scale scores, sufficient to ensure that any client with a pretreatment score of ≤50 is below the likely PTSD threshold at the post-treatment observation (Funder & Ozer, 2019). Using the IES-R cutoff of 33, 75% of the massacre clients had probable PTSD before starting the treatment, but this dropped to 17%. This reduction in probable PTSD is consistent with what was observed following the earthquake and flood RCTs in the broad-spectrum conditions (change of 54–23% and 36–7%, respectively).

Earthquake and Flood Trauma Results

Figures 2a and 2b show comparable IES-R findings for, respectively, the participants in the Christchurch earthquake and the Alberta flood RCTs. As noted, for both of these studies, participants were predominantly women. At baseline, following the earthquake, the range of IES-R scores closely matched that of the massacre survivors, but the range of scores following the flood showed fewer cases reporting high IES-R scores, and here, the mean baseline IES-R score was two scale points below the cutoff for likely PTSD but above the threshold for clinical concern. However, for both sets of participants, the majority (all but two, in both studies) had baseline scores that were above the cutoff for clinical concern, and in the case of earthquake survivors, many were above the likely PTSD threshold.

Among survivors of the earthquake, five participants showed little change in IES-R scores after consuming EMP+, but the majority showed clear benefit, with

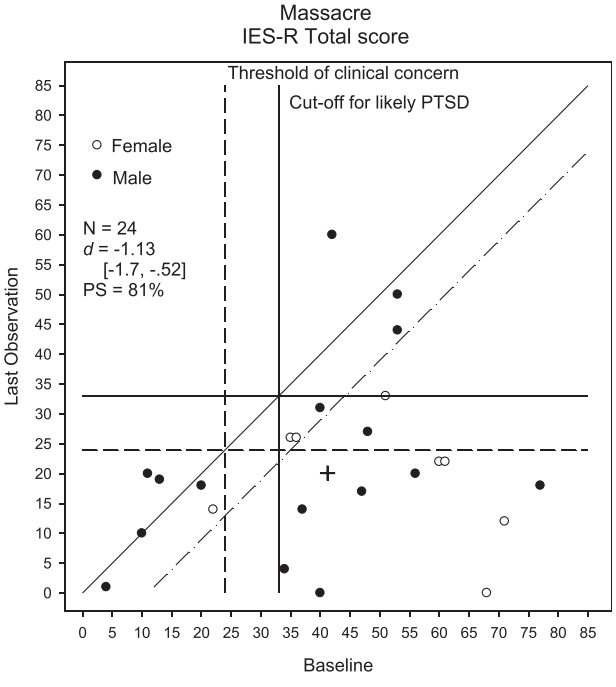

Figure 1. Mosque shooting IES-R scores at baseline and last observation for survivors (event in Christchurch, New Zealand, March 2019). The solid 45° diagonal line is the line of no effect, and the parallel dashed-dotted line shows the lower limit of the RCI. Vertical and horizontal dashed lines indicate the cutoff score for the threshold of clinical concern, and the solid horizontal and vertical lines mark the threshold for likely PTSD diagnosis. The Cohen's *d* with its 95% CI in [ ] and the PS ESs are shown. The cross marks the means at the two time points. The last observation is that recorded for each client and at least 2 weeks since they began the micronutrients. ESs = effect sizes; IES-R = Impact of Event Scale – Revised; PS = percent superiority; PTSD = post-traumatic stress disorder; RCI = Reliable Change Index.

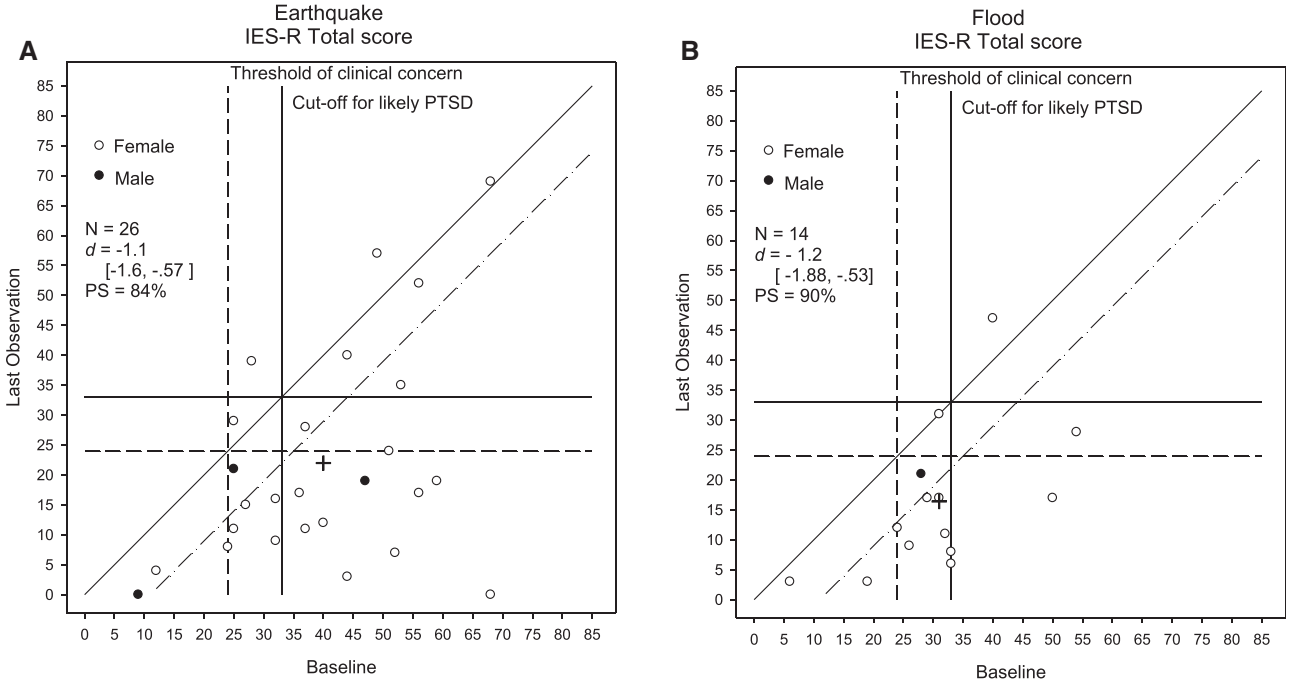

Figure 2. (a) Earthquake IES-R scores at baseline and last observation for survivors (event in Christchurch, Aotearoa New Zealand, February 2011). The last observation was taken at the end of 4 weeks of consumption of eight EMP+ capsules per day. Other features are as for Figure 1. (b) Flood IES-R scores at baseline and last observation for survivors (event in Alberta, Canada, June 2013). The last observation was taken at the end of 4 weeks of consumption of four EMP+ capsules per day. Other features are as for Figure 1. IES-R = Impact of Event Scale – Revised; PS = percent superiority, PTSD = post-traumatic stress disorder.

reduction in most cases below the clinical concern threshold. Again, the ES was large (>0.8) and the mean change was statistically significant. As for the survivors of the massacre, based on the *d* ES, only those with scores >50 would not have been below the likely PTSD cutoff post-treatment. Again, the PS ES showed a high probability of treatment benefit. The pattern for the flood survivors was very similar. Only two cases showed no change over time; the rest showed a clear reduction in IES-R scores to below the clinical concern threshold. The ES is again large (>0.8) and statistically significant, and the PS ES indicated a high likelihood of benefit. The majority of participants in both studies whose scores were above either clinical threshold at baseline reported change that was reliable.

Depression, Stress, and Anxiety Across All Three Disasters

Figures 3a, 3b, and 3c show, respectively, the data for the DASS scores (separately for each subscale, viz. Depression, Anxiety, and Stress) for the survivors of the mass shooting and the participants in the postearthquake and postflood RCTs. For the mosque clients, the pattern observed in their IES-R scores was also evident in their DASS scores, especially for the Depression and Stress subscales, namely, one group who were clearly below the clinical cutoff at baseline (the low distress group) and a second group who were above the respective cutoffs. The range of scores at baseline across the subscales was also large, with individuals scoring from zero to the maximum or close to it. The mean scores for Depression, Anxiety, and Stress were well above the respective clinical cutoff scores indicating at least mild distress. At the last observation reported, for the Depression and Anxiety subscales, one individual in the low distress group showed a small (Depression) to moderate (Anxiety) increase in score. The balance of clients in this group showed little change. However, for most of the rest of the clients, large reductions in depression, anxiety, and stress were evident, with only two clients not demonstrating some reduction in scores, and with only one client reporting an increase in stress. At last observation, the majority reported DASS scores below the mild symptom cutoff score. The PS ESs (79–82%) confirmed a high probability of benefit, and the *d* ES were again all large (at close to 1) and statistically significant.

The pattern of findings on the DASS subscales for the participants in the earthquake and flood RCTs resembles each other and the massacre data. Levels of depression and stress were higher than for anxiety, but baseline mean scores for all three subscales were above the clinical

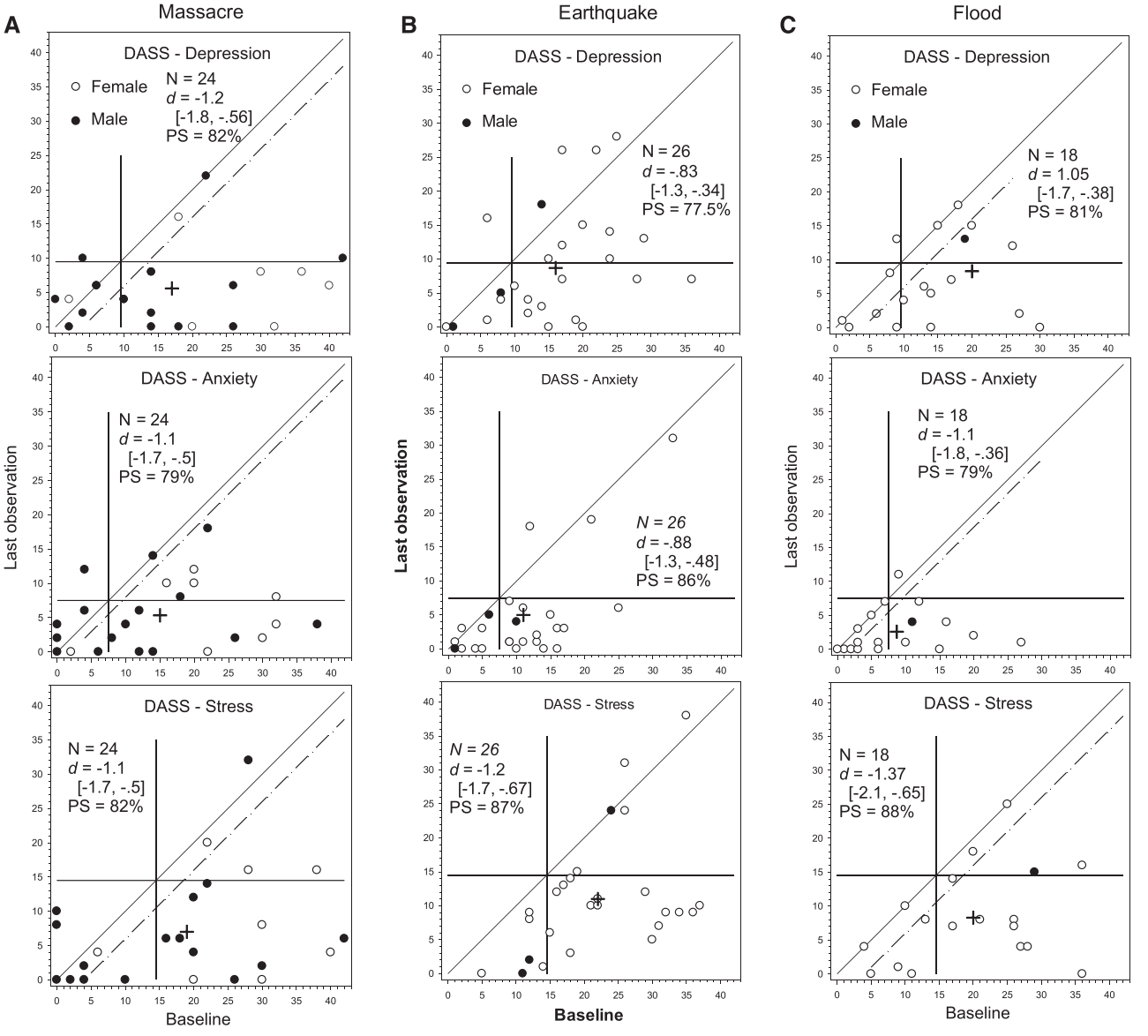

Figure 3. DASS scores shown, respectively, for depression (top panel), anxiety (middle panel), and stress (bottom panel) for mosque shooting clients (a), and earthquake (b) and flood (c) participants. Other features are as for Figures 1 and 2. DASS = Depression Anxiety Stress Scales; PS = percent superiority.

cutoffs for both disaster groups. Five (of 26) individuals in the earthquake RCT reported higher depression scores post-treatment, and two reported more stress. Otherwise, the pattern for participants in both RCTs and across all the DASS measures was for clear reduction in scores post-treatment, with post-treatment means being below the cutoff. The *d* ESs were all large (only slightly so for earthquake Depression and Anxiety) and statistically significant. The *d* ESs were consistently larger for the flood than for the earthquake RCT data, reflecting the lower variability in scores for this group. The PS ESs ranged from 77.5% to 88%, again indicating a high likelihood of benefit. Across the three events, the majority of individuals whose baseline scores were above the respective clinical cutoffs showed reliable reduction in levels of distress post-treatment.

Consistency of Response in Mosque Clients

How consistent were the changes observed across the measured domains of psychological distress for those surviving the massacre? Of the six clients who had low scores on the IES-R at initial presentation, only one initially had slightly elevated depression, anxiety and stress scores close to or slightly above the mild clinical cutoffs for the

DASS. Of the 18 clients who were above the IES-R threshold for likely PTSD, only one displayed a (large) increase in this measure. Of the remaining 17 clients, all of whom showed a reduction in their IES-R scores with treatment, all but two of these clients showed decreases in their psychological symptoms across the four measures.

Classification as "Responders" Using the M-CGI

The M-CGI-I (stress) identified 58% of clients affected by the massacre as "responders" to the treatment (i.e., they self-reported as "much" to "very much" improved). This percentage was again in line with those reported in the earthquake (42%) and the flood (57%) RCTs. It was noted for many clients across all three studies that sleep, irritability, and energy also improved as a result of the intervention. Figure 4 compares the number of responders across the three events, including the active comparator groups from the earthquake and stress studies: B vitamin, treatment-as-usual (TAU), and vitamin D.

Discussion

Translation of knowledge gained from prior controlled research into the clinical work undertaken in the immediate aftermath of the mosque shooting provided evidence that broad-spectrum micronutrients contributed to reducing psychological distress and risk of PTSD, at least in the short term, for massacre survivors who elected to seek this treatment. There are clear methodological limitations arising from the clinical service nature of the work, as is true of any application of research to practice, notably the lack of any control condition or tight control over the dose and duration of treatment. Despite this, these findings are notable because this study was a third replication reporting benefit from micronutrient treatment post-disaster but, as a replication, was a study of a very different kind of disaster (human vs. natural), with males in the majority, and with clients who were largely from an immigrant and refugee community and members of a religious minority (in Aotearoa New Zealand). It also provides a demonstration of translational science in the context of a very traumatic event, and one where cultural factors required care in how the affected community was approached and offered a clinical service based on novel research findings.

The inaugural studies followed the natural disasters of an earthquake (Rucklidge & Blampied, 2011; Rucklidge et al., 2012) and a flood (Kaplan, Rucklidge, Romijn, & Dolph, 2015), each of which badly affected a city and its adjacent region, in two developed countries (Aotearoa New Zealand and Canada). The circumstances under which these studies were conducted permitted methodologically sound research, particularly RCTs, although there were limitations, as might be expected of research in the aftermath of disaster, including only modest *N*s, few male participants, and a relatively homogenous ethnicity among participants. Yet, despite these limitations, the

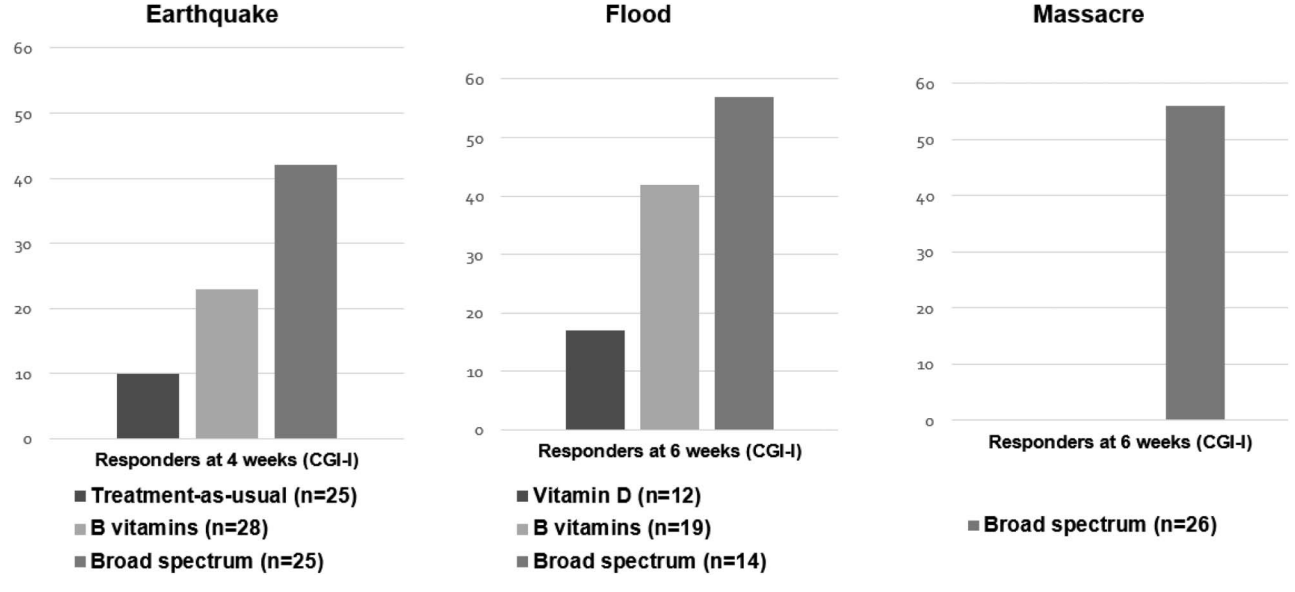

Figure 4. Percent responders (based on M-CGI-I stress) over earthquake, flood, and massacre studies. M-CGI-I = Modified Clinical Global Impression Improvement, responders identified based on self-reports of being much to very much improved.

research showed that survivors of these events who consumed micronutrient supplements reported improved mental health relative to TAU or an active comparator treatment (vitamin D), notably reductions in depression, anxiety, and stress, and a clearly reduced risk of PTSD. The research also showed micronutrients to be as good if not more effective than an active control previously shown to be better than placebo (B vitamins) in managing stress. Following the earthquake, these benefits of micronutrients were still evident at a 1-year follow-up (Rucklidge, Blampied et al., 2014).

The reanalysis of the RCT data presented here permits a systematic comparison of findings across the three replications of micronutrient treatment postdisaster, and the similarities in the findings across the three replications were striking. Of particular note were the IES-R *d* ES of 1.13 (massacre), 1.1 (earthquake), and 1.2 (flood) and the high likelihood of reduced scores after treatment (>80%). Replication is increasingly recognized as critical to progress in science generally (Cohen, 1990; Cumming, 2012; Schmidt, 2009) and in clinical science particularly (Tackett et al., 2019). Demonstrations of close and systematic replication of the effect of a class of treatments across diverse clients and situations provide compelling scientific evidence that there is a reliable phenomenon at work (Haig, 2014), and this is provided here. Furthermore, our conclusion regarding the benefits of micronutrients in reducing stress within disaster environments is strengthened by the placebo-controlled research showing superiority of micronutrients (specifically B vitamins) over placebo in also reducing stress (Young et al., 2019) as well as improving other psychological problems such as autism, aggression, and Attention-Deficit/Hyperactivity Disorder (ADHD; Adams et al., 2011; Gesch et al., 2002; Rucklidge et al., 2018; Rucklidge, Frampton, et al., 2014).

One reason why nutritional supplementation is acceptable to communities affected by disasters is because the message to clients can be simple and couched in terms of the triage theory (McCann & Ames, 2009). Clients resonated with the narrative explaining that the body has limited resources and when survival is threatened, resources become diverted to the flight/flight response, leaving the body nutritionally underresourced for other functions to continue unaffected. This narrative is nonthreatening and presents the struggle with anxiety and stress as a normal physiological reaction to a horrific event. It also identifies an important but neglected component – nutrition – for building personal resilience in a time of great stress. These lessons could now be extended to current stressors associated with the worldwide COVID-19 pandemic, an event that has already been identified as causing mental health challenges (Galea et al., 2020).

From the perspective of a health system dealing with the aftermath of a disaster, the use of a simple intervention that does not require a large specialized workforce to implement, is easy to extend in space and time as required, and has immediate benefits for most consumers and few side effects holds enormous value. There is also a potential long-term cost saving, especially if early provision of micronutrients can permanently divert at-risk individuals from trajectories of distress that lead to PTSD or other major mental health disorders. The current (2020) cost of a month supply of Optimal Balance at the recommended dose is US $45, which could almost certainly be reduced by government procurement. We are not aware of any other treatment that can be supplied simply, can provide relief quickly, has few side effects, and has demonstrated replicability across countries and traumas. Psychologists involved in postdisaster assistance (Williams et al., 2007) need to be aware of the potential use of broad-spectrum nutritional supplements, not only as first-line treatments in their own right, but also as potentially beneficial adjunct treatments for psychotherapy.

The data reported here also show that, for all the disasters documented, there were individuals who did not respond to the micronutrients. Taking nutritional supplements alongside medications has its own unique challenges (Popper et al., 2017), and the challenge of meeting the treatment needs of the individuals who did not respond must not be overlooked. This requires urgent research. It would also be useful to identify the mechanism by which the nutrients exert their effects, within the framework of triage theory or otherwise. Other research has identified that the nutrients increase diversity of the microbiome (Stevens et al., 2019) as well as show small epigenetic effects in terms of increased methylation (Stevens et al., 2018); however, biomarkers could usefully be collected before and after exposure to the nutrients/placebo under stressful situations to better understand the impact that the nutrients may have on cortisol response.

Based on the Chambless and Hollon (1998) criteria for a well-established treatment of at least two good between-group design experiments demonstrating efficacy, either superiority to placebo or equivalence to an already established treatment, there is now sufficient, cumulative evidence that internationally health systems could provide micronutrients as a treatment option for stress after traumatic community events. We urge health system leaders to accept scientific evidence of the kind reported here and implement the findings constructively. This would ensure that the next time any community is affected by a natural or other disaster (as is inevitable), those who suffer in the aftermath are provided with evidence-based best practice to reduce psychological injuries. This will benefit everybody – those directly affected, the wider

community, health personnel and other services, and the taxpayers and governments who must fund services in the aftermath of a disaster.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1027/2157-3891/a000003

ESM 1. The file contains detail of the clinical service work.

References

Adams, J. B., Audhya, T., McDonough-Means, S., Rubin, R. A., Quig, D., Geis, E., Gehn, E., Loresto, M., Mitchell, J., Atwood, S., Barnhouse, S., & Lee, W. (2011). Effect of a vitamin/mineral supplement on children and adults with autism. *BMC Pediatrics*, *11*(1), 111. https://doi.org/10.1186/1471-2431-11-111

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Ames, B. N. (2010). Optimal micronutrients delay mitochondrial decay and age-associated diseases. *Mechanisms of Ageing and Development*, *131*(7–8), 473–479. https://doi.org/10.1016/j.mad.2010.04.005

Armborst, D., Metzner, C., Alteheld, B., Bitterlich, N., Rosler, D., & Siener, R. (2018). Impact of a specific amino acid composition with micronutrients on well-being in subjects with chronic psychological stress and exhaustion conditions: A pilot study. *Nutrients*, *10*(5), 551. https://doi.org/10.3390/nu10050551

Asghari, A., Saed, F., & Dibajnia, P. (2008). Psychometric properties of the Depression Anxiety Stress Scales-21 (DASS-21) in a non-clinical Iranian sample. *International Journal of Psychology (IPA)*, *2*(2), 82–102.

Asukai, N., Kato, H., Kawamura, N., Kim, Y., Yamamoto, K., Kishimoto, J., Miyake, Y., & Nishizono-Maher, A. (2002). Reliabiligy and validity of the Japanese-language version of the Impact of Event Scale-Revised (IES-R-J): Four studies of different traumatic Events. *The Journal of Nervous and Mental Disease*, *190*(3), 175–182. https://doi.org/10.1097/00005053-200203000-00006

Baldwin, D. V. (2013). Primitive mechanisms of trauma response: An evolutionary perspective on trauma-related disorders. *Neuroscience & Biobehavioral Reviews*, *37*(8), 1549–1566. https://doi.org/10.1016/j.neubiorev.2013.06.004

Barlow, D. H., Hayes, S. C., & Nelson, R. O. (1984). *The scientist practitioner: Research and accountability in clinical and educational settings*. Pergamon.

Blampied, N. M. (2017). Analyzing therapeutic change using modified Brinley plots: History, construction, and interpretation. *Behavior Therapy*, *48*(1), 115–127. https://doi.org/10.1016/j.beth.2016.09.002

Blampied, M., Bell, C., Gilbert, C., & Rucklidge, J. J. (2020). Broad spectrum micronutrient formulas for the treatment of symptoms of Depression, Stress, and/or Anxiety: A systematic review. *Expert Review of Neurotherapeutics*, *20*(4), 351–371. https://doi.org/10.1080/14737175.2020.1740595

Blampied, N. M., Mulder, R. T., Afzali, M. U., Bhattacharya, O., Blampied, M. F., & Rucklidge, J. J. (2020). Disasters, policies and micronutrients: The intersect among ethics, evidence and effective action. *New Zealand Medical Journal*, *133*(1508), 8–11.

Bonanno, G. A., Brewin, C. R., Kaniasty, K., & Greca, A. M. L. (2010). Weighing the costs of Disaster. *Psychological Science in the Public Interest*, *11*(1), 1–49. https://doi.org/10.1177/1529100610387086

Bonanno, G. A., Westphal, M., & Mancini, A. D. (2011). Resilience to loss and potential trauma. *Annual Review of Clinical Psychology*, *7*(1), 511–535. https://doi.org/10.1146/annurev-clinpsy-032210-104526

Byrne, B. M. (2016). Adaptation of assessment scales in cross-national research: Issues, guidelines, and caveats. *International Perspectives in Psychology: Research, Practice, Consultation*, *5*(1), 51–65. https://doi.org/10.1037/ipp0000042

Camfield, D., Wetherell, M., Scholey, A., Cox, K., Fogg, E., White, D., Sarris, J., Kras, M., Stough, C., Sali, A., & Pipingas, A. (2013). The effects of multivitamin supplementation on diurnal cortisol secretion and perceived stress. *Nutrients*, *5*(11), 4429–4450. https://doi.org/10.3390/nu5114429

Chambless, D. L., & Hollon, S. D. (1998). Defining empirically supported therapies. *Journal of Consulting and Clinical Psychology*, *66*(1), 7–18. https://doi.org/10.1037/0022-006x.66.1.7

Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature Reviews Endocrinolgy*, *5*(7), 374–381. https://doi.org/10.1038/nrendo.2009.106

Cohen, J. (1990). Things I have learned (so far). *American Psychologist*, *45*(12), 1304–1312. https://doi.org/10.1037/0003-066x.45.12.1304

Craske, M. G., Vansteenwegen, D., & Hermans, D. (2006). Introduction: Etiological factors of fears and phobias. In M. G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning: From basic processes to clinical implications* (pp. 3–13). American Psychological Association.

Creamer, M., Bell, R., & Failla, S. (2003). Psychometric properties of the Impact of Event scale – Revised. *Behaviour Research and Therapy*, *41*(12), 1489–1496. https://doi.org/10.1016/j.brat.2003.07.010

Cumming, G. (2012). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. Routledge.

Deely, J., & Ardagh, M. (2018). *Rising from the rubble*. Canterbury University Press.

Dickstein, B. D., Suvak, M., Litz, B. T., & Adler, A. B. (2010). Heterogeneity in the course of posttraumatic stress disorder: Trajectories of symptomatology. *Journal of Traumatic Stress*, *23*(3), 331–339. https://doi.org/10.1002/jts.20523

Dougall, A. L., Craig, K. J., & Baum, A. (1999). Assessment of characteristics of intrusive thoughts and their impact on distress among victims of traumatic events. *Psychosomatic Medicine*, *61*(1), 38–48. https://doi.org/10.1097/00006842-199901000-00008

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, *2*(2), 156–168. https://doi.org/10.1177/2515245919847202

Galea, S., Nandi, A., & Vlahov, D. (2005). The epidemiology of post-traumatic stress disorder after disasters. *Epidemiologic Reviews*, *27*(1), 78–91. https://doi.org/10.1093/epirev/mxi003

Galea, S., Merchant, R. M., & Lurie, N. (2020). The mental health consequences of COVID-19 and physical distancing: The need for prevention and early intervention. *JAMA Internal Medicine*, *180*(6), 817–818. https://doi.org/10.1001/jamainternmed.2020.1562

Gesch, C. B., Hammond, S. M., Hampson, S. E., Eves, A., & Crowder, M. J. (2002). Influence of supplementary vitamins, minerals and essential fatty acids on the antisocial behaviour of young adult prisoners. *British Journal of Psychiatry*, *181*(1), 22–28. https://doi.org/10.1192/bjp.181.1.22

Haig, B. (2014). *Investigating the psychological world: Scientific method in the behavioural sciences*. MIT Press.

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, *44*(Pt 2), 227–239. https://doi.org/10.1348/014466505X29657

Ironson, G., Wynings, C., Schneiderman, N., Baum, A., Rodriguez, M., Greenwood, D., Benight, C., Antoni, M., LaPerriere, A., Huang, H.-S., Klimas, N., & Fletcher, M. A. (1997). Posttraumatic stress symptoms, intrusive thoughts, loss, and immune function after Hurricane Andrew. *Psychosomatic Medicine*, *59*(2), 128–141. https://doi.org/10.1097/00006842-199703000-00003

Jacobson, N. S., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology*, *59*(1), 12–19. https://doi.org/10.1037//0022-006x.59.1.12

Kaplan, B. J., Rucklidge, J. J., Romijn, A. R., & Dolph, M. (2015). A randomised trial of nutrient supplements to minimise psychological stress after a natural disaster. *Psychiatry Research*, *228*(3), 373–379. https://doi.org/10.1016/j.psychres.2015.05.080

Kaplan, B. J., Rucklidge, J. J., Romijn, A., & McLeod, K. (2015). The emerging field of nutritional mental health. *Clinical Psychological Science*, *3*(6), 964–980. https://doi.org/10.1177/2167702614555413

Kennedy, D. (2016). B vitamins and the brain: Mechanisms, dose and efficacy – A Review. *Nutrients*, *8*(2), 68. https://doi.org/10.3390/nu8020068

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H.-U. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research*, *21*(3), 169–184. https://doi.org/10.1002/mpr.1359

King, D. W., Orazem, R. J., Lauterbach, D., King, L. A., Hebenstreit, C. L., & Shalev, A. Y. (2009). Factor structure of posttraumatic stress disorder as measured by the Impact of Event Scale – Revised: Stability across cultures and time. *Psychological Trauma: Theory, Research, Practice, and Policy*, *1*(3), 173–187. https://doi.org/10.1037/a0016990

Kuijer, R. G., & Boyce, J. A. (2012). Emotional eating and its effect on eating behaviour after a natural disaster. *Appetite*, *58*(3), 936–939. https://doi.org/10.1016/j.appet.2012.02.046

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, *4*, Article 863. https://doi.org/10.3389/fpsyg.2013.00863

Long, S.-J., & Benton, D. (2013). Effects of vitamin and mineral supplementation on stress, mild psychiatric symptoms, and mood in nonclinical samples. *Psychosomatic Medicine*, *75*(2), 144–153. https://doi.org/10.1097/PSY.0b013e31827d5fbd

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the depression anxiety stress scales* (2nd ed.). Psychology Foundation.

McCann, J. C., & Ames, B. N. (2009). Vitamin K, an example of triage theory: Is micronutrient inadequacy linked to diseases of aging? *American Journal of Clinical Nutrition*, *90*(4), 889–907. https://doi.org/10.3945/ajcn.2009.27930

O'Connor, F., Johnston, D., & Evans, I. (2011). The context in which we examine disasters in New Zealand: An editorial. *New Zealand Journal of Psychology*, *40*(4), 2–8.

Orcutt, H. K., Bonanno, G. A., Hannan, S. M., & Miron, L. R. (2014). Prospective trajectories of posttraumatic stress in college women following a campus mass shooting. *Journal of Traumatic Stress*, *27*(3), 249–256. https://doi.org/10.1002/jts.21914

Othman, A. Z., Dahlan, A., Borhani, S. N., & Rusdi, H. (2016). Posttraumatic stress disorder and quality of life among flood disaster victims. *Procedia – Social and Behavioral Sciences*, *234*, 125–134. https://doi.org/10.1016/j.sbspro.2016.10.227

Popper, C. W., Kaplan, B. J., & Rucklidge, J. J. (2017). Single and broad-spectrum micronutrient treatment in psychiatric practice. In P. L. Gerbarg, P. R. Muskin, & R. P. Brown (Eds.), *Complementary and integrative treatments in psychiatric practice* (pp. 75–101). American Psychiatric Association.

Rego, S. A., Muller, K. L., & Sanderson, W. C. (2009). Psychopathological mechanisms across anxiety disorders. In K. Salzinger & M. R. Serper (Eds.), *Behavioral mechanisms and psychopathology*. American Psychological Association.

Reich, J. W. (2008). Integrating science and practice: Adopting the Pasteurian model. *Review of General Psychology*, *12*(4), 365–377. https://doi.org/10.1037/1089-2680.12.4.365

Rucklidge, J. J., & Blampied, N. (2011). Post earthquake functioning in adults with attention-deficit/hyperactivity disorder: Positive effects of micronutrients on resilience. *New Zealand Journal of Psychology*, *40*(4), 51–57.

Rucklidge, J. J., Andridge, R., Gorman, B., Blampied, N., Gordon, H., & Boggis, A. (2012). Shaken but unstirred? Effects of micronutrients on stress and trauma after an earthquake: RCT evidence comparing formulas and doses. *Human Psychopharmacology: Clinical and Experimental*, *27*(5), 440–454. https://doi.org/10.1002/hup.2246

Rucklidge, J. J., Blampied, N., Gorman, B., Gordon, H. A., & Sole, E. (2014). Psychological functioning 1 year after a brief intervention using micronutrients to treat stress and anxiety related to the 2011 Christchurch earthquakes: A naturalistic follow-up. *Human Psychopharmacology: Clinical and Experimental*, *29*(3), 230–243. https://doi.org/10.1002/hup.2392

Rucklidge, J. J., Frampton, C. M., Gorman, B., & Boggis, A. (2014). Vitamin–mineral treatment of attention-deficit hyperactivity disorder in adults: Double-blind randomised placebo-controlled trial. *British Journal of Psychiatry*, *204*(4), 306–315. https://doi.org/10.1192/bjp.bp.113.132126

Rucklidge, J. J., Eggleston, M. J. F., Johnstone, J. M., Darling, K., & Frampton, C. M. (2018). Vitamin–mineral treatment improves aggression and emotional regulation in children with ADHD: A fully blinded, randomized, placebo-controlled trial. *Journal of Child Psychology and Psychiatry*, *59*(3), 232–246. https://doi.org/10.1111/jcpp.12817

Sariçam, H. (2018). The psychometric properties of Turkish version of Depression Anxiety Stress Scale-21 (DASS-21) in health control and clinical samples. *Journal of Cognitive Behavioral Psychotherapy and Research*, *7*(1), 19–30. https://doi.org/10.5455/JCBPR.274847

Schlebusch, L., Bosch, B. A., Polglase, G., Kleinschmidt, I., Pillay, B. J., & Cassimjee, M. H. (2000). A double-blind, placebo-controlled, double-centre study of the effects of an oral multivitamin-mineral combination on stress. *South African Medical Journal*, *90*(12), 1216–1223.

Schmidt, S. (2009). Shall we really do it again? The powerful concept of replication is neglected in the social sciences. *Review of General Psychology*, *13*(2), 90–100. https://doi.org/10.1037/a0015108

Sherin, J. E., & Nemeroff, C. B. (2011). Post-traumatic stress disorder: The neurobiological impact of psychological trauma. *Dialogues in Clinical Neuroscience*, *13*(3), 263–278. https://doi.org/10.31887/DCNS.2011.13.2/jsherin

Smith, P., Perrin, S., Dyregrov, A., & Yule, W. (2003). Principal components analysis of the impact of event scale with children in war. *Personality and Individual Differences*, *34*(2), 315–322. https://doi.org/10.1016/S0191-8869(02)00047-8

Sole, E. J., Rucklidge, J. J., & Blampied, N. M. (2017). Anxiety and stress in children following an earthquake: Clinically beneficial effects of treatment with micronutrients. *Journal of Child and Family Studies*, *26*(5), 1422–1431. https://doi.org/10.1007/s10826-016-0607-2

Spearing, M. K., Post, R. M., Leverich, G. S., Brandt, D., & Nolen, W. (1997). Modification of the Clinical Global Impressions (CGI) scale for use in bipolar illness (BP): The CGI-BP. *Psychiatry Research*, *73*(3), 159–171. https://doi.org/10.1016/s0165-1781(97)00123-6

Stevens, A. J., Rucklidge, J. J., Darling, K. A., Eggleston, M. J., Pearson, J. F., & Kennedy, M. A. (2018). Methylomic changes in response to micronutrient supplementation andMTHFRgenotype. *Epigenomics*, *10*(9), 1201–1214. https://doi.org/10.2217/epi-2018-0029

Stevens, A. J., Purcell, R. V., Darling, K. A., Eggleston, M. J. F., Kennedy, M. A., & Rucklidge, J. J. (2019). Human gut microbiome changes during a 10 week randomised control trial for micronutrient supplementation in children with attention deficit hyperactivity disorder. *Scientific Reports*, *9*(1), 10128. https://doi.org/10.1038/s41598-019-46146-3

Stough, C., Scholey, A., Lloyd, J., Spong, J., Myers, S., & Downey, L. A. (2011). The effect of 90 day administration of a high dose vitamin B-complex on work stress. *Human Psychopharmacology*, *26*(7), 470–476. https://doi.org/10.1002/hup.1229

Tackett, J. L., Brandes, C. M., King, K. M., & Markon, K. E. (2019). Psychology's replication crisis and clinical psychological science. *Annual Review of Clinical Psychology*, *15*(1), 579–604. https://doi.org/10.1146/annurev-clinpsy-050718-095710

Wang, L., Zhang, J., Zhou, M., Shi, Z., & Liu, P. (2010). Symptoms of posttraumatic stress disorder among health care workers in earthquake-affected areas in southwest China. *Psychological Reports*, *106*(2), 555–561. https://doi.org/10.2466/PR0.106.2.555-561

Weiss, D. S. (2007). The impact of event scale: Revised. In J. P. Wilson & C. S. K. Tang (Eds.), *International and cultural psychology. Cross-cultural assessment of psychological trauma and PTSD* (pp. 219–238). Springer.

Weiss, D. S., & Marmar, C. R. (1997). The impact of event scale-revised. In J. P. Wilson & T. M. Keane (Eds.), *Assessing psychological trauma and PTSD: A practitioner's handbook* (pp. 399–411). Guilford Press.

White, D., Cox, K., Peters, R., Pipingas, A., & Scholey, A. (2015). Effects of four-week supplementation with a multi-vitamin/mineral preparation on mood and blood biomarkers in young adults: A randomised, double-blind, placebo-controlled trial. *Nutrients*, *7*(11), 5451. https://doi.org/10.3390/nu7115451

Williams, T. H., Carr, S. C., & Blampied, N. M. (2007). Psychological intervention in major emergencies: An Asia-Pacific perspective. *New Zealand Journal of Psychology*, *36*(3), 126–135.

Woolf, S. H. (2008). The meaning of translational research and why it matters. *JAMA*, *299*(2), 211–213. https://doi.org/10.1001/jama.2007.26

Young, L. M., Pipingas, A., White, D. J., Gauci, S., & Scholey, A. (2019). A systematic Review and meta-analysis of B vitamin supplementation on depressive symptoms, anxiety, and stress: Effects on healthy and "at-risk" individuals. *Nutrients*, *11*(9), 2232. https://doi.org/10.3390/nu11092232

Zanon, C., Brenner, R. E., Baptista, M. N., Vogel, D. L., Rubin, M., Al-Darmaki, F. R., Gonçalves, M., Heath, P. J., Liao, H. Y., Mackenzie, C. S., Topkaya, N., Wade, N. G., & Zlati, A. (2020). Examining the dimensionality, reliability, and invariance of the Depression, Anxiety, and Stress Scale-21 (DASS-21) across eight countries. *Assessment*, 1073191119887449. https://doi.org/10.1177/1073191119887449

History
Received August 17, 2020
Revision received December 21, 2020
Accepted December 26, 2020
Published online February 17, 2021

Acknowledgments
We thank the Christchurch Foundation, the University of Canterbury Foundation, and individual donors for providing the funds to purchase the micronutrients.

Conflict of Interest
We have no conflicts of interest to declare.

Authorship
Julia Rucklidge: Director of the Mental Health & Nutrition Laboratory, University of Canterbury, led the postearthquake research, organized the supply of micronutrients following the mosque shootings, and coordinated the clinical service. Usman Afzali: A PhD student in psychology who acted as senior liaison with the mosque community in the provision of the micronutrients. We have included his story of participation as Electronic Supplementary Material (ESM 1). Bonnie Kaplan: Led the postflood research at the University of Calgary following the flooding in Alberta. Oindrila Bhattacharya: A doctoral student who assisted Usman Afzali in liaison with the mosque community. Meredith Blampied: A clinical psychologist and PhD student in the Mental Health & Nutrition Laboratory who assisted with clinical supervision of the treatment service to the mosque community. Roger Mulder: A psychiatrist who provided medical guidance and supervision for the clinical service. Neville Blampied: A member of the Mental Health & Nutrition Laboratory team who was involved with the postearthquake research and who did the data analyses and reanalyses reported and wrote the initial draft of the paper.

Author Note
The earthquake and flood data have been previously published in a different form in Kaplan, Rucklidge, Romijn, and Dolph (2015) and Rucklidge et al. (2012). The mosque shooting data have been presented at three conferences as part of keynote presentations: (1) Rucklidge, J. J. (2019, June 6). *Challenges of translation of research to practice: Case example of community trauma* [Conference session]. Lifestyle Medicine, Auckland, New Zealand; (2) Rucklidge, J. J. (2019, October 22). *Innovation to disruption: The next steps in reducing the burden of mental illness* [Conference session]. International Society of Research in Nutritional Psychiatry, London, UK; (3) Rucklidge, J. J. (2020, March 8). *Latest research on nutrition for mental health* [Conference session]. Australasian Integrative Medicine Association, Auckland, New Zealand.

ORCID
Julia J. Rucklidge
http://orcid.org/0000-0003-3793-7342
M. Usman Afzali
http://orcid.org/0000-0001-5119-9388
Bonnie J. Kaplan
http://orcid.org/0000-0003-1911-0472
Oindrila Bhattacharya
http://orcid.org/0000-0003-4421-4759
F. Meredith Blampied
http://orcid.org/0000-0002-8869-1971
Roger T. Mulder
http://orcid.org/0000-0002-8147-5838
Neville M. Blampied
http://orcid.org/0000-0002-0158-4904

Julia J. Rucklidge
School of Psychology, Speech and Hearing
University of Canterbury
Private Bag 4800
Christchurch
New Zealand
julia.rucklidge@canterbury.ac.nz

