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Micronutrients reduce stress and anxiety in adults with Attention-Deficit/Hyperactivity Disorder following a 7.1 earthquake

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ABSTRACT

The role of good nutrition for resilience in the face of stress is a topic of interest, but difficult to study. A 7.1 earthquake took place in the midst of research on a micronutrient treatment for Attention-Deficit/Hyperactivity Disorder (ADHD), providing a unique opportunity to examine whether individuals with ADHD taking micronutrients demonstrated more emotional resilience post-earthquake than individuals with ADHD not taking micronutrients. Thirty-three adults with ADHD were assessed twice following the earthquake using a measure of depression, anxiety and stress also completed at some point pre-earthquake (baseline). Seventeen were not taking micronutrients at the time of the earthquake (control group), 16 were (micronutrient group). While there were no between-group differences one week post-quake (Time 1), at two weeks post-quake (Time 2), the micronutrient group reported significantly less anxiety and stress than the controls (effect size 0.69). These between group differences could not be explained by other variables, such as pre-earthquake measures of emotions, demographics, psychiatric status, and personal loss or damage following the earthquake. The results suggest that micronutrients may increase resilience to ongoing stress and anxiety associated with a highly stressful event in individuals with ADHD and are consistent with controlled studies showing benefit of micronutrients for mental health.

1. Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD), characterized by problems with inattention, hyperactivity, and impulsivity, is estimated to occur in 4–5% of adults (Kessler et al., 2006). Research consistently shows that based on both self-report and physiological responses to artificially created stressors, adults with ADHD report higher levels of stress, anxiety and mood problems than adults without ADHD (Hirvikoski et al., 2009; Lackschewitz et al., 2008).

Numerous articles from around the globe report on the psychological distress symptoms, including heightened anxiety, fear and depression, in those who survive a destructive earthquake (Suhail et al., 2009; Wang et al., 2010). A range of factors impact the amount of psychological distress experienced by survivors including severity of injury to self and important others, level of destruction of one's home and place of business and general loss of resources (Kuwabara et al., 2008; Sattler et al., 2006). Most relevant to this study, researchers in Turkey examining nutritional status and stress symptoms in earthquake survivors found that those who were identified by the researchers as having a 'bad appetite' in the 15–18 months following a 7.6 earthquake also reported poorer psychological recovery (Yesilyaprak et al., 2007). However, no one has previously had the opportunity of examining whether micronutrient supplementation could play a role in people's emotional resilience following the distress of a natural disaster.

On Saturday, September 4, 2010, at 4:35 am, an earthquake with a magnitude of 7.1, struck Christchurch, New Zealand, population 340,000. Property damage and on-going disruption to services such as water, power, and sewage, was extensive. If the initial earthquake was not distressing enough, Christchurch experienced 935 aftershocks, of which 10 were a magnitude 5 or greater and 105 were a magnitude of 4 or greater (source: www.geonet.co.nz; see Fig. 1) in the two weeks period when data were collected. These quakes caused on-going disturbance of sleep and heightened arousal, as well as property damage (source: http://earthquake.usgs.gov).

No studies have investigated the impact of treatment on post-earthquake emotional recovery in a sample of adults with ADHD. Recently, the use of micronutrients, defined as vitamins, minerals and amino acids, has been revisited for the treatment of ADHD symptoms. Researchers have also reported on the impact of the nutrients on other areas of functioning such as depression, anxiety and stress. Most studies examining micronutrients in the treatment of ADHD have been published within the last decade and have been more positive than earlier studies (Arnold et al., 1978), perhaps because different doses have been evaluated as well as different combinations of micronutrients (Rucklidge et al., 2009). One micronutrient formula,

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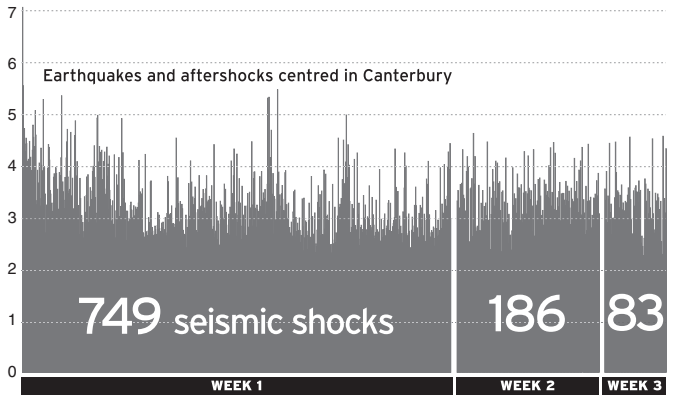

Fig. 1. Earthquakes and aftershocks endured by participants during the duration of the study (printed with permission from The Press — Fairfax New Zealand).

known as EMPowerplus (EMP+), which consists of 36 ingredients (14 vitamins including all the B vitamins, vitamins A, C, D, E and H, 16 minerals (calcium, iron, phosphorus, iodine, magnesium, zinc, selenium, copper, manganese, chromium, molybdenum, potassium, boron, vanadium, nickel, and germanium), 3 amino acids and 3 antioxidants — list of ingredients and doses can be found at www.truehope.com), has been shown to be beneficial for ADHD symptoms across open label case series, database analyses and case studies (Kaplan et al., 2004; Rucklidge et al., 2010, 2011; Rucklidge and Harrison, 2010). Symptoms noted to improve include ADHD symptoms, mood, anxiety and stress (Rucklidge et al., 2011).

There is a longer history of studies, including controlled trials, investigating the impact of micronutrients on a variety of emotional disturbances albeit different studies use different combinations and doses of micronutrients so cross comparison is problematic. Nevertheless, studies consistently show good effects. For example, Schlebusch et al. (2000) found that adults given a broad micronutrient formulation showed improved stress during a 30-day clinical trial, compared with participants receiving a placebo. Carroll et al. (2000) showed similar changes in that their sample of 80 healthy men who consumed a complex nutrient formula reported significant decreases in anxiety and perceived stress as compared to a placebo control group. Studies of geriatric populations have also shown that mood can be improved with micronutrient interventions (Gariballa and Forster, 2007; Gosney et al., 2008).

The 7.1 earthquake occurred in the context of ongoing trials of New Zealand adults with ADHD taking a micronutrient supplement (EMP+). The earthquake provided an opportune moment to use a real-life stressor to compare the self-reported depression, anxiety and stress responses of adults with ADHD who were and were not taking the micronutrient supplement at the time of the earthquake. We expected that those consuming micronutrients (micronutrient group) would have lower scores on measures of emotional responses post-earthquake compared with a sample of adults with ADHD not taking micronutrients at the time of the earthquake (control group) and that this group difference would increase over time. We hypothesized that differences would not be explained by other variables such as pre-earthquake measures of psychological functioning, psychiatric status, gender, ethnicity, age, pre-earthquake responses to micronutrients, and time between the earthquake and when the pre-earthquake measures were taken. We also expected that compared to baseline, post-earthquake scores of depression, anxiety and stress would be significantly lower for the micronutrient group but not for the control group.

2. Methods

2.1. Participants

Participants were recruited from ongoing and completed studies investigating the role of micronutrients on ADHD symptoms in adults aged 16 and over. Three studies were pooled: 1) 14 adults with ADHD who had participated in an 8 week open-label trial in 2008 (Rucklidge et al., 2011); 2) an ongoing case series of 3 young adults with ADHD being studied in an ABAB design in which participants are on the micronutrients (8 weeks), off (8 weeks), and back on for six months; and 3) an ongoing double-blind, randomized controlled trial (RCT) comparing placebo with micronutrients in adults with ADHD. In the RCT, participants are in the randomized phase for 8 weeks, then enter an open-label phase for 8 weeks and are then followed over time post trial, regardless of whether they continue to take the micronutrients. Only participants currently enrolled in the open-label trial or those who had completed the study were contacted ($n=32$). All those enrolled in the RCT phase ($n=8$) had started the trial within two weeks of the earthquake (see inclusion criteria) and therefore were not included.

2.1.1. Inclusion criteria for the micronutrient group

To maximize numbers, the participants had to have been consuming micronutrients for at least two weeks prior to the earthquake. Given this is a relatively short period of time for the micronutrients to affect psychological functioning, this inclusion criterion is conservative in that it would decrease the chances of finding an effect of micronutrients. Participants also needed to be compliant with taking, at a minimum, 50% of the optimal dose. Participants had to be free of psychotropic medications for the trial; however, one participant taking micronutrients who had completed the trial 3 months prior to the quake had started a very low dose of venlafaxine (37.5 mg) the week prior to the earthquake. As the analyses were not affected by whether she was included or excluded, we included her given that the dose was deemed very low.

2.1.2. Inclusion criteria for the control group

Participants had to be free of psychotropic medications and other supplements, and have been off EMP+ for at least two weeks prior to the earthquake or not have started EMP+. Two people in the control group had only completed the baseline assessments when the earthquake occurred.

2.1.3. Inclusion criteria for both groups

All participants had to be present in Christchurch at the time of the earthquake. Other inclusion/exclusion criteria for general participation in the studies are described in detail in Rucklidge et al. (2011). See Fig. 2 for a description of inclusion/exclusion for the sample.

The final sample consisted of 33 participants (age range 16 to 70): 17 were not taking micronutrients (9 males, 8 females) — known as the control group — and 16 were taking micronutrients (11 males, 5 females) — known as the micronutrient group. There was no significant difference in the mean ages of the two groups, gender, and marital status (see Table 1). Based on estimated IQ (using the Vocabulary and Block Design subtests from the Wechsler Adult Intelligence Scales (WAIS-III); Wechsler, 1997) available for all but one control participant, there was no between-group difference in estimated IQ scores. There was also no between-group difference in socioeconomic status (using the NZSEI-96; Davis et al., 1997), with the mean for both groups falling in the low to middle income range. Ethnicity was similar across groups with the majority of participants being New Zealanders of European decent (82.3% of the control group and 81.5% of the micronutrient group).

Participants for these three studies were recruited through referrals from the public health service, private clinicians and self-referrals, as well as university research databases. Participants had to meet criteria for ADHD based on the Conners' Adult ADHD Diagnostic Interview for DSM-IV (CAADID; Epstein et al., 2002) and show clinical elevations on at least one of the DSM-IV subscales of the Conners' Adult ADHD Rating Scales (CAARS; Conners et al., 2003). The Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version (SCID-I; First et al., 2002) was also administered to assess Axis I disorders. Both groups were comparable in rates of co-occurring disorders and in rates of ADHD subtypes across the two groups, χ^2 ($N=33$) = 2.36, *ns* (see Table 1). There were no between-group differences in baseline mood disorder, anxiety disorder, alcohol abuse, or substance abuse. Three participants in the control group and two participants in the micronutrient group had a previous history of PTSD symptoms although none were experiencing these symptoms at the time of the assessment.

2.2. Measure

2.2.1. The Depression Anxiety and Stress Scale

The Depression Anxiety and Stress Scale (DASS; Lovibond and Lovibond, 1995b) is a 42-item questionnaire which assesses an individual's current severity of symptoms relating to depression, anxiety and stress. The DASS has good internal consistency within each subscale (Cronbach's $\alpha=0.84$–0.91) and shows good correlations (0.74–0.81) with other validated measures of anxiety and depression (Lovibond and Lovibond, 1995a). Exploratory and confirmatory factor analyses support the three factor structure (Brown et al., 1997).

The participants were asked to rate each item on the scale as it applied to them over the past week, ranging from *did not apply to me at all* (0) to *applied to me very much*, or *most of the time* (3). Examples of items include: "I couldn't seem to experience any positive feeling at all" (depression), "I had a feeling of faintness" (anxiety), and "I found myself getting upset by quite trivial things" (stress). Higher scores reflect greater impairment. Cutoffs have been provided to indicate mild, moderate or severe problems; anything below 13 (for depression), 10 (for anxiety) and 18 (for stress) is considered within the normal to mild range.

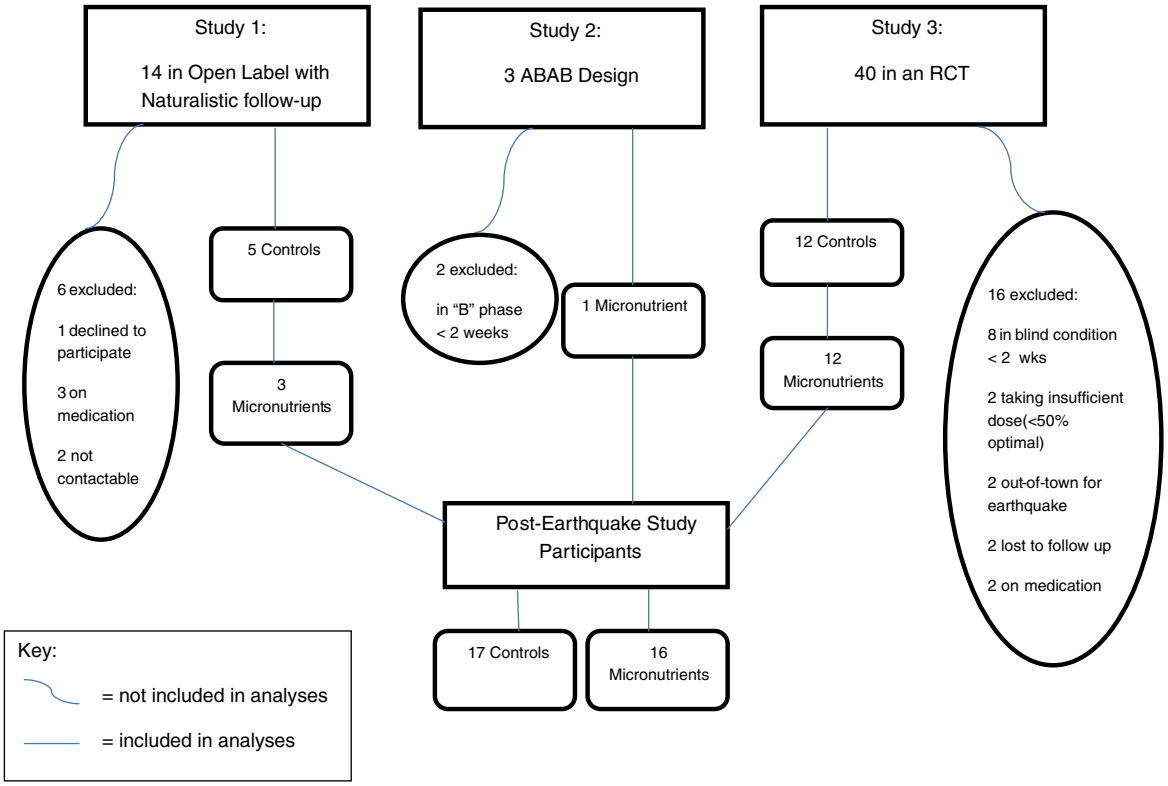

Fig. 2. The inclusion and exclusion of participants across the three studies.

2.3. Intervention

For those participants currently enrolled in the open-label phase of the RCT, capsules were dispensed every two weeks and adherence was monitored with a diary as well as pill counts. Most participants were taking the full dose of 15 capsules per day, preferably in 3 doses of 5 capsules, taken with food and plenty of water, although a few chose to take a lower dose (between 6 and 12), stating that they were "sensitive" to medications in that they experienced side effects even with small doses. Safety, adherence and adverse effects were assessed at each visit and all participants were monitored by the study psychiatrist. Safety data have been published on 14 participants and are detailed in Rucklidge et al. (2011). Based on pill counts and self-report, the mean dose of our participants was 12.88 pills (S.D. ± 3.08).

Table 1
Demographics, ADHD subtypes and co-occurring diagnoses for the control group and the micronutrient group.

	Control group ($N=17$)	Micronutrient group ($N=16$)	
	Mean (S.D.)	Mean (S.D.)	t
Age	38.71 (10.94)	37.94 (15.38)	0.17
Estimated IQ	117.69 (11.70)	116.19 (12.73)	0.35
Socio-economic status	29.47 (20.63)	37.56 (20.89)	1.02
	N (%)	N (%)	χ^2
Males	9 (52.9)	11 (68.8)	0.86
Married/common-law	8 (47.1)	9 (56.3)	0.28
ADHD type			
Inattentive	3 (17.6)	6 (37.5)	N/A
Hyperactive	1 (5.9)	0 (0)	N/A
Combined	13 (76.5)	10 (62.5)	N/A
Mood disorder	6 (35.3)	6 (37.5)	0.02
Anxiety disorder	10 (58.8)	7 (43.8)	0.75
Alcohol abuse	5 (29.4)	2 (12.5)	1.41
Substance abuse	2 (11.8)	3 (18.8)	0.31

Control group = those participants who were not consuming micronutrients two weeks prior to and through the assessment period post-earthquake, Micronutrient group = those participants consuming micronutrients at least two weeks prior to and through the assessment period post-earthquake, ADHD = Attention-Deficit/Hyperactivity Disorder.

2.4. Procedures

All participants were contacted by phone between 7 and 10 days post earthquake. First, informed consent was obtained. Participants were then asked whether they had suffered any damage to their home, had incurred any physical injuries or had someone close to them suffer extensive damages or personal injuries. We also assessed whether they were taking any medications or supplements, and their adherence with the micronutrients, if taking them. Then the DASS questions were asked, reflecting on the week post-earthquake (Time 1). Between 7 and 10 days after the first phone call, the participants were contacted again to re-administer the DASS. They were asked to consider the week since the previous phone call (Time 2). All participants had completed the DASS as part of baseline assessments for all three studies — the baseline varied depending on date of enrolment in the study and for both groups, ranged from about six weeks to 2.5 years pre-earthquake. At baseline, participants were not consuming medications or micronutrients. Data collection was complete within 18 days of the earthquake.

All three studies have received ethical approval from both the University Ethics Committee and the Health and Disability Ethics Committee and the trials have been registered. This amendment was approved by the University Ethics Committee.

2.5. Statistical approach

The data were analyzed using IBM SPSS Statistics 19. Two-tailed independent t-tests were used to compare groups and paired sample t-tests were used for within group comparisons; $p<0.05$ was used to assess for significance. Effect size were based on Cohen's d, a score of <0.20 was considered as no effect; 0.2–0.5 was considered a mild/small effect; 0.5–0.8 a moderate effect; 0.8–1.2 a large effect; and >1.2 was considered a very large effect.

3. Results

Based on interview responses, both groups suffered similar levels of injury and personal loss. No one sustained serious physical injuries or extensive damage to or loss of their homes. Typical experiences included minor bruises and cuts, fallen chimneys, broken windows and cracks in the walls of homes.

Independent sample t-tests (two-tailed) were used to examine specific between-group differences. There were no between-group differences on baseline reports of depression ($t(31)=-0.007$, *ns*,

Cohen's $d=0$), anxiety ($t(31)=-1.25$, *ns*, $d=-0.43$) and stress ($t(31)=-1.43$, *ns*, $d=-0.49$). The effect sizes suggest that the micronutrient group was slightly more stressed and anxious at baseline than the control group. There were also no between-group differences at Time 1 for depression ($t(31)=0.75$, *ns*, $d=0.26$), anxiety ($t(31)=1.16$, *ns*, $d=0.40$) and stress ($t(31)=1.17$, *ns*, $d=0.41$). However, there were group differences at Time 2 for anxiety ($t(31)=2.08$, $p<0.05$, $d=0.69$) and stress ($t(31)=2.08$, $p<0.05$, $d=0.69$) but not depression ($t(31)=1.63$, *ns*, $d=0.55$), with the micronutrient group reporting significant reductions in both anxiety and stress levels as compared to the control group at Time 2.

To investigate whether the micronutrient group recovered more quickly following the earthquake, a 2 (group) by 2 (Time 1 and Time 2) MANOVA was conducted. The MANOVA revealed a significant main effect of time for anxiety ($F(1, 62)=5.302$, $p<0.05$), and significant group effects for anxiety ($F(1, 62)=4.982$, $p<0.05$) and stress ($F(1, 62)=5.241$, $p<0.05$). However, the interaction was not significant.

Paired sample *t*-tests showed that within the control group, participants reported less depression at Time 1 as compared to baseline. The micronutrient group reported less stress and had lower overall DASS scores at Time 1 as compared to baseline. Further, the micronutrient, but not the control group, reported significantly less depression, anxiety and stress at Time 2 compared to baseline (see Table 2). To quantify the between-group differences, Table 2 also shows the percentage reduction in symptoms from baseline at Time 1 and Time 2. At Time 1, the control group reported a 24% increase in anxiety following the earthquake as compared to baseline. All other measures for both groups show a small reduction in reported symptoms in comparison to reported levels prior to entry into the trials. At Time 2, the micronutrient group showed a reduction from baseline in anxiety and stress that was about six times greater than the reduction observed in the control group; the reduction in depression in the micronutrient group was twice that observed in the control group.

3.1. Micronutrient response prior to the earthquake

We examined whether the micronutrient group was a biased sample in that many were participants who had chosen to stay on the pills following participation in the research and as such, they may represent those who responded more favorably to the micronutrients. To analyze for this possibility, we compared the DASS scores for participants from *both* groups who had completed at least 8 weeks in the open label phase on EMP+ (15 from the control group (2 controls had yet to start the trial) and 12 from the micronutrient group) *and* had completed a DASS (12 from each group showing that 3 of the controls had not completed the DASS). Table 3 shows that there were no between-group differences on any of the DASS subscales. However, based on the effect sizes, it appears that the control group derived less benefit than the micronutrient group in terms of improved mood, although for both groups, the means were within the normal range across all three subscales at the end of 8 weeks of taking micronutrients. Fig. 3a–c show the DASS subscale scores for these 24 participants for the four time periods (baseline pre-earthquake, post 8 weeks of taking EMP+ measured pre-earthquake, Time 1 post-quake, and Time 2 post-quake). These figures illustrate the likely progression of symptoms over time, showing that the baseline scores are probably not representative of the emotional states just prior to the earthquake. The means of this subsample of 24 participants for baseline, Time 1 and Time 2 are comparable to the full sample for their respective group.

Table 3
Pre-earthquake between group comparison of depression, anxiety and stress scores collected for those participants who had completed at least 8 weeks open label on micronutrients pre-earthquake.

	Sub sample of control group ($N=12$)	Sub sample of micronutrient group ($N=12$)	*t* test	Effect size[a]
	Mean (S.D.)	Mean (S.D.)		
Depression	9.33 (8.93)	4.83 (4.32)	1.57	0.62
Anxiety	2.92 (2.81)	3.17 (3.64)	−0.19	−0.07
Stress	10.58 (7.49)	9.42 (6.33)	0.41	0.17
DASS total	22.83 (16.80)	17.42 (12.30)	0.90	0.37

Sub sample of control group = those participants who were not consuming micronutrients two weeks prior to the earthquake and through the assessment period post-earthquake but had completed an 8 week open-label phase on micronutrients pre-earthquake, Sub sample of micronutrient group = those participants consuming micronutrients at least two weeks prior to and through the assessment period post-earthquake and who had also completed an 8 week open-label phase on micronutrients pre-earthquake, DASS = Depression Anxiety and Stress Scale.
[a] Effect size is based on Cohen's *d*, calculated as the difference in means between the two groups divided by the pooled standard deviation.

3.2. Time between baseline and earthquake

Given that participants enrolled in the studies on different dates, the time elapsed since baseline varied across participants. The mean time since baseline for the control group was 1.13 years (S.D. ± 0.78) and 0.83 years (S.D. ± 0.64) for the micronutrient group; these means were not significantly different ($t(31)=1.20$, *ns*).

Table 2
Depression, anxiety and stress across time and within groups.

	N	Baseline	Time 1	Time 2	Baseline–Time 1			Baseline–Time 2		
		Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Paired *t-test*	Effect size[a]	% ↓ from baseline	Paired *t-test*	Effect size[a]	% ↓ from baseline
Control group	17									
Depression		15.35 (8.92)	10.53 (9.90)	10.71 (11.20)	2.13*	0.51	−31.4%	1.89	0.45	−30.2%
Anxiety		7.76 (3.01)	9.65 (7.66)	6.76 (7.68)	−0.85	−0.21	24.4%	0.45	0.11	−12.9%
Stress		19.12 (7.71)	18.18 (9.53)	17.47 (10.96)	0.42	0.10	−5.9%	0.66	0.16	−8.6%
DASS total		43.41 (14.34)	38.35 (22.78)	34.94 (26.29)	0.83	0.20	−11.7%	1.27	0.31	−19.5%
Micronutrient group	16									
Depression		15.38 (9.00)	8.00 (9.46)	5.13 (8.17)	1.85	0.46	−48.0%	2.92*	0.73	−66.6%
Anxiety		10.81 (9.60)	6.88 (5.84)	2.56 (2.61)	2.10	0.52	−36.4%	3.39**	0.84	−76.3%
Stress		23.5 (9.81)	14.19 (10.03)	10.56 (7.76)	2.38*	0.59	−39.6%	4.01**	1.00	−55.1%
DASS total		49.81 (24.53)	29.06 (19.54)	18.25 (16.12)	2.50*	0.63	−41.7%	4.03**	1.01	−63.4%

*$p<0.05$, 2-tailed, **$p<0.01$, 2-tailed, Baseline: represents entry point into the study, a time before the earthquake and before consumption of micronutrients that varied across participants, Time 1: one week post-earthquake, Time 2: two weeks post earthquake, Control group = those participants who were not consuming micronutrients two weeks prior to and through the assessment period post-earthquake, Micronutrient group = those participants consuming micronutrients at least two weeks prior to and through the assessment period post-earthquake, DASS = Depression Anxiety and Stress Scale.
[a] Effect size is based on Cohen's *d*, calculated as the difference in mean symptom severity at Baseline and at Time 1 (Time 2), divided by the standard deviation of the differences across participants.

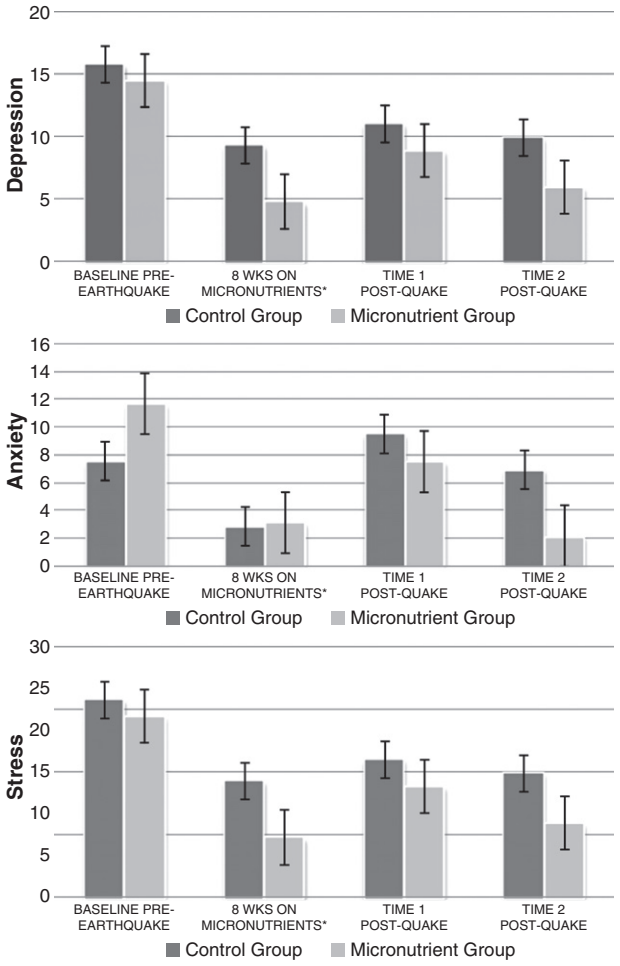

Fig. 3. Graphical depiction across time of symptom change (a. depression, b. anxiety, and c. stress) of a subgroup of participants from both groups (12 in each) who had also completed at least 8 weeks of an open label trial of micronutrients prior to the earthquake.

4. Discussion

This study investigated whether individuals with ADHD taking micronutrients showed more emotional resilience associated with a 7.1 earthquake than individuals with ADHD not taking the micronutrients. Some but not all of the hypotheses were supported and several key findings emerged. While there were no group differences in self reports of depression, anxiety and stress one week post-earthquake (Time 1), at two weeks post-quake (Time 2), those taking micronutrients reported feeling significantly less anxious and stressed than those not taking micronutrients, showing a medium to large effect size. These between-group differences could not be explained by other variables, such as baseline measures of emotions, gender, ethnicity, SES, IQ, age, ADHD type, co-occurring disorders, pre-earthquake responses to micronutrients, personal loss or damage following the earthquake or by time between baseline measures and the earthquake. In comparing within-group scores, at Time 1, the control group was significantly less depressed than at baseline and the micronutrient group was significantly less stressed than baseline. However, at Time 2, there were no significant changes from baseline for the control group, while significant changes were observed in all areas assessed (depression, anxiety and stress) for the micronutrient group (all large effect sizes).

Although comparisons with other studies on micronutrients are problematic given that different studies use different combination of nutrients as well as different doses, the pattern across studies is consistently showing that micronutrients can be associated with improvements in symptoms of mental illness including Bipolar Disorder, autism, ADHD, stress and anxiety (Carroll et al., 2000; Frazier et al., 2009; Gately and Kaplan, 2009; Mehl-Madrona et al., 2010; Rucklidge, 2009; Rucklidge et al., 2010). They are also consistent with other research showing that people with ADHD report high levels of stress generally (Lackschewitz et al., 2008).

Due to the unpredictability of the event, we did not have a measure of emotions just prior to the earthquake; recall that in many cases, baseline scores were months or more before the earthquake. The benefit of the baseline scores is that they provide a snapshot of how the participants were doing at a moment in time before the earthquake and before exposure to micronutrients. As such, they provide us with some confidence that the two groups were generally equivalent when starting in the research trials giving greater confidence that the between group differences observed post-earthquake were due to exposure to micronutrients throughout the distressing event. As the baseline measures do not reflect emotions just prior to the earthquake, they cannot be used to assess the emotional response to the earthquake. The subset of participants for whom we had DASS scores following at least 8 weeks of consumption of the micronutrients gets us closer to emotional changes over time (Fig. 3 and Table 3), particularly for the micronutrient group given that they continued to consume micronutrients post trial and through the earthquake assessment period. We speculate that those in the micronutrient group maintained their reported improvements up to the earthquake, then showed a worsening of their symptoms post earthquake, followed by a rapid recovery. While it is also possible that the effects of the micronutrients had worn off prior to the earthquake, in those individuals whom we have followed over time, we have observed continued improvement over time (e.g., Rucklidge et al., 2011).

Many researchers have speculated why micronutrients may be beneficial to mental health. Micronutrients serve as essential co-factors for manufacturing neurotransmitters required for optimal brain functioning and individuals with mental illness may have higher nutritional requirements than those without mental illness (Kaplan et al., 2007). This increased nutritional need in combination with evidence showing that horticultural practices, favoring high yield cultivars that cause genetic dilution, have resulted in depletions in essential nutrients (Davis, 2009; Mayer, 1997) could make some individuals more vulnerable to mental illness. Others have speculated that the B vitamins have similar structural properties to dopamine and as such, may play a role similar to methylphenidate at the presynaptic cleft (Shaw et al., 2010). Other studies suggest that the manufacture of adenosine triphosphate (ATP), the energy source of the mitochondria, is compromised in individuals with mental illness (Gardner and Boles, 2005). There is also growing evidence that in-born errors of metabolism reduce the binding affinity of enzymes, which in turn lowers the rate of metabolic reactions, explaining some physical illnesses, errors that can be corrected with nutrients (Ames et al., 2002). According to McCann and Ames (2009), the stress response and short-term survival have a high nutritional requirement and take precedence over other long-term biological needs in order to ensure survival of the organism. It is possible that during high stress, other normal biochemical reactions of the body become compromised. Adding micronutrients at a time of stress may then meet the biological needs of the whole organism.

A small sample size precluded us from investigating more thoroughly the relationships among changes in depression, anxiety and stress over time. We were also limited by the measures administered prior to the earthquake in order to control for pre-earthquake states. While this is also a strength of the study, as baseline measures were comparable for both groups, the fact that baseline scores were typically months or more before the earthquake, they are less useful for assessing change through the pre-earthquake to post-earthquake time period. Ideally, we would have had measures just prior to the earthquake.

As there were no open facilities post-earthquake to obtain physiological measures of stress, questionnaires were the only

method available to assess stress responses. To be comparable to laboratory studies (Lackschewitz et al., 2008), it would have been interesting to have complemented the self-report with measures of salivary cortisol to verify whether self-report was consistent with physiological changes. Our lack of a group of individuals without ADHD also means we cannot establish whether the emotional responses and subsequent recovery (for those taking micronutrients) were representative of the general population.

Although a placebo effect cannot be ruled out, there are some compelling reasons why this is unlikely to explain the group differences. Over half of those in the micronutrient group had been taking the formula for over 6 months, some as long as two years, thus making a placebo effect unlikely. In addition, the stressor was substantial and ongoing due to the extensive aftershocks and while there is no research that indicates that an earthquake can override the placebo effect, it is hard to contemplate how this mechanism might be a factor. Further, a number of those in the micronutrient group have shown on-off control of symptoms (e.g. (Rucklidge and Harrison, 2010), other case studies are in progress).

The sample consisted of individuals who met criteria for ADHD at baseline. They had not been selected for high anxiety or stress. As such, we cannot generalize their responses to other clinical populations. Some research suggests that people with ADHD respond differently to stress than individuals without ADHD (King et al., 1998). However, over half of our sample had a co-occurring mood or anxiety disorder at baseline and thus it is possible the benefit could extend to these populations as well. Indeed, benefit has been described in the literature using other combinations of micronutrients for stress and anxiety (Carroll et al., 2000; Schlebusch et al., 2000), and depression (Gariballa and Forster, 2007; Gosney et al., 2008). Further, it is also possible that our population of ADHD individuals represent a biased sample of the ADHD population, a group able to cope with the expectations of a research trial. The high estimated IQ (High Average) indicates that they may be a more educated sample of the ADHD population. Nevertheless, research suggests that there are no differences in quality of life, psychosocial functioning, psychiatric co-occurring diagnoses and executive functioning deficits between high IQ adults with ADHD and average IQ adults with ADHD (Antshel et al., 2009).

Finally, the micronutrient group consisted of over half ($N = 10$, 62.5%) who were self-selected in that they had chosen to continue to take the micronutrients, likely because they were deriving benefit from them. Our sub-analyses demonstrated that members of both groups benefitted from micronutrients with no between-group differences, providing some evidence that the micronutrient group was not a biased sample of responders. Likewise, the control group was also self-selected in that they largely represented people who had chosen not to continue taking the micronutrients following participation in the trial. Many cited financial reasons for discontinuation and difficulty consuming the large number of pills, even when benefit had been clearly documented.

This study provides preliminary evidence that micronutrients positively influence emotional responses to a highly stressful event. The data are compelling enough to warrant further studies investigating the role that micronutrients might play in reducing stress responses to distressing events, extended to individuals with or without mental illness.

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