Mental Health Effects of the 2011 Tohoku Disaster on Kita Ibaraki: Intervention Project Baseline Data on Morbidity and Provided/Received Social Support

（ソーシャルサポートの提供と受領が東日本大震災における被災者のメンタル・ヘルスに及ぼす効果：　北茨城における介入プロジェクトのベースラインデータをもとに）

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筑波大学大学院博士課程人間総合科学研究科

レ ボ ウ イ ッ ツ・アダム・ジョン

Table of Contents

Tables and Figures

Table 16 Effect size changes (in parenthesis) from ANCOVA controlling for relational satisfaction from received and provided social support

Introduction

Background

A priority of community psychology has been the study of environmental impact on community (Murrell & Norris, 1983) by looking at associations between resource loss and stress (Dohrenwend, 1978; Hobfoll, 1989), and between stress and morbidity (Lin & Ensel, 1989). Disaster events create these conditions and profoundly affect the mental health of a community. Investigating which conditions associate most significantly with morbidity can clarify individual and community impact of disasters. In addition, understanding behavior that mitigates impact is also important.

On 11 March, 2011 at 2:46 pm a magnitude 9.0 earthquake occurred 130 km from Sendai, Miyagi Prefecture off the Sanriku Coast in Northeastern Japan. Over 15,000 people died with over 2,000 missing due to tsunami waves caused by the offshore tremors (Fire and Disaster Management Agency, 2012; National Police Agency, 2013). Ports, buildings, and over 83,000 homes were destroyed (JMA, 2012). The Fukushima No.1 Electric Power Plant, a nuclear facility south of Sendai run by Tokyo Electric Company (TEPCO), was also heavily damaged. Airborne radiation forced the evacuation of residents within 30km-radius of the plant and many are still displaced.

After the accident the plant has been a constant source of radioactive water used to cool the damaged reactor. While TEPCO holds the water with the highest levels (10,000x above the legal limit) in tanks, it dumped 11,500 tons of water 100x the legal limit into the ocean in April, 2011 (Strickland, 2011). This has had serious consequences for communities along the coast down current from the nuclear facility who depend upon fishing as an economic resource. Therefore, other seaside communities who did not evacuate have also been affected by the disaster.

One of these communities is Kita-Ibaraki City (pop. 45,000, Figure 1) in Ibaraki Prefecture 90 km south of the Fukushima nuclear plant. The city sustained massive building damage (Figure 2) but limited casualties (an estimated five persons were killed). Ocean-borne radiation disrupted the fishing industry, an important economic resource. When fishing reopened in Hirakata and Otsu ports in Kita Ibaraki on 5 April, catches of *kounago* sand lance (Ammodytes personatus) were found to have elevated levels of cesium and iodine. Catches further south were below dangerous levels but an all-prefecture sales ban was instituted because the sand lance swims south. Other fish species throughout the prefecture tested within safe levels; however, public perception of the dangers of contamination caused wholesale prices to drop 65%-75% (Yomiuri Shinbun, 2011). In fiscal year 2010, Hirakata and Otsu had a combined catch of just over 7,000 metric tons worth 1.126 trillion yen; in 2011, the harvest was reduced to below 2,000 tons valued at 650 million yen (Kita Ibaraki City Government, 2012). As a result, the population is at risk for elevated psychological stress due to resource loss and the inconclusive nature of the disaster, since irradiated water from cooling the reactor continues to be stored and released into the ocean.

Figure 3 Area Map: A = Kita Ibaraki, B = Fukushima TEPCO Nuclear Plant, C = U of Tsukuba, D = Tokyo


Figure 4 Kita Ibaraki Seaside Damage from 3-11 Tsunami (Photo: Asahi Shinbun)

Nine to twelve months after the disaster, subjects (N=466, 351 female, mean age 60.4y, SD=14.0) presented higher levels of depression compared to the national average: 23% of the female participants and 17% of the male participants could be diagnosed with depression, compared with 3-7% of the general population (Ministry of Health, Welfare, and Labor, 2013). The scores also showed clinical concern for PTSD: 24.2%, versus 1.4% nationwide.

Literature Review

Hobfoll's Conservation of Resources (COR) theory (Hobfoll, 1989) has been used to analyze post-disaster stressors impacting MH sequelae. To conserve is to "retain, protect, and build" resources, and the "potential or actual loss" is "threatening" (Hobfoll, 1989:516). Longitudinal studies that consider the COR model have found survivors experiencing job and income loss to be especially at risk for MH morbidity including anxiety, depression, and PTSD (Adeola, 2009; Arata, Picou, Johnson, & Mcnally, 2000; Galea, Tracy, Norris, & Coffey, 2008). If a community is in a state of "resource dependency" (Adger, 2000) and the economy is based on the natural environment, it will be vulnerable to resource-related stress from a disaster that heavily impacts the environment. The Exxon Valdez oil spill in an Alaskan fishing community is an example (Arata et al., 2000; Gill & Picou, 1997).

Disasters stemming from human agency – technical accidents, or intentional events such as terrorism (Ohbu et al., 1997; Shalev et al., 2003) and war (Hobfoll et al., 2012; Karsenty et al., 1994; Khamis, Macy, & Coignez, 2004) -- are particularly stressful for survivor communities. After accidents, there may be an aftermath of environmental toxicity making future healthy living untenable in the area (Freudenburg & Jones, 1991; Marshall & Picou, 2008; Picou, 2009) related to on-going (Shultz et al., 2011) or "slow-motion" (Cline et al., 2010) events. These events are stressful because of the physical threats of the toxins, and because these threats are unresolved with no clear conclusion in sight (Bonanno, Brewin, Kaniasty, & Greca, 2010; Cline et al., 2010). As the number of years living in the community increases so does the stress level (Picou & Martin, 2007).

However, social support has long known to enhance resiliency to stressors (Lin, Ensel, Simeone, & Kuo, 1979). Pearlin and colleagues in an influential paper (Pearlin, Menaghan, Lieberman, & Mullen, 1981) created a conceptual stress model integrating social resources and coping skills. They concluded emotional social support in the form of trust and intimacy bolster self-image to aid coping, and therefore indirectly prevents increase in depression. Recent reviews and meta-analyses of the extensive research over the last thirty years (Holt-Lunstad, Smith, & Layton, 2010; Thoits, 2011; Uchino, Bowen, Carlisle, & Birmingham, 2012) confirm social support as a robust indicator of physical and mental health via the buffering model.

Quantifying the relationship between resource and stress variables, Norris and Murrell found stronger resources such as social support could behave as a damper on individual post-event symptomology, including depression, in older adults (Norris & Murrell, 1984). It is most effective when addressing tangible (Kaniasty & Norris, 1995, 2000) needs. The existence, amount, and effect of social support on post-disaster stress depends on many variables: kin or nonkin support networks (Kaniasty, Norris, & Murrell, 1990; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008), severity of the disaster exposure (Arnberg, Hultman, Michel, & Lundin, 2012), post-event timing (Rubonis & Bickman, 1991), expectations of survivors (Kaniasty & Norris, 2000), and ethnicity (Kaniasty & Norris, 2000). Victim demographics and exposure amount can affect the amount of forthcoming social support (Arnberg & Melin, 2013).

The above research is about receiving support, but in non-disaster situations, there is evidence both receiving and providing social support is beneficial to mental health. Reciprocal altruism as a theory of behavior was introduced over forty years ago (Trivers, 1971). The act of providing support may be a reciprocal response to having received support (Liang, Krause, & Bennett, 2001). When social support operationalized as mattering – the feeling that others depend on you -- is regressed with depression testing, both experienced and perceived mattering are associated with lower scores (Taylor & Turner, 2001). Among the elderly, giving emotional support to a spouse and instrumental support to others outside the household may be linked to greater longevity (Brown, Nesse, Vinokur, & Smith, 2003). Greater satisfaction from giving versus receiving support may be

a key feature of East Asian culture especially among the elderly. Research among the elderly in Korea has shown a positive association between life satisfaction and providing social support (Lee, Lyu, Lee, & Burr, 2013; Sung, 2003), even when compared to receiving only (Lee et al., 2013). The benefits of providing versus receiving were also found in elderly populations in Japan (Kim, Sugisawa, Okabayashi, Fukaya, & Shibata, 1999). Reciprocal support, where providing and receiving support are equal, has been linked to mental and physical health in Taiwan student populations (Jou & Fukada, 1996).

The altruistic community following disaster (Fritz, 1961) is marked by high levels of solidarity and common assistance. Investigating provided support between communities impacted differently by Hurricane Hugo in the southern US, Norris and Kaniasty found among survivors that higher levels of reciprocity existed in communities more heavily impacted (Kaniasty & Norris, 1995). Volunteers participating in rebuilding areas impacted by the Hurricane Katrina natural disaster found the experience positively transforming (Dass-Brailsford, Thomley, & de Mendoza, 2011).

However, although the potential of reciprocity in post-disaster interventions has been suggested (Brown et al., 2003; Thoits, 2011), it has received less attention compared to the outcomes of received support. Provided support appears neither in the *Textbook of Disaster Psychiatry* (2007) nor *Mental Health and Disasters* (2009), two disaster mental health textbooks. One reason may problematic construct validity due to the absence of reliable testing instruments. For example, current tests measuring reciprocity in supportive relationships have difficulty differentiating between instrumental and emotional support (Shakespeare-Finch & Obst, 2011).

In response to the perceived shortcomings of existing instruments, recently new ones have been created to analyze provided and reciprocal support among disaster survival populations. Two instruments are the 2-Way Social Support Scale (2-Way SSS) by Shakespeare-Finch and Obst (Shakespeare-Finch & Obst, 2011) in Australia, and the Brief Inventory of Social Support Exchange Network (BISSEN) by Aiba and colleagues (Aiba et al., 2013) at the U of Tsukuba in Japan. Preliminary development of the 2-Way SSS found the two most stable factors were emotional and instrumental support. The developers used principal component analysis to show a clear separation between the four hypothesized dimensions of social support: receiving emotional, receiving instrumental, providing emotional, and providing instrumental. For example, the instrumental items describe providing transport, financial assistance, and support for other tasks and responsibilities; and the emotional items include statements about trust, feeling valued, being able to confide, and a “circle of friends”. Good convergent validity and predictive viability were established through associations with other tests. The instrument showed robust results for the effectiveness of giving and receiving emotional support on positive well-being following a natural disaster (the 2011 Queensland floods). This is evidence of the importance of public policy encouraging community involvement in post-disaster relief (Shakespeare-Finch & Green, 2013).

Similar to the 2-Way SSS, the BISSEN was developed because other tests for reciprocity were considered problematic (Aiba et al., 2013). The test was shown to have good test-retest reliability among the general population across all age groups (20's to 70's) concerning the source of reciprocal support. However, the structure of these tests is not the same. The 2-Way SSS tests functional support by focusing on descriptions of emotional and instrumental support. The BISSEN contains fewer items about types of functional support, but attempts to ascertain the support network by asking who receives and provides support among family, relatives, friends, neighbors, and colleagues. In addition, there are also questions about the density of the support network; that is, if members within the network know each other.

Intervention: The U of Tsukuba *Genki Mura Project*

The U of Tsukuba Department of Psychiatry funded by the Health Ministry began a five-year longitudinal intervention project in December 2011. The intervention program is a collaboration headed by the U of Tsukuba, a national research university and medical school, with federal, prefectural, and local hospitals and public health facilities. In addition thirty "facilitators" from the local community supported the medical professionals.

This intervention functions as research and health promotion. Research aims of the project are: 1) Assess the long-term mental health impacts of this continuing technical disaster, and 2) examine if intervention programs can mitigate stress. Rather than solely a clinical focus on treating psychiatric illness, the intervention aims to promote community health since the aim is to mitigate the personal and community impact from disaster through the actions of the community itself (see Gil-Lacruz, 2011). Therefore, the intervention is *collaboration* within the university between the medical school and other research disciplines such as physical education and nutrition studies; between the university and local municipal and health authorities; and between the staff and the community through local facilitators.

The intervention design is interdisciplinary in scope. Participants receive assessments for mental health and daily life impacts from the disaster, and can choose an intervention program: psychiatric counseling, nutritional advice, exercise classes, or job retraining (word processing). This vocational support is to support the unemployed from the fishing industry. Through these programs the intervention tries to promote mental and physical health, and contribute to personal and community resources to aid resilience during this continuing technical disaster. The first-year focus of the study was intervention preparation and early treatment. Three pillars formed the early and preventative intervention: 1) the establishment of an out-patient psychiatric facility at the city's only municipal hospital; 2) normalizing mental health assessment in the community and creating a feedback system between staff and subjects; and 3) and the planning of the emotional support and training center called *Genki Mura (Healthy Village)*.

There appears to be growing recognition of post-disaster recovery as a "community-centric/community-driven process" (Sullivan, 2003). Interventions should have more emphasis on input from the community level (Schoch-Spana, Franco, Nuzzo, & Usenza, 2007). For example, the US National Biodefense Science Board in the US wrote: "Establishing a true dialogue and engaging with the public before, during, and after an event promotes a sense of collective competency in mastering the challenges posed by the event and a sense of collective efficacy, essential ingredients to a community's resilience." (Disaster Mental Health Subcommittee of the National Biodefense Science Board, 2008:3). However, despite these advisories community collaboration is still not a standard medical competency (Lebowitz, 2014).

This study is an assessment of the mental health of participants from two neighborhoods in Kita Ibaraki who volunteered for an intervention program within one year of the disaster. Ten predictor categories (four demographic and six impact) were assessed for outcomes of depression and trauma. Next, relational satisfaction based on survivors receiving and providing social support within their community was considered. Treated as predictor covariates, the effect of social support-based satisfaction on morbidity was investigated. This study is designed to show that when individuals interact with their communities in a post-disaster environment, it can benefit mental health. Community-based interventions should promote this kind of interaction.

Methods and Procedures

The Kita Ibaraki General Hospital opened the *Kokoro-no-Ke'a* ("Heart Care") booth on 13 December, 2011. From the previous October, the local government began to distribute fliers informing residents from the Hirakata and Otsu neighborhoods (pop. 7,000), which was the target population. The homepage for the program was opened at this time, and an announcement appeared in the December issue of the City Hall monthly news magazine. Staff were on rotation from the U of Tsukuba, the Ibaraki Prefectural Medical Center of Psychiatry, and the National Center of Neurology and Psychology (NCNP). A manual was produced and distributed to each hospital together with a flow chart constructed to manage time, and a check sheet with a list. In addition thirty local "facilitators" from the local community supported the medical professionals. These facilitators acted as "go-betweens" by waiting at tables in the hospital to explain the program to participants and answer questions during assessments. A goal was set for a maximum of 15 in the morning and 15 in the afternoon for a total of 30 possible participants. Between December 2011 and January 2012 the window was opened once a week, and twice a week for February and March, 2012. People with mental disability not deemed competent to give consent, and youth under 20 years were excluded. Personal and clinical data is stored in a stand-alone computer in the facility. Between December, 2011 and March, 2012, 466 individuals came to the hospital (N=466, 351 female, mean age 60.4y, SD=14.0) who met the inclusion criteria for this research.

Measures

Two different categories of information were included in this study that became the predictor variables: demographic (age, sex, marital status, and education level), and impact. The impact data consisted of the following measures:

- *Location during the disaster event* (nominal): initially six groups -- at home, working indoors, shopping, working outdoors, at school, and other -- recoded as dummy categories 0="at home" and 1="outside home"
- *Acquaintance Casualty* (nominal): originally questions about acquaintances who were missing, injured, or died, recoded as a dummy variable 0="did not know casualty" and 1="did know casualty"
- *Home Water Incursion* (nominal): originally contained four answers about house water incursion from the tsunami – under the floor, over the floor, none/not registered, and "other" recoded into 0="no" and 1="yes".
- *Household Damage* (ordinal variable): 1="no damage", 2="partial damage", 3= "half-damaged", 4= "major damage", and 5= "complete damage".
- *Income Change* Participants were provided with three choices for income change: no change, becoming higher, and becoming lower. Due to the small respondents for the second group, this group was removed from the sample and it was recoded as 0= "no change", 1= "change".

The outcome measures consisted of self-assessment of depression and trauma symptoms, and about social support satisfaction. Symptoms of depression were assessed using the self-reporting CES-D (Center for Epidemiologic Studies Depression Scale) a 20-item scale used to measure symptomology experienced weekly (Radloff, 1977). This CES-D is scored on a 4-point scale from "None of the time" to "Most or all of the time" -- written as "At least five days a week" in the Japanese version – with higher scores indicating more frequent symptoms. The CES-D has been used for populations following natural disasters (Norris, Kaniasty, Perilla, Riad, & Lavizzo, 1999; Picou & Hudson, 2010), technical disasters (Picou & Martin, 2007), and terrorism (Salguero, Fernández-Berrocal, Iruarrizaga, Cano-Vindel, & Galea, 2011). It has also been applied to non-disaster situations, such as acculturation-related stress in international student populations in US universities (Yoon, Langrehr, & Ong, 2011). The Japanese version has high validity and reliability (Shima, Shikano, Kitamura, & Asai, 1985) and has previously it has been used to research populations displaced by the Miyake Island volcano (Goto, Wilson, Kahana, & Slane, 2006) and East Japan earthquake rescue workers concerned with radiation exposure (Matsuoka et al., 2012). Although Radloff and Norris et al. (Norris et al., 1999; Radloff, 1977) deny the CES-D is a diagnostic tool, Shima and colleagues found the Japanese version highly correlated with the diagnostic HRSD (Shima et al., 1985).

The IES-R (Impact of Event Scale – Revised) is a 22-item scale measuring three categories of symptoms – avoidance, intrusive thoughts, and hyperarousal -- associated with Post-Traumatic Stress Syndrome (D. Weiss & Marmar, 2004). The earlier IES test (Horowitz, Wilner, & Alvarez, 1979) although widely used was viewed inadequate for only measuring the first two categories (Creamer, Bell, & Failla, 2003) and therefore revised. There is a possible 5-point response (0-4) for each item and either the sum score or mean of non-missing items assessed. It has been translated for use in different traumatic situations,

including into German for former political prisoners (Schützwohl & Maercker, 1999), Quebecois-French for young mothers following an ice storm (Laplante et al., 2004), and for Norwegian survivors of the Southeast Asian tsunami (Nygaard, Wentzel-Larsen, Hussain, & Heir, 2011). A Japanese version tested on survivors of the Hanshin-Awaji Earthquake, the Tokyo subway sarin attack, and a neighborhood criminal poisoning found good validity and reliability (Asukai et al., 2002).

The next outcome measurement was subjects' satisfaction levels concerning relationships. These relationships were based on support the subject both received and provided. The scale was drawn from an original 8-item questionnaire developed by faculty at the U of Tsukuba called the Brief Inventory of Social Support Exchange Network (BISSEN) by Aiba and colleagues (Aiba et al., 2013). The questionnaire taps reciprocal support -- support received *and* provided by the respondent – demonstrated to be positively correlated to individual self-esteem and life fulfillment (Miura & Agari, 2006). Previous use of this scale has indicated it is a reliable instrument (internal reliability for received category $\alpha>.70$, provided category $\alpha>.80$). The test was shown to have good test-retest reliability among the general population across all age groups (received $r=.62$, provided $r=.73$) concerning the source of reciprocal support. There was good convergent validity with tests about perceived socioeconomic status and stress, and good concurrent validity with tests about networks of support (Aiba et al., 2013).

The BISSEN consists of eight questions. Four of these questions tap emotional and tangible support the subject receives and provides:

- Now is there anyone who helps you feel better and listens to you when you are feeling down?
- Now is there anyone who does what is necessary for you or your cohabitating family if physically incapacitated?
- Now, is there any individual whom you help feel better and listen to when they are feeling down?
- Now, is there any individual or their cohabitating family for whom you do what is necessary if physically incapacitated?

The responses for these questions were "cohabitating family or relative", "other relative", "friend", "neighbor", "colleague", "other", and "none". More than one response was possible.

For two questions, respondents rated the quality of relationship between themselves and individuals providing them support and receiving their support based on a Likert-scale (from 1="Very Satisfied" to 6="Very Dissatisfied"):

- How do you feel about your relationship with those providing you support?
- How do you feel about your relationship with those to whom you provide support?

Two questions tapped the density of the network of personal relationships:

- Do the people from whom you receive support know each other?
- Do the people to whom you provide support know each other?

Responses were 1-4 “everyone knows each other”, “most people know each other”, “some people know each other”, and “nobody knows each other”.

Data Analysis

In empirical studies the most important outcome is effect size (Cohen, 1988; Lakens, 2013), rather than between-group differences (Ferguson, 2009). The main concern of this study is effect size change when controlling for certain dependent variables, although the differences are also reported. For the first step several analyses of variance were conducted between the different social or impact grouping variables and the outcome symptomology variables to determine partial eta-squared (η_p^2) values. The η_p^2 value is defined as “the proportion of variance accounted for by population membership.” (Jacob Cohen, 1988) This can be stated as the question, “If the group is known, what is the outcome score prediction?” Therefore, this value is the proportion of the mean group variance to the mean total population variance; in other words, it is the amount of total variance that is due to different group membership. In this study η_p^2 is preferable because the factors in this sample are similar to the larger population and not experimental (Kline, 2004). That is, the predictors – e.g., gender, age, and extent of impact -- are naturally occurring for all disaster populations.

Another reason η_p^2 was chosen as the effect size value is because the outcome variables of depression and trauma symptomology are continuous. Bonanno et al. believe in the importance in continuous variables: “…the use of continuous measures has practical applications; most notably, it allows for comparative analyses across conditions and types of disaster and provides a handy estimation of the duration of postdisaster impact.” (Bonanno, Brewin, Kaniasty, & La Greca, 2010:10). This explanation reflects the APA’s concern with study replicability based on effect size reporting (Wilkinson & APA Task Force on Statistical Inference, 1999). Eta-squared values can be compared in different studies no matter the number of groups in the predictor variable. One criticism against squared effect size values in general is they are so small they may be considered unimportant (Rosenthal, 2000). This is purely a subjective assessment, and it is important to remember that the accumulation of small effects determine disaster mental health outcomes (Bonanno et al., 2010).

Of course, the proportion of variance when the predictor variable contains only two groups (k=2) can be expressed as the point-biserial r^2. However, predictors in this study have more than two groups: e.g., age and house damage. Cohen’s f assumes equal sample size (Wuensch, 2013), and many of the groups in the predictor variables were of unequal size. Other measurements, such as odds ratios and phi, are for dichotomous outcomes (Sánchez-Meca, Marín-Martínez, & Chacón-Moscoso, 2003). Effect sizes concluded in this study will also be useful for replication, since it is the ultimate aim to understand the effectiveness of this intervention program over time as a model to be applied to other situations. Replicability is important in the disaster field because there is still no consensus on what constitutes a “normal” or “standard” reaction to disaster. This is another reason why effect size is preferable to odds ratios that reduce effects to binary

outcomes. It will help in the understanding of the number of observations necessary to yield similar results (i.e., power).

Between-group χ^2 and t-tests were used to evaluate differences between groups in the predictor categories. Welch's t-test was used to test for significant differences between means. The Welch's t-test and the ANOVA are considered robust to unequal variances and unequal sample sizes (Boneau, 1960; Schmider, Ziegler, Danay, Beyer, & Bühner, 2010). Distributions were sufficiently normal across both symptomology categories with skews < |2.0| and kurtoses < |9.0| (Schmider et al., 2010). Possible CES-D scores were between 0-60, and IES-R scores between 0-88. Homogeneity of variance was tested prior to this transformation on the raw data using a non-parametric Levene's test of equal variance as devised by Nordstokke and Zumbo (Nordstokke & Zumbo, 2007). This is an ANOVA between the mean differences ranks of the pooled MH data robust to both non-normal distribution and different sample sizes in three steps: (i) pool the data and replace the original scores by their ranks, (ii) separate the data back into their groups and (iii) apply the mean-based Levene's test to the ranks. The results of this test for each independent variable is reported in the results section. Where possible, effect size results from the analyses of variance are compared to previous research as recommended by the APA Board of Scientific Affairs (Wilkinson & APA Task Force on Statistical Inference, 1999).

Confidence intervals (90% CI) are constructed around effect sizes as recommended by Cohen (Cohen, 1994). Confidence intervals for partial eta-squared were calculated. It has been recommended that confidence intervals are calculated for effect size estimates because it infers the importance of replicability through comparing effect size intervals in previous studies (Steiger, 2004; Thompson, 2002). Exact p-values are stated as recommended by the APA *Publication Manual* (American Psychological Association, 2001). After the effect-size estimate was established, social support relationship satisfaction for providing support, receiving support, and as a factor combining the two interpretable as reciprocity was controlled as a covariate to see which kind of support exerted the greatest change on the effect size of the different independent variables. All statistical analysis was done on SPSS software version 22 (2013) for Windows, except for the effect-size confidence intervals calculated with the MBESS (Methods for the Behavioral, Educational, and Social Sciences) (Kelley, 2007) statistical package from R programming language.

Results 1: Demographic and Impact Predictors on Depression and Trauma

The demographic and impact characteristics of the participants are presented in Table 1. Overall, there were almost three times as many female participants as male participants and the frequency difference was statistically significant (χ^2 = 118.009, p = .000). The elderly adults were overrepresented among the three groups (χ^2 =193.28, p=.000): 20-39 (n = 42), 40-59 (n = 139), and 60+ (n=286). Originally, marital status was between three groups (married n=334, single n=24, Divorced/Widowed/Other n=110; χ^2 = 328.359, p = .000), and recoded as married n = 334 and unmarried n = 134, χ^2 =85.470, p = .000.

These descriptive impact statistics show that almost as many participants were at home as were not at home during the earthquake and tsunami (52.4% vs. 47.5%). Since a large percentage of participants were elderly and female, there may have been many retirees and homemakers in this sample; in fact, 46% of respondents stating they were "unemployed" or "homemakers" (see Table 2). Only 5.9% of respondents had a casualty acquaintance reflecting the low death and injury rate from the disaster despite the physical damage. A large percentage of respondents (90.9%) reported some household water incursion suggesting the tsunami had a physical impact on the home, although 79.1% responded that their homes had no or only partial damage. Around 6% responded their homes were mostly or completely damaged. Over one-third reported some workplace damage (38.3%), and an almost similar percentage (30.6%) reported income reduction.

Table 1
Demographic and Impact Characteristics of the Participants

		Frequency (N)	Percentage (%)
Sex	Female	349	74.6
	Male	115	24.6
Age	20-39	42	8.9
	40-59	139	29.7
	60+	286	61.2
Marital Status	Married	333	71.3
	Unmarried	134	28.6
Education Level	JHS Graduate	136	29.3
	HS Graduate	227	48.9
	Univ and above	101	21.7
Location during disaster	Home	245	52.4
	Outside Home	222	47.5
Casualty Acquaintance	No	439	94.0
	Yes	28	5.9
Home Water Incursion	No	41	9.0
	Yes	413	90.9
Home Damage	No Damage	131	28.9
	Partial Damage	231	50.9
	Half-Damaged	51	11.2
	Major Damage	27	5.9
	Complete Damage	14	.03
Workplace Damage	No/Homemaker	280	61.7
	Yes	174	38.3
Income Reduction	No	315	69.4
	Yes	139	30.6

Table 2
Occupation before disaster

Occupation	**N**
Commercial, fisheries	22
Commercial, non-fisheries	76
Self-employed, fisheries	5
Self-employed, non-fisheries	61
Tourism	10

Agriculture	26
Forestry	0
Fishing	4
Construction	2
Civil Service (Fire/Police/Military)	1
Civil Service (other)	9
Housewife	120
Student	2
Other	25
Unemployed	103
Missing	2

Table 3 shows the correlations between the various predictors. The strongest correlation was between water incursion and house damage r =-.598, p < .001, and modest-to-moderate correlations between age and education r =-.318, p < .001, between house and workplace damage r =.238, p < .001, house damage and income change r =.215, p < .001, and workplace damage and income change r =.354, p < .001. However, the tolerance values were such that multicollinearity was not a problem. Regressing water incursion with house damage, the R^2 was .358. Subtracting from 1, the tolerance level was .642, which is considerably higher than the .10 cutoff suggested by Cohen et al. (Jacob Cohen, Cohen, West, & Aiken, 2013).

Table 3
Correlations between Demographic and Impact Variables

	Sex	Age	Marriage	Educa-tion	Location	Casualty Acquaint.	Water Incursion	House Damage	Workplace Damage	Income Change
Sex	1	.116*	-.160**	.038	.015	-.031	-.015	-.006	.066	.022
Age		1	.073	-.318**	-.132**	.006	.050	-.058	-.163**	-.119*
Marriage			1	-.216**	-.055	.099*	-.071	.056	.007	.014
Education				1	.191**	.012	-.044	.105*	.145**	.073
Location	.				1	-.042	-.113*	.108*	.068	.107*
Casualty Acquaintance						1	.014	.069	.098*	.120*
Water Incursion							1	-.598**	-.067	-.189**
House Damage				.				1	.238**	.215**
Workplace Damage									1	.354**
Income Change										1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 4

Sample Characteristics of Depressive Symptomology with Effect Size Estimates

Variables	***M* (95% CI)**	**SD**	**t or χ^2**	**p**	**η_p^2 (90% CI)**
Demographic					
Gender			1.65	.064	n/s
Female	11.20 (10.31-12.09)	8.45			
Male	9.81 (8.59-11.03)	6.61			
Age			13.32	.001	.028 (0.0068-0.0544)
20-39	14.6 (11.79-17.49)	9.15			
40-59	11.35 (10.12-12.59)	7.36			
60+	10.04 (9.11-10.97)	8.00			
Marital Status			1.69	.130	n/s
Married	10.44 (9.65-11.23)	7.32			
Unmarried	11.86 (10.24-13.48)	9.48			
Education Level			4.08	.131	n/s
JHS Graduate	9.81 (8.52-11.10)	7.62			
HS Graduate	11.51 (10.47-12.55)	7.96			
Univ. and above	10.71 (9.00-12.43)	8.68			
Impact					
Location during disaster			.39	.70	n/s
Home	10.98 (10.00-11.97)	7.80			
Outside Home	10.69 (9.60-11.79)	8.26			
Casualty Acquaintance			2.31	.021	.011 (0.0009-0.0324)
No	10.63 (9.88-11.37)	7.95			
Yes	14.25 (10.99-17.51)	8.40			
Home Water Incursion			3.07	.002	.020 (0.0043-0.0455)
No	14.51 (11.06-17.96)	10.93			
Yes	10.41 (9.68-11.14)	7.56			
Home Damage			29.64	.000	.06 (0.0245-0.0919)
No Damage	8.89 (7.73-10.04)	6.67			
Partial Damage	10.84 (9.83-11.85)	7.77			
Half-Damaged	10.88 (8.87-12.89)	7.14			
Major Damage	17.81 (12.76-22.87)	12.78			
Complete Damage	13.57 (9.83-17.31)	6.48			
Workplace Damage			2.32	.128	n/s
No/Homemaker	10.29 (9.39-11.20)	7.71			
Yes	11.56 (10.31-12.82)	8.39			
Income Reduction			7.51	.007	.02 (0.0043-0.0464)
No	10.05 (9.26-10.84)	7.12			
Yes	12.44 (10.85-14.03)	9.50			

Table 5

Sample Characteristics of Trauma Symptomology with Effect Size Estimates

Variables	***M* (95% CI)**	**SD**	**t or χ^2**	**p**	**η_p^2 (90% CI)**
Demographic					
Gender			2.72	.003	.016 (0.0024- 0.0392)
Female	17.24 (15.59-18.89)	15.67			
Male	12.83 (10.45-15.22)	12.92			
Age			3.0	.224	n/s
20-39	18.02 (12.36-23.69)	18.18			

40-59	14.30 (12.18-16.43)	12.66			
60+	16.63 (14.80-18.46)	15.69			
Marital Status			2.81	.011	.017 (0.0029-0.0409)
Married	14.82 (13.32-16.33)	13.94			
Unmarried	19.14 (16.17-22.11)	17.39			
Education Level			2.72	.259	n/s
JHS Graduate	16.48 (13.87-19.08)	15.35			
HS Graduate	16.94 (14.90-18.97)	15.57			
Univ. and above	14.01 (11.32-16.69)	13.60			
Impact					
Location during disaster			1.23	.22	n/s
Home	16.88 (15.00-18.76)	14.95			
Outside Home	15.16 (13.14-17.18)	15.28			
Casualty Acquaintance			1.60	.109	n/s
No	15.78 (14.38-17.17)	14.87			
Yes	20.50 (13.41-27.59)	18.29			
Home Water Incursion			3.34	.001	.023 (0.0060-0.0507)
No	23.51 (17.39-29.63)	19.38			
Yes	15.33 (13.93-16.73)	14.45			
Home Damage			32.76	.000	.07 (0.0289-0.0993)
No Damage	13.15 (10.95-15.34)	12.69			
Partial Damage	16.16 (14.21-18.11)	15.01			
Half-Damaged	13.41 (9.84-16.98)	12.68			
Major Damage	29.81 (21.44-38.19)	21.16			
Complete Damage	25.14 (15.78-34.50)	16.21			
Workplace Damage			.533	.466	n/s
No/Homemaker	15.51 (13.76-17.25)	14.85			
Yes	16.98 (14.65-19.30)	15.55			
Income Reduction			5.23	.023	.014 (0.0016-0.0367)
No	14.90 (13.37-16.42)	13.78			
Yes	18.73 (15.79-21.68)	17.55			

Results for the analysis of variance between groups across the different predictor variables for depressive and trauma symptomology are in Tables 4 and 5. Overall, the impact variables tended to show effect sizes across both outcome symptomology variables, whereas the demographic variables did not. Home damage appeared to explain the largest proportions of variance in both depression (η_p^2=.06, *d*=.51, *p*=.000) and trauma (η_p^2=.07, *d*=.55, *p*=.000). These levels are considered moderate to large (Jacob Cohen, 1988). The next largest effects, considered small-to-moderate, were found in home water incursion: CES-D, η_p^2=.020, *d*=.44, *p*=.002; IES-R, η_p^2=.023, *d*=.48, *p*=.001. These categories also showed the largest between-groups differences. There was considerable difference in the variance and sample sizes of the water incursion category, but Nordstokke and Zumbo's (Nordstokke & Zumbo, 2007) robust Levene's test showed that the variances were not significantly different from each other: CES-D F(1,466)=.406, *p*=.524; IES-R F(1,465)=.198, *p*=.656. In addition, the homogeneity of variance assumption was tested and confirmed for house damage: CES-D F(4,461)=.599, *p*=.664; IES-R F(4,460)=.470, *p*=.757. A Tukey's HSD procedure was done to test significant differences between the five means of each symptom category. With the exception of "complete damage", comparisons between major damage and other groups were significant at the *p*<.05 level for both outcome variables.

Income reduction also showed significant effect size changes across both symptomology categories, η_p^2=.02, *p*=.002, *d*=.29 for depression, and η_p^2=.014,

p=.013, *d*=.29 for trauma. Interestingly, significance between income change groups was not matched by significant differences between workplace damage groups, despite the significant correlation between these two categories. Having a casualty acquaintance appeared to explain some amount of depressive symptomology η_p^2=0.011, *p*=0.021, *d*=.21, but not trauma. No significant effects were shown by being at home/not at home during the event, nor workplace damage.

Examining the demographic predictors, females were statistically associated with a slightly higher trauma levels, but not depression, than men. Among the age groups, the youngest group (20-39 y) had the highest numerically mean and standard deviation for depression and trauma scores, but only mean differences in depression were significant. Three Fisher's LSD post-hoc tests were conducted to further evaluate the nature of the difference between age groups for depression. There were significant differences between the age 20-39 young group and age 40-59 middle-aged group (t(465)=-3.51, p=<.001, *d*=.33), and between the age 60< elderly group (t(465)=-2.30, p=.022, *d*=.21). However, there was no significant mean difference between middle-aged and elderly groups. Being unmarried (single/divorced/separated/widowed) seemed to significantly effect trauma scores, η_p^2 = .017, p=.005, *d*=.16. Education level was not significant.

Discussion 1

The current study investigated the prevalence of depression and trauma among an adult population nine months to one year following a combined earthquake and tsunami disaster in Kita Ibaraki. These results show the predictors for depressive symptoms are age, casualty acquaintance, home water incursion, home damage, and income reduction. Predictors for trauma symptoms are gender, marital status, home water incursion, home damage, and income reduction. Keeping in mind that disasters are distinct and their community impact depends on local capacity as much as the size and strength of the event itself, it is still necessary to examine the literature for effect size comparisons. Here, effect sizes for other selected studies are examined to see if they fall within the effect size confidence intervals calculated for each of the predictor variables. Although partial eta-squared estimates are used for this study, they are equivalent to eta-squared because one independent variable is used for each calculation (Pierce, Block, & Herman, 2004). Effect sizes conversions were done on formulae provided by Dunst et al. (Dunst, Hamby, & Trivette, 2004), and the converting effect sizes spreadsheet developed by Jamie DeCoster available at www.stat-help.com.

Gender on Trauma: η_p^2 = .016 (0.0024- 0.0392) Five earthquake research papers in this literature sample showed effect sizes within the interval suggested by this research (Table 6). Three were conducted ≤1 year post-event (Kun et al., 2009; Wang et al., 2009; Zhang, Shi, Wang, & Liu, 2011). It continued to be moderately so over after one year in a non-epicenter community impacted by the 1999 Turkey earthquake (Basoglu, Kilic, Salcioglu, & Livanou, 2004), and even four years for older Hanshin-Awaji earthquake survivors whose homes were seriously damaged (Kimura, Hayashi, & Tatsuki, 1999; see also Tatsuki & Hayashi, 2001). In the Turkey study, gender was a high predictor in an epicenter

community with poor building standards. It was an especially high predictor for the impoverished survivors of Haiti in tent camps where sexual violence was a daily occurrence (Cénat & Derivois, 2014). Two years post-disaster among temporary-housed survivors of the Chi-Chi earthquake in Taiwan (Chen et al., 2007) gender predicted moderately high levels of trauma. These studies suggest the background environment such as reconstruction and public safety influence gender as an independent predictor following an earthquake over time. Unsurprisingly, it was a robust predictor (η^2 = .04-.06) in the early 1-4 month period immediately following the quake (Zhang & Ho, 2011; Zhang, Wang, Shi, Wang, & Zhang, 2012). In contrast, gender became a non-significant predictor after six months in communities exposed to the disaster but able to remain living in their homes (Chou et al., 2007), and in moderately damaged or supported communities (Guo et al., 2014; Kun et al., 2009). After Hurricane Katrina, delayed community recovery also seemed to play a role in gender as a predictor of stress (Galea et al., 2007; Picou & Hudson, 2010). An earlier study of note investigated the Exxon Valdez oil spill (Palinkas, Petterson, Russell, & Downs, 1993). This man-made technical disaster seriously affected livelihood over an extended period, and one year later gender was still a robust predictor of trauma. It was also a moderate predictor associated with terrorist attacks (Bleich, Gelkopf, Melamed, & Solomon, 2006; S Galea, Tracy, et al., 2008; North, Nixon, McMillen, Spitznagel, & Smith, 1999).

Table 6 *Summary of studies: Effect size of gender predictor on trauma*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CI 0.0024-0.0392 (If no, +/-)**
Basoglu et al, 2004	530 (site I), 420 (site II)	14mths post Turkey quake	.048 (site I), .028 (site II)	No +, Yes
Bleich et al, 2006	501	44mnths of continued terrorism	.021	Yes
Bonnano et al, 2007	2752	6mths post 9-11	.049	No +
Cénat, Derivois 2014	1355	2.5yrs post Haiti quake	.135	No +
Chen et al, 2007	6412	2yrs post-Chi Chi quake	.059	No +
Chou et al, 2007	216	6mths post-Chi Chi quake	n/s	No -
Galea et al, 2007	1043	5-7mths post-Katrina	.07	No +
Galea et al, 2008	2752	6-30mths post-9-11	.017	Yes
Guo et al, 2014	1066	8mths post Wenchuan quake	n/s	No -
Kimura et al, 1999	915	4 yr post-Hanshin/Awaji quake	.033	Yes
Kun et al., 2009	446	2.5mths post Wenchuan quake	.0058 heavily damaged areas, n/s moderately damaged	Yes, No -
Liu et al 2006	33340 (includes children aged 7+)	6yrs post Hunan flood	.001	No -
Norris, Sherried, Galea 2010	658	2-6mths post-Hurricane Ike	.008	Yes
North et al, 1999	182	6mths post-Oklahoma bombing	.052	No +
Palinkas et al., 1993	599	1yr post Exxon Valdez spill	.045	No +

Picou & Hudson, 2010	810	2yrs post-Katrina	.028	Yes
Wang et al., 2009	1563	3mths post Sichuan quake	.015	Yes
Zhang & Ho, 2011	956	1-2mths post Wenchuan quake	.062	No +
Zhang et al., 2011	311	1yr post-Wenchuan quake	.016	Yes
Zhang et al, 2012	505	3-4mnths post Yushu quake	.04	No +

Age on Depression: η_p^2 = .028 (0.0068-0.0544) Age was a moderate predictor soon after the Wenchuan earthquake (Table 7) (Zhang & Ho, 2011), although it became close to non-significant a year later (Zhang et al., 2011), especially in moderately vs. heavily impacted communities (Xu, Mo, & Wu, 2013). Older age also explained larger proportions of variance in symptomology vs. middle age (Kun et al., 2009). Literature shows that palpably similar effect sizes over time were mid-aged adult evacuees of the volcanic eruption on Miyake Island, Japan (Goto et al., 2006). Among that community, elderly adults showed much higher levels of depression perhaps because they were more strongly attached to a location they might never be able to return. In US hurricane studies age exerted effect sizes close to or inside the interval suggested by this study (Acierno, Ruggiero, Kilpatrick, Resnick, & Galea, 2006; Vu & VanLandingham, 2012), but did not in another (Norris, Sherrieb, & Galea, 2010), and time appeared to dissipate age-related effects (Ruggiero et al., 2009). Even when the effect was not significant, age was still important in the Taiwan post-disaster environment interacting with home damage and social ties (Seplaki, Goldman, Weinstein, & Lin, 2006).

Table 7 *Summary of studies: Effect size of age predictor on Depression*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CI 0.0068-0.0544 If no (+/-)**
Acierno et al, 2006	1,543	8-12mths post Florida Hurricane	.06	No +
Goto et al, 2006	231	10mths post volcano in Miyake Island, Japan	.019	Yes
Kun et al., 2009	446	2.5mths post Wenchuan quake	Age 35-64y, .003 Age 65y<, .068	No -, No +
Norris, Sherrieb, Galea, 2010	658	2-6mths post-Hurricane Ike	.006	No -
Ruggiero et al, 2009	1,452	4yrs (?) post Florida Hurricanes	.0049	No -
Vu & VanLandingham, 2012	82	1yr post-Katrina	.13	Yes
Xu et al, 2013	704	1yr post Sichuan quake	.085 heavily damaged, n/s moderately damaged	No +, No -

Zhang & Ho, 2011	956	1-2mths post Wenchuan quake	.02	Yes
Zhang et al., 2011	311	1yr post-Wenchuan quake	<.0001	No -

Marital status on Trauma: η_p^2 = .017 (0.0029-0.0409) Married status (Table 8) has been identified as a post-disaster stressor for women (Norris et al., 2002), possibly following technical disasters in particular (Couch & Coles, 2011). Kita Ibaraki results, at this early point after the disaster, showed the opposite with unmarried status as the predictor. Similar predictive levels were found in sheltered residents 2 years post-earthquake (Chen et al., 2007), and higher levels in heavily damaged areas (Kun, Tong, Liu, Pei, & Luo, 2013) or in areas with little chance of return (Goto et al., 2006). However, it was also a non-significant predictor in other studies.

Table 8 *Summary of studies: Effect size of marital status predictor on trauma*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CO (0.0029-0.0409) No +/-**
Chan et al 2012	1725	7-8mnths post Sichuan quake	n/s (bereaved or non-bereaved)	No -
Chen et al 2007	6412	2yrs post-Chi Chi quake	.01	Yes
Chou et al, 2007	216	6mths post-Chi Chi quake	n/s	No -
Galea et al, 2008	2752	6-30mths post-9-11	n/s	No -
Goto et al, 2006	231	10mths post volcano in Miyake Island, Japan	.09	No +
Kun et al, 2013	1890	2.5-3mths post Wenchuan quake	.18 (heavily damaged), n/s (moderately damaged)	No +, No -
Nyagaard et al, 2011	641	2yrs post SE Asia Tsunami	n/s	No -
Zhang et al, 2011	311	1yr post Wenchuan quake	n/s	No -
Zhang et al, 2012	505	3-4mnths post Yushu quake	n/s	No -

In this study, education level did not predict either of the symptoms. Low levels of education are generally seen as a risk for PTSD (Chan et al., 2012; Rhoads, Pearman, & Rick, 2007). It was not a predictor for trauma in this study population, and in two studies reviewed it was a small predictor for depression (Norris, Sherrieb, & Galea, 2010; Zhang, Wang, Shi, Wang, & Zhang, 2012). Location -- being at home or not at home -- was also not a significant predictor in this study. When defined as "area", location as a variable has been criticized for being a "coarse predictor" when used for disaster event proximity (Carr, Lewin, Webster, & Kenardy, 1997). While this may be true for natural disasters, proximity and exposure to terrorism may be a robust predictor of post-event depression (S Galea et al., 2002; Stein, Schorr, Krantz, & Dickstein, 2013; Vlahov et al., 2002).

Casualty Acquaintance on Depression: η_p^2 = .011 (0.0009-0.0324) Knowing someone who was killed, injured, or missing showed the lowest effect size values overall in this study, and the lower bound of the confidence interval as a predictor for depression came closest to zero. It was not a significant predictor of trauma in this study. However, it has been shown as a small predictor within one year (Chan et al., 2012), and moderate predictor of depression in longitudinal studies 1-2 years post event, perhaps as survivors remember (Adams, Boscarino, & Galea, 2006) (Table 9). Acquaintance loss is associated with depression in conflict in the Palestinian territories (Hobfoll et al., 2012). Other human-caused disasters appear in the trauma literature; for example, losing a friend or relative is moderately-to-highly associated with PTSD after the 2011 World Trade Center attack (Brackbill et al., 2011; Neria, DiGrande, & Adams, 2012; Stellman et al., 2008). It is considered one element of trauma in areas with ongoing terrorist attacks in Israel (Bleich et al., 2006). The Sri Lanka tsunami, coming after a prolonged civil war, also showed casualty acquaintance to be a robust predictor of PTSD (Nomura et al., 2010). After the Sichuan earthquake, which caused the collapse of several schools, loss of a child was a strong predictor of PTSD (Chan et al., 2012).

Table 9 *Summary of studies: Effect size of Casualty Acquaintance on Depression*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CI (0.0009-0.0324) No +/-**
Adams et al, 2006	1681	1-2yrs post-9-11	.04 (casualty acquaintance one element of exposure)	No +
Chan et al, 2012	1725	7-8mnths post Sichuan quake 0.017	.017	Yes
Hobfoll et al, 2012	1196	West Bank/Gaza conflict	.006 (casualty acquaintance one element of exposure)	Yes
Ishino et al, 2012	4000 households	3-7mnths post Tohoku	n/s	No - (outcome: subjective well-being)

House Damage on Depression η_p^2 = .06 (0.0245-0.0919), and on Trauma η_p^2 = .07 (0.0289-0.0993) In this study, house damage was responsible for explaining the largest proportion of variance in both symptomologies, and other studies have observed comparable trauma data <1 year post quake (Kun et al., 2009; Yang et al., 2003) (Table 10). Of note is one Wenchuan study that found house damage explained trauma variance at twice the level within the same time period; in this study, ethnic minorities were a large portion of the sample (Kun et al., 2013). Unlike casualty acquaintance, explained depression variance is reduced over time (Tang, Liu, Liu, Xue, & Zhang, 2014), perhaps because houses can be rebuilt.

Table 10 *Summary of studies: Effect size of Home Damage on Depression and Trauma*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CI Depression (0.0245-0.0919) No +/-**	**Within CI Trauma (0.0289-0.0993) No +/-**
Chan et al, 2012	1725	7-8mnths post Sichuan quake	.008 (dep)	No -	
Chou et al, 2007	216	6mths post-Chi Chi quake	n/s (trauma)		No -
Kun et al, 2009	446	2.5mths post Wenchuan quake	.04 (trauma heavily-damaged), .11 (trauma moderately-damaged)		Yes, No+
Kun et al, 2013	1890	2.5-3mths post Wenchuan quake	.15 (trauma)		No +
Seplaki et al, 2006	1160	Within one year (?) post Chi Chi quake	.001 (trauma)	No -	
Tang et al, 2014		Review	.0002 (trauma)	No -	
van der Berg et al, 2012	1116	18mnths post-fireworks accident	.001 (trauma)		No -
Yang et al, 2003	663	3-4mnths post-Chi Chi quake	.08 (trauma)		Yes

Income Reduction on Depression $\eta_p^2 = .02$ (0.0043-0.0464), and on Trauma $\eta_p^2 = .14$ (0.0016-0.0367) Of note in this literature sample (Table 11) are two studies investigating unresolved human-caused technical disasters. The oil spills in these studies can have devastatingly long-term mental health impacts due to disrupted livelihoods (Arata et al., 2000; Grattan et al., 2011) . Communities making their livelihood from the surrounding environment are at risk for trauma when the environment is impacted by disaster (van Griensven et al., 2006; M. G. Weiss, Saraceno, Saxena, & Van Ommeren, 2003). In the Kita Ibaraki study sample, only a small percentage of respondents were associated with the fishing industry, so the direct impact of ocean contamination was probably dispersed. Job loss also explained high levels of trauma in a low-income community impacted by Hurricane Ike, although predicted levels of depression were lower (Norris et al., 2010). Proportion of variance approached the upper bound of the trauma confidence interval almost two years post-Katrina in an economically-stressed community (Galea, Ahern, et al., 2008). In contrast, the effect of income loss on

trauma following personal accidents seems small when compared to community-encompassing events (Maes, Mylle, Delmeire, & Janca, 2001).

Table 11 *Summary of studies: Effect size of Income Reduction on Depression and Trauma*

Author, Year	**Size (N)**	**Time/Event**	**Effect Size (η^2)**	**Within CI Depression (0.0043-0.0464) No +/-**	**Within CI Trauma (0.0016-0.0367) No +/-**
Arata, et al 2000	125	6yrs post-Exxon Valdez spill	.06 (dep & Trauma) "loss spiral"	No +	No +
Galea et al, 2008	810	18-24mths post-Katrina	.03 (trauma)		Yes
Gratten et al, 2011	71	During Horizon Deepwater Oil Spill (5mths)	.06 (dep)	No +	
Maes et al, 2001	182	7-9 mnths post-Motor accident, nightclub fire	.007 (trauma)		Yes
Norris et al, 2010	658	2-6mths post-Hurricane Ike	.02 (dep) .096 (trauma)	Yes	No +

Results 2: Controlling Social Support-Based Relational Satisfaction

The next step to this analysis is to investigate relational satisfaction from social support. Shakespeare-Finch and Green found strong correlations following a natural disaster at the r = .49-.62 level between positive relations and support, both receiving and providing (Shakespeare-Finch & Green, 2013). The aim is to see how relations based on receiving and providing support in the early months after the disaster in Kita Ibaraki influence the predictor variables on symptomology as covariates. Controlling the covariates through ANCOVA can measure the amount of influence these covariates exert on the predictor variable by the effect size change on the outcome variable. If there is an influence, then it can be concluded that social support -- conceptualized as relational satisfaction through social support -- is associated with post-disaster symptomology. This investigation can be posed as the question: What effect size do the independent predictor variables of demography and disaster impact have on the outcome variables when relational satisfaction from support is controlled?

Before the covariate analysis was done, the reliability of BISSEN was examined. The BISSEN tests three factors: support type by relational group, density of support network, and satisfaction with the support relationships. Reliability tests were conducted separately. Cronbach's alpha for each relational group -- family, relatives, friends, neighbors, colleagues, and other -- for both receiving and providing support was between α = .82-.76 which showed high reliability and internal consistency. For a new test such as BISSEN, $\alpha > .70$ is recommended (Lance, Butts, & Michels, 2006). Items that tapped support network density – i.e., how well people from whom support was received or to whom was provided knew each other – had high reliability α = .82 and were also highly correlated at r

= .69. Relational satisfaction scales from provided and received support also had high reliability α = .87 with high correlations *r* = .76.

Prior to the ANCOVA measuring the effect of relational support satisfaction on symptomology, correlations were investigated between the different relational categories and support satisfaction, relational categories and symptomology, network density and satisfaction, and network density and symptomology. Since relational satisfaction in this instrument did not differentiate between emotional and tangible support, these support types were combined into single components using Principal Components Analysis. High correlations provided a positive manifold to treat relational categories as single components. Separate receiving and providing support components were created for each relational category, and there were combined receiving-providing support components for each relational category (Table 12). Relational satisfaction scales were also combined into a composite because of high correlations between these variables and very high component loadings (0.934) (Table 13).

With the exception of a small correlation between Provided Support Relational Satisfaction x Other: Receiving Support *r* = .098, and x Other: Combined Support *r* = .093, both p<.05, there were no significant interactions between relational satisfaction and relational categories, nor between symptomology and relational categories (Table 14). Also, there was no correlation between network density and these variables (Table 15). These results show how the BISSEN tests social support and symptomology. Question items about support source and support network density do not yield data about symptoms, but items about relational satisfaction do.

Table 12
BISSEN scale descriptive statistics and within-relational category correlation matrix

Family		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Family	**Received Emotional Support**	1				.754
	Received Instrumental Support	.516**	1			.825
	Provided Emotional Support	.542**	.523**	1		.831
	Provided Instrumental Support	.413**	.573**	.675**	1	.821
	Cronbach's α	.821				
Relative		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Relative	**Received Emotional Support**	1				.761
	Received Instrumental Support	.530**	1			.798

	Provided Emotional Support	.535**	.675**	1		.841
	Provided Instrumental Support	.432**	.616**	.609**	1	.835
	Cronbach's α	.824				
Friend		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Friend	**Received Emotional Support**	1				.762
	Received Instrumental Support	.368**	1			.709
	Provided Emotional Support	.542**	.387**	1		.836
	Provided Instrumental Support	.387**	.616**	.524**	1	.763
	Cronbach's α	.769				
Neighbor		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Neighbor	**Received Emotional Support**	1				.761
	Received Instrumental Support	.451**	1			.764
	Provided Emotional Support	.552**	.498**	1		.847
	Provided Instrumental Support	.432**	.503**	.503**	1	.809
	Cronbach's α	.803				
Colleague		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Colleague	**Received Emotional Support**	1				.736
	Received Instrumental Support	.426**	1			.756
	Provided Emotional Support	.469**	.368**	1		.816
	Provided Instrumental Support	.426**	.619**	.471**	1	.770
	Cronbach's α	.741				
Other		**Received Emotional Support**	**Received Instrumental Support**	**Provided Emotional Support**	**Provided Instrumental Support**	**Component Weightings**
Other	**Received Emotional Support**	1				.741
	Received Instrumental Support	.426**	1			.724
	Provided Emotional Support	.469**	.358**	1		.797

	Provided Instrumental Support	.426**	.493**	.609**	1	.829
	Cronbach's α	.760				

**p<.01

Table 13

Correlations between outcome variables and relational satisfaction based on received and provided social support

	CES-D	**IES-R**	**Relational Satisfaction w/ Receiving Support**	**Relational Satisfaction w/ Providing Support**
CES-D	1	.601**	.305**	.331**
IES-R		1	.234**	.215**
Relational Satisfaction w/Receiving Support			1	.762**
Relational Satisfaction w/ Providing Support				1

**p<.05

Table 14

Correlation matrix: relational categories vs. relational support satisfaction, symptomology

		Relational Satisfaction w/ Receiving Support	**Relational Satisfaction w/ Providing Support**	**Combined Relational Support Satisfaction**	**CESD**	**IESR**
Family Support Components	Received	-.032	-.036	-.044	.000	.005
	Provided	-.063	.008	-.020	-.046	-.042
	Combined	-.053	-.015	-.036	-.025	-.021
Relative Support Components	Received	-.007	.039	.017	-.026	-.024
	Provided	.051	.016	.024	-.035	.006
	Combined	.024	.028	.021	-.032	-.007
Friend Support Components	Received	-.016	-.083	-.067	-.024	.028
	Provided	-.018	-.057	-.056	-.038	-.009
	Combined	-.019	-.075	-.067	-.036	.008
Neighbor Support Components	Received	-.073	-.039	-.069	.020	.028
	Provided	-.008	.003	-.010	.038	.060
	Combined	-.043	-.019	-.042	.034	.050
Colleague Support Components	Received	.039	.045	.049	.005	.042
	Provided	.039	.059	.057	-.031	.003
	Combined	.042	.057	.057	-.015	.023
Other Support Components	Received	.051	**.098***	.083	.046	.034
	Provided	.056	.070	.070	.043	.031
	Combined	.060	**.093***	.085	.050	.037

*p<.05

Table 15

Correlation matrix: network density vs. relational support satisfaction, symptomology (p-value)

	Relational Satisfaction w/ Receiving Support	**Relational Satisfaction w/ Providing Support**	**Combined Relational Support Satisfaction**	**CESD**	**IESR**
Received Support Network Density	.049 (.298)	.001(.977)	.026(.590)	-.026(.585)	.029(.531)
Providing Support Network Density	.051(.282)	.021(.662)	.039(.420)	-.044(.352)	.057(.230)

Results: The effect of relational support satisfaction on symptomology

In the ANCOVA analysis, relational satisfaction levels from provided and received support were controlled as separate covariates, and the combined received-provided composite component of both types of relational satisfactions was also controlled. It is common in research examining satisfaction towards provided social support to also examine satisfaction levels towards reciprocity. With a composite component, satisfaction towards both kinds of support can be investigated without losing degrees of freedom, and it only becomes necessary to do one homogeneity of co-variance test.

Prior to each covariance analysis, the assumption of the homogeneity of regression was tested. This is to see if the covariate has an equal regression coefficient associated with across all groups in a predictive category. If it fails to be rejected, then regression coefficients for each group on symptomology are not significantly different . If rejected at the $\alpha<.05$ level, then the between-group regression differences are significant, and an overall effect size change for that predictive variable cannot be estimated.

Table 16
Effect size changes (in parenthesis) from ANCOVA controlling for relational satisfaction from received and provided social support

Predictor	**Outcome**	**Effect size (η_p^2)**	**Controlling Composite Satisfaction**	**Controlling Provided Satisfaction**	**Controlling Received Satisfaction**	**$\lvert M_{predictor}\ \Delta\eta_p^2\rvert$**
Gender	IES-R	0.0158**	0.0130** (-.0028)	**0.0122** (-.0036)**	0.0155** (-.0003)	|.0022|
Age	CES-D	0.02785***	0.02654*** (-.00131)	0.02789*** (+.00004)	**0.02575*** (-.0021)**	|.00115|
Marital Status	IES-R	0.01673**	?	?	?	
Casualty Acquaint.	CES-D	0.0113**	0.0139** (+.0026)	0.0118** (+.0005)	**0.0144** (+.0031)**	|.0021|
Water Incursion	CES-D	0.0198***	**0.0181*** (-.0017.)**	0.0193*** (-.0005)	0.0189*** (-.0007)	|.0010|
	IES-R	0.0234***	?	?	**0.0217*** (-.0017)**	|.0017|
Home Damage	CES-D	0.0604***	?	**0.0652*** (+.0048)**	?	|.0048|
	IES-R	0.0665***	?	**0.0632*** (-.0033)**	?	|.0033|
Income Reduction	CES-D	0.0202***	?	**0.0222*** (+.0022)**	?	|.0022|
	IES-R	0.0137**	0.0124** (-.0013)	0.0145** (+.0008)	**0.0090** (-.0047)**	|.0023|
Covariate $\lvert M\Delta\eta_p^2\rvert$			|.00194|	|.00197|	|.0021|	

***p<.005, **p<.05, ?= Homogeneity of regression test does not hold at the $\alpha<.05$ level

$\lvert M\Delta\eta_p^2\rvert$ = Absolute value mean average of effect size change

Largest effect size changes **in bold, $\lvert M\Delta\eta_p^2\rvert$ = \|.0030\|**

Table 16 shows the ANCOVA results. The differences between the groups in the categories of gender, age, casualty acquaintance, water incursion for depression, and income reduction for trauma still manifest themselves in the data for each covariate controlled. In house damage for both symptomologies, and in income reduction for depression, the relational satisfaction based on providing social support covariate had homogeneity of regression, but the other two covariates did not. In water incursion for trauma, the relational satisfaction based on receiving social support covariate had homogeneity of regression. Only in marital status did none of the covariates pass the homogeneity test, meaning the regression coefficient for each group within this category was significantly different.

Gender For gender, the largest change came from the covariate of relational satisfaction was negative from *providing* social support, $\Delta\eta_p^2 = -.0036$. The change was above the mean of largest changes at $|M\Delta\eta_p^2| = |.0030|$. The proportion of variance in trauma scores were explained less by gender when relational satisfaction from social support was removed. The changes were uniform across the covariates, meaning the changes were all in the same direction. Therefore, providing support, receiving support, and the composite all exert change on the predictor variable in the same way and make it more robust.

Age The covariate responsible for the greatest change in effect size was relational satisfaction from *received* support $\Delta\eta_p^2 = -.0021$, which was below the mean of largest changes. The outcome of depression was less predicted by age without this covariate. Interestingly, there was not uniformity among the changes exerted by the covariates, because controlling for *provided* support-based relational satisfaction raised the predictive power, although at a much smaller level. This shows that support exert changes in both directions for this variable.

Marital Status Because none of the covariates passed the test for homogeneity of regression, effect size changes for each covariate could not be investigated.

Casualty Acquaintance There was uniformity in effect size change among the controlled covariates. This category became a weaker predictor for depression, which is not surprising since satisfaction with relations may buffer against depression associated the loss of relations associated with disaster. The largest change was exerted by satisfaction from *received* help $\Delta\eta_p^2 = +.0031$ which is slightly larger than the mean of largest changes.

Water Incursion/Depression The composite support-based relational satisfaction covariate exerted the largest effect size change. The change was negative $\Delta\eta_p^2 = -.0017$, which means that it was a strong predictor when the covariates were not controlled. It was smaller compared to the mean of largest changes. The changes were uniform across all covariates. The average of all the covariate changes was in this category was the smallest among all predictor categories.

Water Incursion/Trauma The only covariate to pass the regression of homogeneity test was for relational satisfaction from *receiving* social support. The change was $\Delta\eta_p^2$ = -.0017, smaller compared to the mean of largest changes.

House Damage/Depression This category only had one covariate pass the regression homogeneity test: *provided* support-based relational satisfaction. However, the change was very large $\Delta\eta_p^2$ = +.0048. This was the largest effect size change among all covariates in all categories. The direction of the change was positive meaning that house damage became a more robust predictor of depression with relational satisfaction removed. Stated differently, relational satisfaction based on providing support buffered against the depression-associated effects of house damage.

House Damage/Trauma Similar to the above category, the only covariate with homogeneity of regression was *provided* support-based relational satisfaction. However, the direction of the change was negative $\Delta\eta_p^2$ = -.0033, which is slightly larger than average. Interestingly, within the house damage predictor, this similar covariate changed the direction of the effect size depending on the outcome variable.

Income Reduction/Depression Similar to both outcome categories connected to house damage, only *provided* support-based relational satisfaction passed the regression homogeneity test. In addition, similar to house damage/depression, the effect size change was positive $\Delta\eta_p^2$ = +.0022 and smaller. Because the proportion of depression variance from income damage was greater without the covariate, relational satisfaction weakens this variable as a predictor, which suggests buffering.

Income Reduction/Trauma All covariates had homogeneity of regression, but this category was the only category besides age where the effect-size change among covariates was not uniform. The largest effect size change was when relational satisfaction from *received* support was controlled and was negative $\Delta\eta_p^2$ = -.0047. This was close to largest effect size change. Also similar to age, *provided* support-based relational satisfaction influenced the effect size in the opposite direction at a smaller level $\Delta\eta_p^2$ = +.0008. Social support through relational satisfaction exerts change in both directions for this variable.

In summary, the effect on the outcome variable explained by differences between groups in each predictive category either increased or decreased when social support-related satisfaction was controlled. Looking at which controlled covariate exerted the biggest effect size change, this was also different for each predictive category. For age, casualty acquaintance, and income reduction (trauma), the largest change was relational satisfaction based on *receiving* support. For gender, house damage (both symptoms), and income reduction (depression), *providing* support exerted the biggest change. For water incursion (depression), the composite component of both types of support was responsible for the largest change. Five categories had homogeneity of variance for all covariates, although in two of these categories (age and income reduction/trauma) the effect size changes were not all in the same direction. In

the predictive categories where only one covariate passed the homogeneity of regression test (house damage for both symptomologies, income reduction for depression, and water incursion for trauma), relational satisfaction from *providing* support was the passing covariate for both house damage outcomes and income reduction. For water incursion/trauma, *receiving* support passed the test.

Discussion

These results support the prediction that social support in the form of relational satisfaction based on social support has an influence on outcome symptomology. The mean of largest changes was $|M\Delta\eta_p^2| = |.0030|$. Controlling for relational satisfaction from *providing* support was responsible for the largest effect size changes in four of the predictor categories, four were from *receiving* support, and in one predictor the largest changes were from the composite provide/receive component. Therefore in general using this set of predictors, providing support affected the outcome as much as receiving support. However, the average effect size change was larger for received support-based relational satisfaction $|M\Delta\eta_p^2| = |.0021|$ than for provided support-based satisfaction $|M\Delta\eta_p^2| = |.00197|$. The satisfaction composite average effect size change was $|M\Delta\eta_p^2| = |.00194|$. Therefore, while we can say that providing and receiving support influenced an equal number of predictive variables, it is possible that the influence from received support was larger on aggregate. The social support composite component had the largest influence on only one outcome variable, water incursion on depression. Reciprocity could be a major factor for this outcome. Shakespeare-Finch and Green credit "bi-directionality of support" with interpersonal well-being. This indicates a potentially interesting area for further study.

In age and income reduction/trauma categories, controlling the covariates both lowered and raised the effect size change. Non-uniformity of effect size change shows that support*predictor interaction is complex in these categories. Interestingly, in both these categories, relational satisfaction from *provided* support raised the effect size estimate, while *received* support lowered it greater.

The next issue to consider the results in context of post-disaster social support and morbidity . It is possibly easier to draw conclusions from the positive effect size changes than negative ones. If the proportion of symptomology variance is explained more by the predictor variable when the covariate is controlled, we can say relational satisfaction from social support makes the predictor less robust for morbidity. In other words, the covariate insulates – or "buffers" – the subject from the effects of the predictor variables. This "buffering", signified by positive effect size changes when covariates are controlled, occurs only in the impact variables predicting depression, except for one small effect size change in income reduction/trauma. Even for age -- the demographic variable predicting depression – one covariate shows positive effect size change. It is also important to note that except for the casualty acquaintance factor, all positive effect size changes for predicting depression occurred with controlling *providing* social support. This reflects the findings of Taylor and Turner that a feeling of others having to depend on you is associated with lower scores for depression .

A causal relationship between social support and depression may be inferred from changes of effects size in a positive direction, but negative changes are difficult to interpret. Controlling the covariate makes the trauma predictor less robust (except for marital status in which none of the covariates passed the regression homogeneity test). Because results are consistent across all categories, relational satisfaction from social support may be considered one useful indicator of PTSD symptomology, as has been confirmed in other review studies . However, the results of this study are the opposite of others where social support buffers against PTSD levels . This may be an issue of data interpretation, as the direction of the association between support and stress is not always clear. For example, for a population with both high stress and high social support, the support could be the source the stress, or support sought due to stress .

Overall, comparing results with other research may be difficult because other studies do not use this method to understand how social support influences outcomes. However, understanding the influence of relationship satisfaction on effect size can help to clarify how predictive variables affect outcome variables. Furthermore, as post-disaster social support research comes to focus on support reciprocity, understanding the dynamic between providing and receiving support becomes more important. In this study, four out of nine predictors for symptomology were related to survivors providing support to other survivors.

Finally, a comment about the size of effect size changes when relational satisfaction is controlled. In each predictor category, mean changes ranged from $|M_{\text{predictor}}\Delta\eta_p^2| = |.0010|$ (water incursion/CES-D) to $|M_{\text{predictor}}\Delta\eta_p^2| = |.0048|$ (home damage/CES-D), with an overall mean average change of $|M_{\text{all predictors}}\Delta\eta_p^2| = |.0023|$. The effect size changes are in hundredths of percentage points. These effect size changes may appear marginal, but these small changes in measurement are still pertinent and should be considered in context. During intense episodes – which certainly the continuing radiation disaster is -- Abelson said "…one should not necessarily be scornful of miniscule values for percentage variance explanation, provided there is statistical assurance that these values are significantly above zero…" (Abelson, 1985:133)

Conclusion

This paper attempts to answer two questions about a self-selected population in the early stages of a continuing technical disaster immediately following a natural disaster. First, among a set of predictor variables which are the strongest indicators of post-disaster depression and trauma? Secondly, does social support change the effect size on the outcome variables? Social support in this study is measured as the level of satisfaction concerning a supportive relationship. This supportive relationship can be receiving support from someone or providing support to someone. Reciprocal support is not directly investigated here, but measured statistically through a composite variable. Therefore, a corollary to the second question concerning social support on morbidity is: Is providing support

beneficial to post-disaster mental health? This question has received little attention compared to receiving support.

The answer to the first question is, for depression the strongest predictors: house damage, age, income reduction, home water incursion, and casualty acquaintance; for trauma, the strongest predictors are: home damage, home water incursion, unmarried status, and female gender. Education level, location during the disaster, and workplace damage proved non-significant for both outcome variables. Morbidity levels were low compared to other human-created disasters, but comparable to other studies of well-sourced communities heavily impacted by natural disasters who could remain either in their homes or community.

Concerning the second question, controlling for relational satisfaction based on all three types of social support satisfaction changes effect sizes of the social and impact variables on depressive and traumatic symptomology. In general, controlling for provided-support based relational satisfaction enacts a positive change in depression effect size, suggesting a "cause-effect" buffering relationship. It is difficult to compare these results with other research. For example, providing support has been found not to predict depression in a non-disaster situation (Shakespeare-Finch & Obst, 2011), and the one other study examining post-disaster provided support does not consider depression directly (Shakespeare-Finch & Green, 2013). The advantage of the present study is that the provided-support is measured in terms of community relations, and treated as a covariate of other demographic and impact variables. This approach helps to clarify community-wide behavior after a disaster.

On the other hand, controlling for received-support based relational satisfaction results in a negative change in the predicted proportion of trauma. These results are more difficult to explain, although it may indicate that individuals feeling higher levels of trauma may be more sensitive to received support. In addition, difficulty in interpreting results may be due to no data about perceived and actual received support. The benefits of perceived social support -- "cognitive appraisal of being reliably connected to others" (Barrera, 1986) – in post-disaster mental health has been the subject of many studies (see for example, Bokszczanin, 2012; Kaniasty & Norris, 2009; Lowe, Chan, & Rhodes, 2010; Miyazaki, Kodama, & Sasaki, 1991; Norris & Kaniasty, 1996; Panagioti, Gooding, Taylor, & Tarrier, 2013; Procidano & Heller, 1983). Based on Wethington and Kessler's (Wethington & Kessler, 1986) idea that actual support's salutary effects come from raising perception of support, Norris and Kaniasty suggested a Social Support Deterioration Deterrence (SSDD) model, where disaster lowers perception of support, which can add to distress (Norris & Kaniasty, 1996; see also Tyler, 2006). In general, actual received support and trauma exposure are highly correlated, and perceived support is negatively (Kaniasty, 2005). It is important to note the dichotomy between perceived and actual support has been questioned for two reasons (Hobfoll, 2009). One reason is data depends on the recall of survey respondents for two distinct time periods: actual support focuses on the specificities of the stressful event, while perceived support covers various relations over a wider period. Another reason is if respondents were well-

supported in the pre-event period, they may "perceive" the presence of post-event support based on experience. The pre-disaster support level of respondents in this study is not known, nor whether support is perceived or real. However, the effect size changes are consistently in the same direction for the IES-R outcome variable when the covariate is controlled. This shows the methodology is measuring reliably; *what* it is measuring is less clear.

There are other important issues to consider. The impact of natural, human-made, and technical disasters on mental health of older adults can vary. Individual severity depends on numerous factors such as direct exposure, disruption to personal and familial resources, availability of and willingness to accept support, and experiences prior to the event including socioeconomic conditions and prior morbidity (Cook & Elmore, 2009; Norris et al., 2002). Therefore, it is difficult to establish a vulnerability differentiation based on age (see also Kun et al., 2009; Xu & Wu, 2011). Furthermore, concerns remain that earlier questions concerning mechanisms (for example, see House, Landis, & Umberson, 1988) have not been sufficiently addressed and remain unidentified. More specifically, the pathways linking social interaction and psychological health require elucidation. Identifying these pathways can aid in the development of intervention strategies (Thoits, 2011; see also Uchino, Cacioppo, & Kiecolt-Glaser, 1996). In this regard, the results of Holt-Lunstad and colleagues' (Holt-Lunstad et al., 2010) review linking social isolation with higher rates of mortality may be especially important, especially in community-based interventions. These results suggest that interventions encouraging social interaction or that build-upon existing social networks may be efficacious. Future intervention programs could consider this.

This study has several limitations. One problem involves sampling. Respondents were self-selected individuals who volunteered for assessment from one area of the city. Because this is not a random sample, it cannot be said to represent accurately the city's population. The results of this study can only be applied to volunteers for an intervention program. A connected issue is the sample of employed respondents. Almost one-half of respondents were unemployed or retired, which may have lowered the effect size for workplace damage on outcome symptomology. To check this, a Welch's t-test on only the employed group was performed with workplace damage as the predictor variable. In fact, there was no significant difference between means for either symptomology: CES-D $t(239)=.467$, $p=.650$, IES-R $t(238)=.013$, $p=.990$. Therefore, workplace damage did not exert a significant effect size for symptoms overall with this sample.

Another issue involves the test items themselves. Much of the data was self-reported which is problematic. There were not questions about pre-disaster traumatic experiences. Assessing the communities in Kita Ibaraki City may also require inquiring into attitudes about nuclear energy. This is because the community is affected by a continuing technical disaster from the Fukushima nuclear power plant, although the association between negative concern and negative outcomes is dubious (Freudenburg & Jones, 1991).

The cross-sectional design is also a weakness of this study. Controlling for social support satisfaction both raised and lowered effect size changes. These results demonstrate the difficulty of cross-sectional disaster research because predictors and outcomes are confounded (Bonanno et al., 2010). Cross-sectional design cannot investigate temporal relations between distress and social support. This problem of clarifying "perceived" support discussed earlier is connected to the issue of time. Longitudinal research will be necessary to understand the impact of the contaminated ocean on livelihood, especially on the fishing and tourism industries.

"Reciprocity" in this study may be problematic because it was a covariate created by statistically combining the two other "received" and "provided" support covariates. In general, there may be construct validity due to the absence of reliable testing instruments. For example, current tests measuring reciprocity in supportive relationships have difficulty differentiating between instrumental and emotional support (Shakespeare-Finch & Obst, 2011). This is important since there have been studies showing the deleterious effects of instrumental support on physical health (Hays, Saunders, Flint, Kaplan, & Blazer, 1997; Seeman, Bruce, & McAvay, 1996).

Another possible criticism of this study is the use of ANCOVA in a non-experimental design. Co-variance analysis is generally used to control noise in experiments rather than in multi-variable prediction (Tabachnick & Fidell, 2001). For this study ANCOVA was used to get a clearer picture of the interaction – interpretable as "noise" – between social support-based relational satisfaction and the predictor demographic and impact variables. While regressing each predictor group on the outcome symptomology variables can yield important information about the association between these variables, the emphasis of this study was on effect size estimation, which is better understood through controlling covariates. Effect size reporting is considered essential by the APA Task Force on Statistical Inference (Wilkinson & APA Task Force on Statistical Inference, 1999). Furthermore, using the prior homogeneity of regression test is a convenient way of rejecting the null hypothesis that there was no social satisfaction by demographic or impact effect on symptomology.

The results appear to confirm the beneficial effects of "mutual aid" (*gōjō* in Japanese) on mental health. Mutual aid is considered one component of "social capital" (Ichida, Goshu, Hirai, Kondō, & Kobayashi, 2005). Recent studies (Goryakin, Suhrcke, Rocco, Roberts, & Mckee, 2013; Rothon, Goodwin, & Stansfeld, 2012; Thuy & Berry, 2013) appear to confirm positive mental health outcomes through increased social participation. Researching the association is difficult because of conceptual differences: social capital is a collective phenomenon, while mental health concerns the functioning level of the individual (De Silva, McKenzie, Harpham, & Huttly, 2005; McKenzie, Whitely, & Weich, 2002). However, recent research in Japan on the elderly in non-disaster situations uses multi-level analysis to examine the relationship between individual health status changes and the social environment (Aida et al., 2009; Fujisawa, Hamano, & Takegawa, 2009; Hanibuchi, Kondo, Murata, & Hirai, 2010; Ichida et al., 2009; Ichida, Goshu, Hirai, Kondō, & Kobayashi, 2005; Kondō, Hirai,

Takeda, Ichida, & Aida, 2010; Kondō, 2010). By operationalizing mutual aid as post-disaster receiving and providing support, this research may help to clarify social capital's relationship with human health.

Overall, the Kita Ibaraki intervention is for a community currently facing considerable challenges. Although outside the evacuation area and still relatively intact, it remains an example of Edelstein's "mitigatory gap": "In toxic events, the epicenter may be physically dangerous, but the margins are a social catastrophe." (Edelstein, 2004:165). The psychosocial effects of this continuing technical require regular monitoring so the most effective intervention protocols can be established. The intervention also serves the need (Bonanno, Westphal, & Mancini, 2011) of contributing to the corpus of resilience literature by generating longitudinal data. Variables in combination predict mental health outcomes (Bonanno et al., 2010), so to meet demands of community (Kaniasty & Norris, 1995) diverse instruments to measure psycho-social impacts are necessary. A longitudinal intervention by, with, and for the community will hopefully enable the community to maintain of altruism over time. Understanding the dynamic of providing and receiving social support and its association with positive community relations may be key to the continuing this feeling of altruism.

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