

The impact of the Chi-Chi earthquake on quality of life among elderly survivors in Taiwan – A before and after study

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Abstract

This paper examines the impact of the Chi-Chi earthquake, which hit central Taiwan on September 21, 1999, on the quality of life among the elderly survivors. The 28-item Taiwanese-adapted brief version of the World Health Organization's quality of life questionnaire (WHOQOL-BREF) was used to measure quality of life in four domains: physical capacity, psychological well-being, social relationships, and environment. These measures were coincidentally collected in a separate study from 368 subjects aged 65 and older in the affected area shortly before the earthquake. Of these subjects, 268 were interviewed in a follow-up assessment 12 months after the earthquake. Linear mixed models were applied to investigate how quality of life in each of the four domains changed from the pre-earthquake assessment to 12 months after the earthquake, and how these changes depended on the level of damage to residences. In conclusion, elderly survivors tended to report lower quality of life in physical capacity, psychological well-being, and environment 12 months after the earthquake than at the assessment prior to the earthquake, regardless of the level of damage to their residences during the earthquake. However, those whose residences completely collapsed during the earthquake reported a higher quality of life in social relationships while others reported the opposite.

Key words: Earthquake, Elderly, Epidemiology, Quality of life, Taiwan, WHOQOL-BREF

Abbreviations: WHOQOL-BREF – brief version of the World Health Organization's quality of life questionnaire; ADL – activities of daily living; GDS – geriatric depression scale; MMSE – mini-mental state examination; CI – confidence interval

Introduction

At 1:47 a.m. on September 21, 1999, an earthquake rated 7.3 in the Richter scale struck the central region of Taiwan with its epicenter at Chi-Chi, Nantou County, killing 2,437 people [1], and injuring more than 11,305 [2]. It also caused 107,002 houses to collapse and resulted in financial losses of about US\$11.5 billion [2].

The elderly were more vulnerable than others during and after the earthquake. The death toll for people aged 65 or older was 645 which comprised 27% of the total deaths due to the earthquake even though the people in this group account for only 8.1% of the total population in Taiwan. Several studies have confirmed that elderly people experience higher mortality rates during earthquakes [3–5] than do the younger ones. It has also been de-

termined that elderly earthquake survivors are more likely to suffer from acute earthquake-related deaths such as heart disease [6–10] and stroke (11). Further, they are at a greater risk of psychological morbidity [12, 13].

While these epidemiological studies have focused on univariate measures of mortality or morbidity [3–14] resulting from earthquakes, the multidimensional impacts of earthquakes on the quality of life remain little explored. Quality of life is multi-dimensional construct that includes at least such domains as physical capacity, psychological well-being, social relationships, and environment. The detailed information collected on quality of life measures in these domains is useful in assisting health workers in identifying and meeting the needs of elderly survivors. This is especially important because the elderly survivors tend to report fewer complaints than do younger survivors after experiencing a natural disaster [3, 15]. In addition, there is evidence that a large amount of resources, both domestic and international, was under-utilized in the efforts to assist the earthquake victims [16], and therefore, knowledge of changes in quality of life over time after an earthquake might help guide health programs to efficiently allocate resources at different times.

This article presents a 12-month follow-up study comparing the before- and after-earthquake quality of life among elderly survivors. The before-earthquake information was coincidentally collected in an initial assessment interview administered in a separate study shortly before the earthquake hit the area.

Materials and methods

Study subjects

Shin-Sher Township, Taichung County is a rural agricultural area with a high proportion of elderly people. The percentage of residents aged 65 and older is 11.9%, compared to 8.6% in Taiwan as a whole. Out of 13 villages in Shin-Sher Township, two villages that had the largest elderly populations were selected for a fall-related study (Risk Factors for Falls among Rural Elderly People), sponsored by the National Science Council and China Medical College, Republic of China, in

1999. A total of 608 people aged 65 or older in the two villages were on record in the Household Registration Office at Shin-Sher Township when the study started. Household Registration Offices in Taiwan are responsible for collating and disseminating demographic information and officially recognizing personal status and relations. Excluding those elderly who were not ambulatory, the study identified 368 subjects who agreed to participate in the initial assessment. This assessment was completed during the week of September 13 to 18, 1999, shortly before the Chi-Chi earthquake hit the area on September 21. A follow-up assessment was conducted 12 months after the earthquake. Of the 368 subjects who participated in the first assessment, only 268 were interviewed in the follow-up assessment. The remaining 100 subjects did not participate because 17 had died, 5 were hospitalized, 15 had moved out of the area, 14 were lost to follow-up, and 49 declined the follow-up interview. Most of the subjects who declined the interview did so because they were weary of the earthquake subject after the terrible disaster.

Of the 368 subjects who participated in the initial assessment, 17 and 28 suffered complete and partial collapse of their residences during the earthquake, respectively. Of the 268 subjects that participated in the follow-up assessment, 6 and 23 suffered complete and partial collapse of their residences during the earthquake, respectively.

The 368 subjects that participated in the initial assessment were found not to statistically differ with respect to the distribution of age, gender, and level of damage to their residences during the earthquake from the remaining 270 elderly that were on record in the House Registration Office when the study started but who did not participate in the study. Pearson χ^2 -statistics for the three variables were 2.1, 0.0, and 1.4, respectively. Further, the 268 respondents to the follow-up assessment were found not to statistically differ with respect to the distribution of age and gender from the 100 non-respondents. Pearson χ^2 -statistics were 2.9 for age and 0.7 for gender, respectively. However, the percentage of subjects whose residences had completely collapsed during the earthquake among the 268 respondents of the follow-up assessment was smaller than that among the 100 non-respondents. The Pearson χ^2 -statistic

was 7.0. In other words, subjects whose residences completely collapsed during the earthquake were less likely to agree to be interviewed at the follow-up assessment than subjects whose residences partially collapsed or remained intact.

Data collection

At the initial assessment, personal interviews with structured questionnaires were conducted at the subjects' residences by trained interviewers to collect related information. Interview procedures and interviewers' attitudes were standardized by a 4-hour training course. An interview session lasted approximately 30–50 min.

The major component of the interview was to assess health-related quality of life among the elderly with respect to what they had experienced during the 2 weeks prior to the interview. The Taiwanese-adapted brief version of the World Health Organization's quality of life (WHOQOL-BREF) [17, 18] was used for this purpose. This brief version was developed in 1999 in compliance with World Health Organization (WHO) guidelines [19, 20]. A core team was responsible for translating the definitions of WHOQOL facets (items) from English into Chinese and adding new items (facets) of local importance. The translation was carefully reviewed by a separate group of monolingual and bilingual individuals [21]. The review process included translating the definitions from Chinese back into English and then comparing that with the original English version. Excellent reliability and validity of this adapted version were reported [17]. As detailed in the Appendix, the Taiwanese-adapted WHOQOL-BREF comprises 26 items translated from the original WHOQOL-BREF [22], plus two additional items of local importance. The first two questions in the Taiwanese-adapted WHOQOL-BREF concern the overall quality of life. According to the WHOQOL group, the remaining 26 items can be appropriately grouped into four major domains [17, 18]. More specifically, Q3, Q4, Q10, Q15, Q16, Q17, and Q18 are grouped into the physical domain; Q5, Q6, Q7, Q11, Q19, and Q26 are grouped into the psychological domain; Q20, Q21, Q22, and Q27 are grouped into social relationships; and Q8, Q9, Q12, Q13, Q14, Q23, Q24, Q25, and Q28 are grouped into the environmental domain. Each

question uses a scale that ranges from 1 to 5 with a higher score indicating a higher quality of life. Adding scores across all the items (facets) in one domain generates the raw score for that domain. This raw score is then standardized to a scale ranging from 0 to 100 to represent the score for that domain.

In addition to administering the Taiwanese-adapted WHOQOL-BREF, interviewers also collected information on birth date, gender, educational level, residence type (single, one-story, apartment), marital status (spouse present, widowed/divorced/single), smoking status, alcohol consumption, regular exercise, insomnia (never, 1–3, 4 days or more per week), comorbidity, depression level, cognitive status, and activities of daily life (ADL). In more details, comorbidity was assessed by a list of 24 comorbid conditions that are likely to affect the elderly. The level of depression was assessed by a short form of the geriatric depression scale (GDS) with 15 items [23]. The GDS scores range from 0 to 15. A score higher than 5 points is indicative of a tendency to clinical depression, and a score higher than 10 of severe depression [24]. Cognitive status was assessed by the mini-mental state examination (MMSE) [25]. Commonly used in epidemiological studies, this questionnaire assesses the cognitive status of subjects with respect to orientation, registration, and recall of information, attention and calculation, language, and visuospatial construction. Due to the lack of reading ability in a substantial proportion of the elderly participants, portions of the MMSE that require reading and writing were not used. A higher score on the MMSE is indicative of better cognitive status. Activities of daily living (ADL) were assessed by eight items including self-feeding, self-dressing, grooming, walking, transferring, bathing, controlling bladder and bowels, and the presence of another to help with ADL tasks [26].

At the follow-up assessment, the 28 items of the Taiwanese-adapted WHOQOL-BREF were re-assessed in a follow-up interview conducted at 12 months after the earthquake. In addition, information on the level of damage to the primary residence of subjects was collected. For this task, we recorded whether the primary residence of a subject had partially or completely collapsed during the earthquake, according to a list from the

local authorities based on assessments by structural architects. Partial or complete collapse of a residence represents additional intensity of exposure to the earthquake.

Data analysis

The goal of the analysis was to examine the impact of the earthquake on the quality of life among elderly survivors. Presumably, the intensity of exposure to the earthquake, which is reflected by the level of damage to one's residence in our data, is a key factor affecting the status of one's quality of life. Therefore, we included the level of damage to one's residence as a key predictor in our analysis.

Survivors can be classified into three groups depending on the level of damage to their residences: no collapse, partial collapse, and complete collapse. To ensure that subjects in these three groups were comparable prior to the earthquake, we first examined whether these three groups were similar with respect to baseline characteristics. To this aim, distributions of baseline characteristics among the three groups were compared using Pearson χ^2 -tests or Fisher's exact test for categorical characteristics and Mantel-Haenszel χ^2 -tests for ordinal characteristics.

Using one-way analysis of variance (ANOVA), we investigated how changes in scores of each domain from the initial to the follow-up assessment were related to the level of damage to one's residence and to baseline characteristics. This analysis provides a summary of the marginal relationships between changes in domain scores and level of damage to one's residence or a particular baseline characteristic. However, it neither controls for possible confounders, nor takes into account initial scores. To overcome these shortcomings, we used a linear mixed model [27, 28] for our primary analysis. This allowed us to investigate how quality of life measures changed over time and how this course depended on multiple potential factors. In this analysis, the two overall scores for quality of life and four domain scores were each treated as an outcome variable in the linear mixed model. One dummy variable was created for the follow-up assessment and two dummy variables were created for the elderly whose residences partially or completely collapsed, respectively.

We used a method developed by Kazis et al. [29] to quantify the clinical importance of the changes in quality of life in each of the four domains. By Cohen's criteria [30], the change in one domain is considered small, moderate, or large if the mean change in scores for that domain from the pre-earthquake assessment to 12 months after the earthquake divided by the standard deviation of the initial score is from 0.2 to 0.5, from 0.5 to 0.8, or greater than 0.8, respectively. Statistical Analysis Software (SAS) version 6.12 was used for all statistical analyses.

Results

Table 1 summarizes the distributions of baseline characteristics in the three groups classified by level of damage to one's residence. These three groups are similar with respect to all baseline characteristics except for ADL independence.

Table 2 shows average score changes of the four domains from the initial to the follow-up assessment among 368 elderly by characteristic. Elderly who were female or widowed/divorced/single, or who suffered insomnia 1–3 days per week responded with higher negative score changes in physical capacity. These who had the lowest baseline GDS scores were associated with higher negative score changes in the psychological domain. Neither residence status during the earthquake nor any baseline characteristic was significantly associated with score changes in social relationships. Elderly who were female, who had the lowest GDS scores, and who performed independently on eight items of ADL were associated with more negative score changes in the environmental domain.

The two overall scores for quality of life and the four domain scores are each treated as outcomes in the linear mixed model. Neither of the two overall scores for quality of life was found to have changed significantly from the initial assessment to 12 months after the earthquake (results not shown). The paths for these two overall scores did not depend on the level of damage to one's residence either.

The results of the linear mixed model treating each domain score as an outcome variable are shown in Table 3. In summary, scores in all do-

Table 1. Frequency (%) distributions of characteristics measured in the initial assessment among 368 elderly people according to residence status during the Chi-Chi earthquake in Shin-Sher Township, Taichung County, Taiwan

Characteristic	Non-collapse <i>N</i> = 323	Partial collapse <i>N</i> = 28	Complete collapse <i>N</i> = 17	<i>p</i> -Value ^a
Age (years)				
65–70	151 (46.8)	16 (57.1)	3 (17.7)	0.180
71–75	97 (30.0)	6 (21.4)	8 (47.1)	
76+	75 (23.2)	6 (21.4)	6 (35.3)	
Gender				
Female	139 (43.0)	13 (46.4)	12 (70.6)	0.082
Male	184 (57.0)	15 (53.6)	5 (29.4)	
Educational level				
Senior high and above	34 (10.9)	5 (20.0)	0 (0.0)	0.274
Elementary or junior high	182 (58.5)	15 (60.0)	10 (58.8)	
No formal education	95 (30.6)	5 (20.0)	7 (41.2)	
Residence type				
One-story house	95 (29.4)	16 (57.1)	9 (52.9)	0.489
Single house	197 (61.0)	10 (35.7)	8 (47.1)	
Apartment	31 (9.6)	2 (7.1)	0 (0.0)	
Marital status				
Spouse present	222 (70.7)	18 (66.7)	7 (43.8)	0.072
Widowed/divorced/single	92 (29.3)	9 (33.3)	9 (56.3)	
Current smoking				
No	234 (72.7)	23 (82.1)	14 (82.4)	0.394
Yes	88 (27.3)	5 (17.9)	3 (17.7)	
Regular alcohol consumption				
No	262 (82.1)	24 (88.9)	16 (94.1)	0.431
Yes	57 (17.9)	3 (11.1)	1 (5.9)	
Regular exercise				
No	116 (37.4)	9 (32.1)	8 (47.1)	0.638
Yes	194 (62.6)	19 (67.9)	9 (52.9)	
Insomnia (days per week)				
Never	192 (60.2)	14 (51.9)	8 (53.3)	0.207
1–3	87 (27.3)	7 (25.9)	4 (26.7)	
4+	40 (12.5)	6 (22.2)	3 (20.0)	
Falling during past year				
No	264 (81.7)	22 (78.6)	12 (70.6)	0.493
Yes	59 (18.3)	6 (21.4)	5 (29.4)	
Number of comorbid conditions				
0	84 (26.3)	5 (17.9)	2 (11.8)	0.430
1	72 (22.6)	9 (32.1)	6 (35.3)	
2+	163 (51.1)	14 (50.0)	9 (52.9)	
GDS score for depression^b				
0–5	246 (78.3)	21 (75.0)	10 (28.8)	0.176
6–10	50 (15.9)	4 (14.3)	4 (23.5)	
11+	18 (5.7)	3 (10.7)	3 (17.7)	
MMSE score for cognition^c				
0–18	149 (47.3)	14 (51.9)	10 (58.8)	0.208
19–22	121 (38.4)	6 (22.2)	4 (23.5)	
23	45 (14.3)	7 (25.9)	3 (17.7)	
ADL independence^d				
Seven items or below	28 (8.7)	5 (17.9)	5 (29.4)	0.011
Eight items	295 (91.3)	23 (82.1)	12 (70.6)	

^a Pearson χ^2 -test or Fisher's exact test (if expected number less than 5) for categorical variables or Mantel–Haenszel χ^2 -test for trends for ordinal variables.

^b A short form of the GDS: a higher score indicates a higher level of depression.

^c A higher score indicates better cognitive status.

^d ADL were feeding oneself, dressing, grooming, walking, transferring, bathing, controlling bladder and bowels, and the presence of another to help with ADL tasks.

Table 2. Score changes with standard deviation in each domain from pre-earthquake to 12 months after the earthquake according to residence status during the earthquake and baseline characteristics among 368 elderly in Shin-Sher Township, Taichung County, Taiwan

Characteristic	Physical capacity	Psychological well-being	Social relationships	Environment
Residence status during the earthquake				
Not collapsed	-1.8 ± 14.0	0.3 ± 18.7	1.5 ± 16.8	-1.3 ± 15.3
Partially collapsed	-3.9 ± 20.4	-0.7 ± 16.6	-1.4 ± 19.0	-3.4 ± 18.2
Completely collapsed	-6.0 ± 17.2	0.7 ± 13.0	12.2 ± 24.5	6.0 ± 9.8
Age (years)				
65–70	-1.2 ± 13.8	-1.6 ± 17.3	1.5 ± 15.7	-2.1 ± 13.4
71–75	-1.7 ± 12.7	1.0 ± 15.3	1.7 ± 17.4	1.2 ± 15.3
76+	-5.1 ± 18.4	3.6 ± 23.7	1.4 ± 19.9	-3.4 ± 18.8
Gender				
Female	-4.9 ± 16.9*	-1.8 ± 18.6	0.9 ± 18.0	-3.5 ± 17.6*
Male	-0.3 ± 12.5	1.9 ± 18.1	2.0 ± 16.6	0.3 ± 13.3
Educational level				
Senior high and above	-4.7 ± 16.0	-0.6 ± 17.6	-1.2 ± 20.5	-3.3 ± 18.8
Elementary or junior high	-1.9 ± 12.9	0.0 ± 17.6	0.7 ± 16.6	-2.0 ± 14.2
No formal education	-0.2 ± 15.2	2.8 ± 19.0	4.1 ± 15.7	1.4 ± 16.1
Residence type				
One-story house	-3.0 ± 14.8	-1.4 ± 17.1	0.4 ± 17.9	-2.8 ± 13.4
Single house	-2.6 ± 14.4	2.3 ± 21.2	2.6 ± 16.8	0.4 ± 18.7
Apartment	4.4 ± 13.5	5.5 ± 15.4	5.8 ± 12.4	2.9 ± 14.2
Marital status				
Spouse present	-1.1 ± 12.9*	0.5 ± 18.0	1.7 ± 16.2	-1.6 ± 13.0
Widowed/divorced/single	-5.3 ± 17.9	-0.8 ± 19.8	0.1 ± 18.9	-1.4 ± 19.8
Current smoking				
No	-3.1 ± 15.2	0.4 ± 17.7	1.2 ± 17.1	-1.7 ± 15.7
Yes	0.4 ± 12.5	0.1 ± 20.1	2.2 ± 17.5	-0.1 ± 14.4
Regular alcohol consumption				
No	-2.6 ± 14.8	0.7 ± 18.4	1.7 ± 17.2	-1.3 ± 15.4
Yes	0.3 ± 14.0	-1.8 ± 19.1	1.1 ± 17.7	-0.7 ± 15.8
Regular exercise				
No	-0.7 ± 14.7	1.1 ± 19.7	2.5 ± 14.2	-0.6 ± 14.7
Yes	-3.5 ± 14.2	-0.2 ± 17.9	1.2 ± 18.9	-1.9 ± 15.8
Insomnia (days per week)				
Never	-2.4 ± 12.5*	-0.5 ± 18.6	1.0 ± 16.1	-1.0 ± 14.0
1–3	-5.3 ± 17.4	1.8 ± 16.6	1.3 ± 20.0	-4.0 ± 14.1
4+	2.4 ± 14.7	0.7 ± 21.8	1.8 ± 15.1	0.4 ± 21.1
Falling during past year				
No	-2.0 ± 14.3	0.2 ± 18.0	1.9 ± 16.9	-0.9 ± 14.9
Yes	-3.5 ± 16.1	1.2 ± 20.2	-0.1 ± 18.8	-3.6 ± 17.6
Number of comorbid conditions				
0	-1.3 ± 10.7	2.5 ± 18.7	1.0 ± 16.7	-1.0 ± 12.9
1	-2.1 ± 16.9	-2.1 ± 16.8	5.0 ± 19.2	0.5 ± 12.7
2+	-2.6 ± 15.3	0.5 ± 19.0	0.3 ± 16.4	-2.3 ± 17.5
GDS score for depression				
0–5	-2.9 ± 14.3	-1.7 ± 17.6*	0.8 ± 17.4	-3.1 ± 14.8*
6–10	1.6 ± 14.5	9.2 ± 18.4	4.7 ± 15.3	3.2 ± 11.5
11+	-3.8 ± 19.4	3.0 ± 22.6	2.9 ± 20.3	12.3 ± 24.4
MMSE score for cognition				
0–18	-4.5 ± 16.7	0.1 ± 19.8	1.8 ± 18.3	-2.1 ± 18.5
19–22	-1.1 ± 13.5	0.5 ± 15.6	1.3 ± 16.3	-0.4 ± 12.6
23	1.0 ± 10.5	0.4 ± 20.8	1.6 ± 16.9	-1.5 ± 12.5
ADL independence				
Seven items or below	-0.1 ± 18.7	3.7 ± 19.0	0.1 ± 19.4	9.0 ± 20.1*
Eight items	-2.4 ± 14.2	0.0 ± 18.3	1.7 ± 17.0	-2.3 ± 14.5

* *p*-Value smaller than 0.05 and one-way ANOVA test was used.

Table 3. Results of the linear mixed model analysis: adjusted relative differences (RD) and 95% confidence intervals (CIs) for scores in physical capacity, psychological, social relationships, and environment, respectively, related to time of assessment, residence status during the earthquake, and other factors among 368 elderly in Shin-Sher Township, Taichung County, Taiwan

Characteristic	RD [95% CI]			
	Physical capacity ^a	Psychological ^b	Social relationships	Environment ^c
Time of assessment				
Pre-earthquake	0	0	0	0
12 Months later	-2.1 [(-5.7)–1.5]	-2.9 [(-5.9)–0.0]	1.7 [(-0.3)–3.7]	-5.5 [(-8.0)–(-3.1)]
Residence status during the earthquake				
Not collapsed	0	0	0	0
Partially collapsed	-3.6 [(-8.7)–1.5]	1.2 [(-4.1)–6.5]	2.1 [(-3.5)–7.7]	0.3 [(-4.1)–4.7]
Completely collapsed	-5.9 [(-12.5)–0.6]	-4.5 [(-11.3)–2.2]	-9.1 [(-16.2)–(-2.0)]	-3.9 [(-9.5)–1.7]
Residence status × assessment time				
Partially collapsed × 12 months later	-1.9 [(-7.7)–3.8]	-0.3 [(-7.4)–6.7]	-2.1 [(-9.1)–4.8]	-3.1 [(-8.8)–2.6]
Completely collapsed × 12 months later	-1.0 [(-10.6)–8.5]	-1.1 [(-11.9)–9.6]	11.0 [(0.1)–21.9]	3.7 [(-5.1)–12.5]

^aAdjusted for gender (male, female), gender × time, regular exercise (yes, no), regular exercise × time, insomnia (never, 1–3, 4+ days per week), and insomnia × time.

^bAdjusted for gender, gender × time, depression level (GDS: 0–5, 6–10, 11+), and depression level × time.

^cAdjusted for gender, gender × time, depression level, depression level × time, level of ADL independence, level of ADL independence × time.

mains declined from the pre-earthquake assessment to 12 months after the earthquake except in social relationships and environment among the elderly whose residences completely collapsed. Specifically, with adjustment for gender, regular exercise, insomnia, and interactions of time of assessment with these three variables, scores for physical capacity declined by 2.1 (95% confidence interval (CI): -1.5 to 5.7) points among the elderly whose residences did not collapse during the earthquake. The decline in physical capacity scores was 1.9 (95% CI: -3.8 to 7.7) points larger among the elderly whose residences partially collapsed and 1.0 (95% CI: -8.5 to 10.6) point larger among those whose residences completely collapsed. With adjustment for gender, depression, and interactions of time of assessment with the two variables, scores for psychological well-being declined 2.9 (95% CI: 0–5.9) points among the elderly whose residences did not collapse during the earthquake. The decline was 0.3 (95% CI: -6.7 to 7.4) points larger among the elderly whose residences partially collapsed and 1.1 (95% CI: -9.6 to 11.9) points larger among those whose residences completely collapsed. Scores in social relationships increased 1.7 (95% CI: -0.3 to 3.7) points for the elderly whose residences did not collapse. Compared with the elderly whose residences did not collapse, scores were 2.1 (95% CI: -9.1 to 4.8) points

smaller among the elderly whose residences partially collapsed. In contrast, however, scores in social relationship among those whose residences completely collapsed increased by 12.7 (11.0 + 1.7) (95% CI: 2.0 to 23.4) points from the pre-earthquake assessment to 12 months after the earthquake. The difference in changes in social relationships between the elderly whose residences completely collapsed and those whose residences did not collapse was 11.0 (95% CI: 0.1–21.9). With adjustment for gender, depression, ADL independence, and interactions of time of assessment with the three variables, scores for the environment declined by 5.5 (95% CI: 3.1 to 8.0) points among the elderly whose residences did not collapse. The decline was 3.1 (95% CI: -2.6 to 8.8) points larger among the elderly whose residences partially collapsed. The difference in the changes in environment between the elderly whose residences completely collapsed and those whose residences did not collapse was 3.7 (95% CI: -5.1 to 12.5).

Using Cohen's criteria [30], we found that the earthquake had a small effect in reducing the scores for physical capacity (effect size = -0.27) and environment (effect size = -0.29) among the elderly whose residences partially collapsed. The earthquake also had a small effect in reducing the scores for physical capacity (effect size = -0.22) but moderate and small effects in increasing scores

for social relationships (effect size = 0.69) and environment (effect size = 0.42), respectively, among the elderly whose residences partially collapsed.

Discussion

The data collected in this study provide a unique opportunity to do before- and after-earthquake comparisons of health-related quality of life among elderly people. The multidimensional measures of quality of life in four different domains present a more revealing depiction of what the elderly had experienced in the aftermath of the earthquake than do univariate overall measures. This was evidenced in our data. Even though the two overall scores for quality of life were found not to have changed significantly from the initial assessment to 12 months after the earthquake and not to depend on the level of damage to one's residence during the earthquake, this is not the case with the four domain scores. It was found the impacts of the earthquake on quality of life among elderly people differ over domains and also depend on the level of damage to one's residence during the earthquake.

More specifically, elderly people tended to report a lower quality of life in physical capacity, psychological well-being, and environment 12 months after the earthquake than at the initial assessment prior to the earthquake, regardless of the level of damage to their residences during the earthquake. However, those whose residences completely collapsed during the earthquake reported a higher quality of life in social relationships 12 months after the earthquake than before the earthquake, while others reported a lower quality of life in social relationships.

The improvement in social relationships among the elderly whose residence completely collapsed during the earthquake is both statistically and clinically significant. This improvement may be due to the increased support and care they received from families, relatives, friends, and the community after the earthquake [31]. However, it is not clearly understood why the elderly whose residences completely collapsed took quite a different path in terms of quality of life in social relationships and environment than those whose resi-

dences partially collapsed. A possible speculation is that the elderly whose residences completely collapsed may have received more social support and care than those whose residences partially collapsed. For example, an elderly person whose residence completely collapsed was likely to be provided a temporary accommodation from his/her relative or friend, especially in the early months after the earthquake. On the other hand, an elderly person whose residence partially collapsed may have stayed in his/her original residence. This speculation is indirectly supported by the fact that the elderly whose residences completely collapsed were less likely to be interviewed at or near the original residence locations in the follow-up assessment than those whose residences partially collapsed (6/17 vs. 23/28). In fact, when receiving the second interviews, the subjects with residences collapsed completely lived in the self-built temporary shelters near the original residence locations.

The two overall quality of life items may not be sensitive enough to detect changes in quality of life among the elderly after they experience an earthquake. In addition, the direction and magnitude of the earthquake's impact differ not only over domains of quality of life, but also over items (facets) within a single domain (results not shown). For example, in the psychological domain, the elderly whose residences did not collapse increased not only their negative feelings (Q6) but also their feelings about life's meaningfulness (Q26); furthermore, the elderly whose residences partially or completely collapsed had smaller increases in their feelings of life's meaningfulness as well as in their negative feelings than did those whose residences did not collapse. The heterogeneous effects of the earthquake or its exposure intensity on the score changes in items within a single domain would reduce the sensitivity for detection of change in the domain as a whole. Additionally, this implies that categorization of the 28 items into four domains in the Taiwanese-adapted WHOQOL-BREF based on general population might not be appropriate and should be further validated in elderly populations.

There are several limitations to the study. The first is the issue of selection bias. Elderly subjects interviewed at the initial or follow-up assessment might not be representative of the study popula-

tion. The elderly sample of this study was limited to two of the 13 villages in Shin-Sher Township. Compared with the elderly in the other 11 villages, those in the two villages studied showed no differences in distributions in gender or level of damage to one's residence, but they tended to be older. To investigate the impact of selection bias with respect to age and other potentially influential factors such as educational level and residence type on our conclusions, we included these factors as effect modifiers in the mixed model. However, the effect estimates of the residence status during the earthquake on the changes in each domain scores remained similar when these terms were added in the linear mixed model presented in Table 3, indicating that the selection bias with respect to these factors may not invalidate our conclusions. Furthermore, elderly survivors who were unable to undertake the follow-up interview, especially those who were hospitalized or had moved out of the affected area after the earthquake, would have more likely reported a decreased quality of life. Therefore, the negative effect of the earthquake on quality of life in this study may have been underestimated. Second, acute impacts of the earthquake on the quality of life in elderly people might not have been captured by the post-earthquake assessment administered 12 months after the earthquake. If the impact of the earthquake on quality of life diminished over time, then the maximum impact on each domain of quality of life may have been underestimated. However, an attempt to collect earlier information on elderly survivors was hampered by the authorities who discouraged any activities other than those devoted to rescuing and reconstruction efforts, the earthquake-induced inaccessibility of the affected community, and the persistence of numerous aftershocks. The third and a major limitation of our study is that all subjects in the study experienced the earthquake, and they were not compared to any controls from non-earthquake areas. Therefore, it is impossible to distinguish changes in quality of life due to the earthquake from those due to a natural time trend. However, it may be reasonable to assume that the quality of life among the elderly would have remained relatively unchanged over 12 months if there had been no earthquake, so the changes in quality of life can be attributed to the earthquake.

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Appendix

WHOQOL-BREF: Taiwanese-adapted version

- Q1. How would you rate your quality of life?
- Q2. How satisfied are you with your health?
- Q3. To what extent do you feel that physical pain prevents you from doing what you need to do?
- Q4. How much medical treatment do you need to function in your daily life?
- Q5. How much do you enjoy life?
- Q6. To what extent do you feel your life to be meaningful?
- Q7. How well are you able to concentrate?
- Q8. How safe do you feel in your daily life?
- Q9. How healthy is your physical environment?
- Q10. Do you have enough energy for everyday life?
- Q11. Are you able to accept your bodily appearance?
- Q12. Do you have enough money to meet your needs?
- Q13. How available to you is the information that you need in your day-to-day life?
- Q14. To what extent do you have the opportunity for leisure activities?
- Q15. How well are you able to get around?
- Q16. How satisfied are you with your sleep?
- Q17. How satisfied are you with your ability to perform your daily living activities?
- Q18. How satisfied are you with your capacity for work?
- Q19. How satisfied are you with yourself?
- Q20. How satisfied are you with your personal relationships?
- Q21. How satisfied are you with your sex life?
- Q22. How satisfied are you with the support you get from your friends?
- Q23. How satisfied are you with the conditions of your living place?

- Q24. How satisfied are you with your access to health services?
- Q25. How satisfied are you with your transport?
- Q26. How often do you have negative feelings such as a blue mood, despair, anxiety, or depression?
- Q27. Do you feel respected by others?
- Q28. Are you usually able to get the things you like to eat?

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