

Health problems in the temporary housing in Taiwan

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Received 22 February 2013; revised 25 March 2013; accepted 3 April 2013

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ABSTRACT

To understand the health effects of the temporary housing after the September 1999 earthquake in Taiwan, we conducted the object observation, environmental monitoring, questionnaire survey, and disease analysis in both spring and autumn seasons to rate the presence and magnitude of exposures of environmental hazards. In the hot season more people identified poor ventilation, dampness, hot, odor, and insecurity as sources of hazards. The health effects on the cervix and vagina, liver, and respiratory disease assessed by clinic visits were corresponded to the environmental exposures, and complaints. It was suggested that reducing the risks to temporary housing residences by means of improving housing ventilation and providing community security when the permanent housing was not finished from the experience of Chi-Chi earthquake disaster in Taiwan.

Keywords: Earthquake; Temporary Housing; Health Effects; Ventilation; Community Security

1. INTRODUCTION

On 21 September 1999, at 01:47, an earthquake of magnitude 7.3 on the Richter scale struck the central area of Taiwan [1]. As a result of the earthquake, more than 100,000 houses were collapsed, 2347 people died, and more than 8000 were injured all over the island. This event was the most profound inland earthquake to occur during the past 100 years in Taiwan.

After Chi-Chi earthquake, the Central Government announced three emergency housing policies, which were temporary houses providing, rental subsidies, and 30%-discount public houses sale to support their lives. According to the statistic available in February 2000, 5270 units of temporary housing were constructed: 799 (15.16%) units donated from the public sector, 3470

(65.84%) units donated from private sectors, and 1001 (19.00%) units donated from Japan [2].

Units were generally one of three sizes: 26.45 m², 39.47 m², 42.94 m². Initially only homeowners were eligible to receive temporary houses. Because there were fewer initial applicants than expected, and the heavy demand for temporary housings, eligibility for temporary houses was broadened in November 1999 to include low-income family, physically and mentally disabled family, and aboriginal family. Temporary housing occupation was initially set at one year and later extended to three years after the implementation of “Reconstruction Special Laws” in December 2000.

In Taiwan, the processes of post-quake reconstruction moved in the following subsequences: “Emergency period”, “Placement period”, and “Reconstruction period”. The supply of temporary houses could be in placement period. A number of past studies described about the economic and social impacts of temporary housing policies, such as the needs of employment, income, good lifestyle, and sanitation [3-9]. However, no studies discussed the relationship of housing and health for the temporary housing residences.

To improve preparedness for reconstruction after earthquakes, we must rely on the placement period stably, more understanding about the health, and needs of the temporary housing is an important issue. The studies revealed four aspects including object observation, environmental monitoring, questionnaire, and disease analyses to identify the relationship of the temporary housing and health in order to suggest reconstruction programs accurately.

2. METHODS

2.1. Study Area and Subjects

We selected Puli township as the study area because the temporary houses were constructed the most that occupied 18.6% of the total 5270 units in the Nantou County. There were 2486 persons who lived in these

temporary housing units.

2.2. Object Observation

The detail information of the 978 units (12 sites) including location, offering body, size, materials, effective ventilated index (area of opens/area of floor), population volume (persons/house), and number of temporary houses was summarized in the **Table 1**.

2.3. Environmental Monitoring

Making use of potable meters to measure the indoor air environment including thermal & moisture (Electronic thermal-hygrograph meter; TOMEL CO, Japan), air flow (Mini anemometer, model: ISA-6-3D; SIBATA, Japan), and ammonia level (PAC II; Drager CO, Germany). Meters were calibrated daily before data collection. The temporary housing sites were clustered into four construction types on the basis of occupancy permit by materials. They included Iron room (including cabinet room, and iron-covered room), DaAi-Tsuchi (including DaAi 1-Tsuchi, and DaAi 2-Tsuchi), Cinyan-Japan (including Cinyan6-Japan, Cinyan7-Japan, and Cinyan8-Japan), and The salvation army & Young women's Christian association (TSA& YWCA) (including Chou-chonlin-TSA, Wuson-TSA, Taumi-TSA, Lanchin-TSA, and Puti-Chanchin-YWCA). The first measurements were conducted in February (cold season) 2000, and the final measurements were conducted in August (hot season) 2000 for the 4 items of indoor air environment, respectively. The environmental data was taken from 09:00 to 16:00 in the both measure periods.

2.4. Questionnaire

A structural questionnaire was conducted to interview with the household of the temporary housing residents. The questionnaire included demographic information, environmental health status, and the needs of health and

safety. The questionnaire was pre-tested on a sample of 20 cases, and validated by 8 experts. The purpose of questionnaires was to find out the degree of environmental problems, and recommended strategies of health and safety to the government effectively.

2.5. Disease Analyses

We reviewed disease data before (during February and August, 1999) and after (during February and August, 2000) the Chi-Chi earthquake in Puli township. The data were mainly abstracted from the clinic visit records of the Bureau of National Health Insurance, the only health insurance provider in Taiwan. The international classification disease (ICD-9) was used to define cause of disease.

2.6. Statistic

The one-way analysis of variance test and post-hoc statistic were used to compare the significant differences of indoor measurements among the 4 construction types of temporary houses. Cross-tabs with chi-square analysis were used to compare the differences of environmental compliant for the 978 temporary housing in two survey periods. All analyses were performed with SPSS statistical software (SPSS Inc., Chicago, IL) for Window.

3. RESULTS

3.1. Object Observation

According to statistic available in February 2000, 978 units of temporary houses were constructed in Puli township: 496 units from the domestic private sectors (58 Cabinet room-Evergreen, 14 Iron-covered Room-CGPC, 318 DaAi 1-Tsuchi, and 106 DaAi 2-Tsuchi), 296 units from Japan government (98 Cinyan6-Japan, 150 Cinyan7-Japan, and 48 Cinyan8-Japan), and 186 units from international private sectors (19 Chouchonlin-TSA,

Table 1. Detail information of the 12 temporary housing sites.

Name of sites	Size	Wall	Foundation	Area of opens/area of floor	Population volume	No.
Cabinet room-Evergreen	26.45 m ²	metal	PVC	8.8%	2	58
Iron-covered Room-CGPC	42.94 m ²	LPB	PVC	18.7%	4	14
DaAi 1-Tsuchi	42.94 m ²	LPB	PVC	23.0%	4	318
DaAi 2-Tsuchi	42.94 m ²	LPB	PVC	23.0%	4	106
Cinyan6-Japan	39.47 m ²	FRP	Tatami	28.9%	3	98
Cinyan7-Japan	39.47 m ²	FRP	Tatami	28.9%	3	150
Cinyan8-Japan	39.47 m ²	FRP	Tatami	28.9%	3	48
Chouchonlin-TSA	42.94 m ²	LPB	PVC	23.0%	4	19
Wuson-TSA	42.94 m ²	LPB	PVC	23.0%	4	13
Lanchin-TSA	42.94 m ²	LPB	PVC	23.0%	4	72
Puti-Chanchin-YWCA	42.94 m ²	LPB	PVC	23.0%	4	50

13 Wuson-TSA, 32 Taumi-TSA, 72 Lanchin-TSA, and 50 Chanchin-YWCA). All the sites were located outside of the city, and all the toilets were built in indoors except the Cainet room-Evergreen. The temporary houses were constructed on the farmland and with light materials, such as light partition board (LPB), fibre reinforced polymer (FRP), and poly vinyl chloride (PVC). The population volume was correlated with the housing sizes. The effective ventilated indies were not out of compass ($\geq 5\%$) in all the temporary housing units, however, most of the windows were closed when we surveyed the temporary housing.

3.2. Environmental Monitoring

The standard for the indoor air environment was between 15°C and 28°C for temperatures, between 40% and 70% for moistures, more than 0.2 m/s for air flow, and less than 0.2 ppm for ammonia, respectively. **Table 2** shows the means of the 4 indoor air items among the 4 construction types of temporary houses. There was not any significant difference of indoor air item among the 4 types of temporary houses in cold season and in hot season, respectively (all p values > 0.05). The mean of temperature, and humidity was significantly lower in February than in August in all the 4 types of temporary houses respectively (all p values < 0.05). The mean of air flow was significantly higher as well as the mean of ammonia level was lower in February than in August in all the 4 types except Iron room of temporary houses, respectively (all p values < 0.05). There were fewer indoor air measurements out of compass in all the 4 construction types of temporary houses in the cold season. However, there were many indoor air measurements out of compass in

all the 4 construction types of temporary houses in the hot season. In February: the mean of air flow was lower than the standard tolerance of air flow in iron room. In August: the mean of temperature, and the humidity respectively was higher than the standard tolerance of temperature, and humidity, as well as the air flow was lower than the standard tolerance of air flow in all the 4 construction types of temporary houses; the mean of ammonia level was higher than the standard tolerance of ammonia level in DaAi-Tsuchi, Cinyan-Japan, and in TSA&YWCA temporary houses, respectively. The mean of ammonia level was not higher than the standard tolerance of ammonia level in Iron room either in February or in August, specifically.

3.3. Questionnaire

Table 3 compares the environmental complaints of the temporary housing of the two surveys. There was a great improvement for the drainage capping in the temporary housing, however, the complaint of impeded drainage was still high. Owing to the impeded drainage that could harbor pests, the temporary housing households also complained about the high density of pests in houses in the second survey deservedly.

Table 4 shows the major need of health and safety for the temporary housing households. The major need reported by the first survey was sterilization (20.2%), followed by health care (19.2%), trash management (18.2%), community activity (16.9%), and public order (14%). By the second survey, the major need reported was sterilization (22.5%), followed by health care (21.3%), community activities (20.3%), and public order (18.0%). The greatest percentage of increase in the major need of

Table 2. Indoor air measurements in the 4 construction types of temporary houses.

No.	Iron room 72	DaAi-Tsuchi 424	Cinyan-Japan 296	TSA & YWCA 186	P value
Temperature ($^{\circ}\text{C}$)					
February	21.8 ± 0.5	17.7 ± 0.2	18.0 ± 0.3	19.0 ± 0.4	$P > 0.05$
August	$34.3 \pm 0.9^*$	$28.2 \pm 0.5^*$	$28.1 \pm 0.3^*$	$30.2 \pm 0.2^*$	$P > 0.05$
Moisture (%)					
February	70.3 ± 4.7	66.8 ± 1.8	64.7 ± 1.1	68.0 ± 3.6	$P > 0.05$
August	$85.2 \pm 5.5^*$	$80.2 \pm 1.8^*$	$79.0 \pm 1.7^*$	$86.4 \pm 1.0^*$	$P > 0.05$
Air flow (m/s)					
February	$0.13 \pm 0.03^*$	0.20 ± 0.05	0.26 ± 0.07	0.22 ± 0.06	$P > 0.05$
August	$0.11 \pm 0.03^*$	$0.10 \pm 0.01^*$	$0.12 \pm 0.02^*$	$0.10 \pm 0.03^*$	$P > 0.05$
NH_3 (ppm)					
February	0.16 ± 0.02	0.17 ± 0.03	0.20 ± 0.05	0.19 ± 0.03	$P > 0.05$
August	0.18 ± 0.07	$0.42 \pm 0.12^*$	$0.33 \pm 0.06^*$	$0.35 \pm 0.05^*$	$P > 0.05$

*: out of compass.

Table 3. Environmental complaints of the 978 temporary houses in February's and August's surveys, 2000.

Item	February	August	P value
	Yes (%)	Yes (%)	
Drainage capping*	1.0	42.0	P < 0.05
Drainage is impeded*	30.2	44.0	P < 0.05
Stench	5.8	8.2	P > 0.05
The mosquito are many*	22.4	48.9	P < 0.05
The fly are many*	13.6	46.0	P < 0.05
The cockroach are many*	3.0	79.6	P < 0.05
The rats are many*	1.2	87.6	P < 0.05

*: significant difference.

Table 4. Comparison of major need of health and safety for the 978 temporary housings in February's and August's surveys, 2000.

Item	February	August	% increase
Sterilization	20.2%	22.5%	11.4
Health care	19.2%	21.3%	10.9
Trash management	18.2%	10.9%	-40.1
Community activity	16.9%	20.3%	20.1
Public order	14.0%	18.0%	28.6
Provides the employment	9.4%	6.0%	-31.9
Yelp reduction	2.1%	1.0%	-52.4

health and safety was public order (28.6%), followed by community activity (20.1%) after the disaster reconstruction for 6 months. The increased issues of the major needs implied that environmental safety and social relationship should be emphasized beside the health needs. The major need was sterilization that was well matched to the major complaint; vectors in the surveys.

3.4. Disease Analyses

Table 5 showed the major weekly clinic visit rate of the 2486 persons before and after the Chi-Chi earthquake in Puli township. The greatest weekly clinic visit rate before the Chi-Chi earthquake was acute respiratory infections (30.08 ± 8.80 visits/100 population), follow by infections and inflammatory of skin and subcutaneous (7.84 ± 2.02 visits/100 population), and dorsopathies (4.20 ± 1.24 visits/100 population). Correspondingly, the greatest weekly clinic visit rate after the Chi-Chi earthquake was acute respiratory infections (40.64 ± 9.70 visits/100 population), follow by infections and inflammatory of skin and subcutaneous (9.60 ± 2.92 visits/100 population), and dorsopathies (6.20 ± 1.78 visits/100 population). The greatest increased percentage in weekly clinic visit rate resulted from the Chi-Chi earthquake was inflammatory diseases of uterus, cervix, vagina, and vulva (181.25%), followed by Chronic liver disease and cirrhosis (127.78%). The health effects were corresponded

to the environmental exposures, complaints, and needs in the temporary housing.

4. DISCUSSION

Housing is an important determinant of health, and substandard housing is a major public health issue [10]. The results of this study indicated that people living in the temporary houses were exposed to indoor and outdoor hazards. The assessment methods used—researcher observations via object measurements, environmental monitoring, and questionnaire survey—identified substantial exposures to poor ventilation, hot, damp, vectors, and insecurity were noted. The health effects assessed by clinic visits corresponded to the environmental exposures, complaints, and health needs for the temporary housing.

Ventilation is in many cases used to control the thermal environment or humidity in buildings [11]. The inadequate ventilation could increase interior temperature and moisture, which contribute to an increase in emission of volatile chemical [12]. Therefore, the indoor toilet built combined with the poor ventilation might explain the high concentration of ammonia in hot season in the study. The damp house provides a nurturing environment for mites, coaches, molds, fungi, respiratory bacteria, and virus all of which play a role in respiratory, skin, and vaginal disease pathogenesis of the housing residences [13-18]. The impeded drainage in out doors can harbor

Table 5. The major weekly clinic visit rate of the 2486 persons before and after the Chi-Chi earthquake in Puli township.

Disease (ICD-9)	Pre-earthquake stage clinic visits/100	Post-earthquake stage clinic visits/100	% increase in clinic visit rate
Inflammatory diseases of uterus, cervix, vagina, and vulva (615 - 616)	1.92 ± 0.52	5.40 ± 1.32	181.25
Chronic liver disease and cirrhosis (571)	0.72 ± 0.21	1.64 ± 0.43	127.78
Gastroenteritis and colitis (535, 558, 564, 577)	3.52 ± 1.02	5.68 ± 1.30	61.36
Ischaemic heart disease (410 - 414)	0.96 ± 0.28	1.48 ± 0.40	54.17
Dorsopathies (720 - 724)	4.20 ± 1.24	6.20 ± 1.78	47.62
Acute respiratory infections (460 - 466)	30.08 ± 8.80	40.64 ± 9.70	35.11
Osteoarthritis and unspecific disorders (715, 716, 719)	1.84 ± 0.58	2.32 ± 0.71	6.09
Infections and inflammatory of skin and subcutaneous tissue (680 - 698)	7.84 ± 2.02	9.60 ± 2.92	22.45
Influenza (487)	1.68 ± 0.50	1.84 ± 0.55	9.52
Osteoporosis (733)	1.44 ± 0.44	1.56 ± 0.46	8.33

Pre-earthquake stage: during February and August, 1999. Post-earthquake stage: during February and August, 2000.

pests, which can then infest homes.

Excessive indoor temperature has been linked with irritability and social intolerance [19]. Damp and moldy indoor conditions may be associated with anxiety and depression [20]. The promotion of worm and moist environment of the perineal area could increase the vitality of the etiological agents (*Gardnerella vaginalis*, *Candida albicans*, and *Trichomonas vaginalis*) of cervicovaginitis in women [21,22].

The psychosocial burdens of homelessness were associated with weakening the immune system as responsible factor for the incidence of vulvovaginal mycosis also [23-25]. The second need of health and safety for the 978 temporary housing residents reported in the first and second surveys was health care respectively implied that the victims were experienced the homeless stress also.

Social dimensions of community also affect health. Sampson *et al.* suggested that rates of neighborhood violence were lower in areas with high collective efficacy (a combination of trust, social cohesion, and informal social control) [26]. In addition, physical insecurity and violence can cause people to stay in their homes, thus limiting physical activity [27]. The temporary housing residents may have greater prevalence of irregular dietary habits, more alcohol intake, smoking habit, sleep disturbance, nervous complaints lower HDL-cholesterol level, and high triglyceride level, compared the control group. These data indicate that earthquake-induced stress may influence liver function and lipid metabolism; leading to increase risks of various health impairments for the earthquake victims [28]. There was a higher percentage increase in weekly clinic visit rate for chronic liver disease and cirrhosis of the temporary housing residences in the studies. Our results agreed with Mayumi's suggestion.

Although temporary housing is not a key factor in ending homelessness, temporary housing occupation still

set to three years because the permanent housing was not finished. However, we can reduce the risks to temporary housing residences by means of improving house ventilation and providing community security from the experience of Chi-Chi earthquake disaster.

5. ACKNOWLEDGEMENTS

This work was supported by fund DOH-TD-1218 from the Department of Health, Taiwan.

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ABBREVIATION

CGPC: China general plastics corporation;
PVC: Poly vinyl chloride;
LPB: Light partition board;

FRP: Fibre reinforced polymer;
TSA: The salvation army;
YWCA: Young women's Christian association.