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ORIGINAL PAPER

The comparison analysis of Chinese public perception of earthquakes on different time scales

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Abstract China has suffered from severe earthquake disasters in recent years. In order to explore the impact of severe earthquakes on public risk perception on different time scales, four surveys were conducted twice each after the severe Wenchuan and Yushu earthquakes. *t* tests were performed between two consecutive surveys to explore the change of public risk attitudes. The results demonstrated that after the two severe earthquakes, the public seismic risk acceptance has increased over time, and the comparison between pre- and post-Yushu earthquake illustrated that the severe disaster had more impact on vulnerable population such as females, children and low-income people. Moreover, linear regression models were employed to find the determining factors of public acceptance towards earthquake risks. It was discovered that the public perceived earthquake effect had significant negative relationship with seismic risk acceptance, and public trust towards local government had positive relationship with the risk acceptance. This study could help government to gain better understanding of public mental status and take more effective disaster preparedness measures when preventing and responding to a severe earthquake.

Keywords Earthquake · Risk perception · Time scale · Comparison analysis

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1 Introduction

1.1 Background

In recent years, the world has stepped into a natural disaster-prone period, and the frequent occurrence of natural disasters such as earthquakes, tsunamis and hurricanes pose a great threat to life and property safety all around the world. China has also suffered from severe earthquakes in last 5 years, causing tremendous economic losses and social disorder.

In the afternoon of 12th May 2008, an earthquake of a magnitude of 8.0 on the Richter scale broke out in Sichuan Province, China. The most destructive earthquake since the founding of the P.R. China struck the area of approximately 500,000 km^2 land of Wenchuan County, and Beichuan County in Sichuan Province, causing 69,227 deaths, 374,643 injured, more than 17,000 missing and a direct economic loss of ¥845.2 billion. Incredibly, in <2 years, in the early hours of 14 April 2010, another severe earthquake of a magnitude of 7.1 on the Richter scale hit the surrounding area of Yushu County of Qinghai Province, China. More than 20,000 people were killed in the earthquake, and a large number of residential houses collapsed.

1.2 Risk management

These natural disasters and other uncertain events will reduce the quality of the environment, resulting in the loss of human and social wealth, and are defined as environmental risks (Bi et al. 2006). Slovic and other foreign experts (Grothmann and Reusswig 2006; Lindell and Perry 2000; Slovic 1987) have classified various types of environmental risks into technical risks (such as chemical, nuclear), ecological risks (such as air pollution), daily risks (such as traffic accidents) and natural hazards (such as earthquakes).

Risk management is a method to reduce the risks to the acceptable level and to avoid the serious consequences with prediction, assessment and response (Renn 1998). Understanding the public perception of certain risks is an important foundation to involve the public into risk management decisions (Frewer 2004) and has a very important meaning for better risk management, optimized risk communication and enhanced public participation.

1.3 Risk perception

"Risk perception" in the field of social science mainly refers to individual feelings towards various outside objective risks, and it emphasizes the effect of experiences obtained by the intuitive judgment and subjective feelings on individual awareness (Slovic 1987). The study of public perception of environmental risks mainly focuses on how public respond to a variety of environmental risks (Frewer 2004).

As a severe natural hazard, several demographic factors have been identified to influence the public perception regarding earthquakes (Armas 2006). Gender was often found to be influential that women usually have a higher risk perception than men (Soffer et al. 2011). Age was usually found to be positively correlated with risk perception that elder public were more vulnerable to earthquake (Tekeli-Yesil et al. 2010). In addition, individuals with a higher income or education level might perceive lower threat of earthquakes (Armas 2006). Moreover, some other factors such as geographical factors (Li et al. 2009) and information credibility (Zhu et al. 2011) were also found to be related to public risk perception. In related to earthquakes, public perception was of great significance to the

willingness of taking prevention measures (Lindell et al. 2009). However, former researchers have discovered a lack of sufficient preparation among the public towards earthquakes. A study conducted in Istanbul revealed that most of the respondents did not regard themselves as vulnerable and have no plan for a safer house (Eraybar et al. 2010). Similar findings were discovered in Bangladesh (Paul and Bhuiyan 2010), where an overwhelming majority of respondents were not prepared for a major earthquake. It highlighted the importance of understanding public earthquake risk perception, so as to adopt effective risk communication to raise public awareness of disaster prevention.

Moreover, Cutchin et al. (2008) conducted two surveys before and after a refinery explosion in Texas City to explore how such an industrial accident influences public concern about environmental health risks. Although the overall sample's means on pre- and post-explosion risk perception scores were not statistically different, the patterns showed some significant group differences in concern scores and change in concern.

However, few former researches have explored the effect of severe natural disasters on public risk perception on different time scales. Under the circumstances that severe earthquakes happened frequently in China, it is necessary to understand the public's response to these disasters, which gives us an opportunity to conduct this research.

1.4 Research objectives

This study firstly aimed to explore the impact of a severe earthquake on public risk perception on different timescales by conducting four surveys twice each after Wenchuan and Yushu earthquakes, respectively. Secondly, regression models were employed to find the determining factors of public acceptance towards earthquake risks. This study was designed to help government to gain better understanding of public mental status and take more effective disaster preparedness measures when preventing and responding to a severe earthquake.

2 Methods

2.1 Questionnaire design

Based on the experience of previous studies abroad (Huang et al. 2010; Kunreuther et al. 1990; Slovic 1987; Sjöberg 2000), the questionnaire was designed according to the psychometric paradigm methods and modified based on the Chinese residents' circumstances. The questionnaire mainly consisted of two parts. The first part intended to investigate respondents' level of risk perception towards earthquake. A series of perception variables were selected for the risk perception model, including *newness*, *immediacy*, *knowledge*, *dread*, *familiarity*, *controllability*, *effect*, *trust*, *benefit* and *acceptance*. The response to each question was ranked on a scale using a 5-point Likert-type scale ranging from "1 = minimum" to "5 = maximum". The second part of the questionnaire was designed to collect the respondents' demographic characteristics, such as *age*, *gender*, *education* and *income*.

2.2 Samples and data collection

Nanjing is chosen to be our study area. Nanjing, the capital of Jiangsu Province, is a developed city located in the Yangtze River Delta Region (Fig. 1). Although it is quite far from the earthquake areas Wenchuan and Yushu, due to the extensive media coverage, the

access of earthquake information is in time; moreover, the unaffected respondents in Nanjing are able to give an objective assessment of seismic risk, which enables us to make a more reasonable analysis of the effects of severe disasters on public risk perception on different time scales.

A total of four surveys were conducted, twice each after the Wenchuan earthquake and Yushu earthquake, respectively. Survey 1 was conducted in the end of May 2008, right after the Wenchuan earthquake, and Survey 2 was conducted six months later, in November 2008. Survey 3 was conducted in April 2010, right after the Yushu earthquake, and Survey 4 was also conducted 6 months later, in October 2010. Respondents were selected by a stratified random sampling of those living in 6 districts of Nanjing city. All respondents were interviewed face-to-face by senior students from the School of Environment in Nanjing University who had been well trained in survey techniques.

Out of 300 questionnaires distributed in each survey, the valid responses were 266, 254, 260 and 253, with a response rate of 88.67, 84.67, 86.67 and 84.33 %, respectively. The demographic data of participants of four surveys were quite similar (Table 1), which reduced the impact of sampling bias on the results of analysis. Moreover, the samples matched the population of Nanjing well in terms of "gender" and "age", while high-level education (college) was over-represented compared with local demographics. This phenomenon might result from the fact that higher educated people are more willing to take participation in survey studies.

2.3 Data analysis

In order to remove the effect of the inter-correlation between each two factors, factor analysis was employed. Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. Because the public *acceptance* towards earthquake was asked

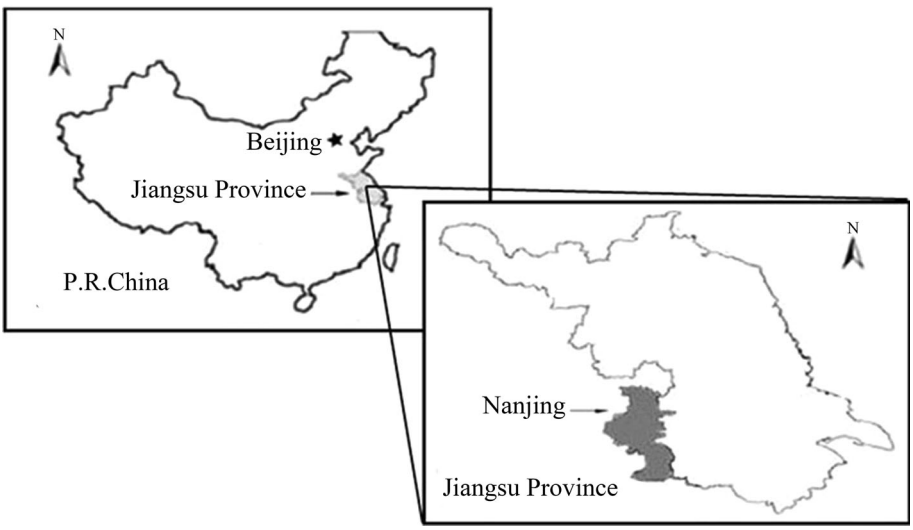

Fig. 1 Location of study area Nanjing

directly in the questionnaire, it was excluded from the factor analysis. Other nine risk perception variables were categorized with maximum variance rotation.

After factor analysis, samples t tests were conducted to determine whether time or demographic differences exist in the public risk perception of earthquake. t test is a statistical hypothesis test with the null hypothesis that the means of two populations are equal. When the null hypothesis is rejected, it can be concluded that two sets of data are significantly different from each other. t tests were firstly employed between two consecutive surveys to explore the change of public seismic risk acceptance and each risk perception factors extracted by factor analysis over time. In addition, t tests were conducted to examine the variance of risk acceptance in each categorized group of respondents between two surveys. The categorized demographic characteristics included gender, age, education and income, each of which was divided into different levels.

Finally, regression equation models were employed to explore the determining factors of public seismic risk acceptance. The dependent variable was risk acceptance, and the independent variables included extracted risk perception variables and four demographic characteristics. Four demographic characteristics were categorized as: gender, male = 1, female = 2; age, 16–20 = 1, 20–39 = 2, 40–60 = 3, >60 = 4; education level, no formal education = 1, primary school = 2, middle school = 3, high school = 4, college = 5, graduate = 6; and income, <2,000 = 1, 2,000–4,000 = 2, 4,000–8,000 = 3, 8,000–20,000 = 4, >20,000 = 5.

All data analysis was processed by SPSS 19.0.

3 Results

3.1 Factor analysis

The factor analysis categorized nine risk perception variables into three risk perception factors. We defined the factor 1 as *effect*, factor 2 as *familiarity* and factor 3 as *trust*. All factor loadings were above 0.4, and the details are shown in Table 2.

3.2 Comparisons of risk perception factors

Table 3 exhibited the comparison results of risk perception factors between two surveys. Firstly, the comparison between survey 1 and survey 2 revealed that the public seismic risk perception factors *acceptance* ($t = -7.53$, $p = 0.00$), *familiarity* ($t = -13.12$, $p = 0.00$) and *trust* ($t = -7.11$, $p = 0.00$) increased significantly, and factor *effect* ($t = 6.14$, $p = 0.00$) decreased significantly in survey 2, indicating a higher level of risk acceptance and risk familiarity and more public trust in local government. Since survey 1 was conducted right after the Wenchuan earthquake and survey 2 was conducted 6 months later, it seemed that the fear of earthquake to some extent fades over time.

Secondly, the comparison between survey 2 and survey 3 might reveal the direct influence of Yushu earthquake on public risk perception since these two surveys were conducted pre- and post-Yushu earthquake. It could be observed that the perception factors *acceptance* ($t = 2.57$, $p = 0.01$), *familiarity* ($t = 8.82$, $p = 0.00$) decreased and factor *effect* ($t = -10.30$, $p = 0.00$), *trust* ($t = -11.50$, $p = 0.00$) increased significantly in survey 3, which illustrated that the happened earthquake lowered public seismic acceptance and perceived cognition of earthquake, but enhanced people's earthquake anxiety and dependence on government.

Table 1 Demographic data of study participants of four surveys

Demographic characteristic	Classification	Percentage % (survey 1)	Percentage % (survey 2)	Percentage % (survey 3)	Percentage % (survey 4)
Gender	Male	56.1	55.4	56.9	53.8
	Female	43.9	44.6	43.1	46.2
Age	16–20	6.0	8.8	13.5	4.6
	20–39	70.9	66.9	67.1	74.0
	40–60	18.4	17.1	14.0	15.3
	>60	4.7	7.2	5.4	6.1
Education	No formal education	1.0	0.4	0.4	0.4
	Primary school	4.5	3.4	3.3	1.4
	Middle school	20.0	12.3	24.0	16.6
	High school	25.8	25.3	28.7	19.1
	College	41.9	41.8	42.0	53.7
	Graduate	6.8	16.8	1.6	8.8
Income (yuan per month)	<2,000	19.6	19.8	34.9	24.0
	2,000–4,000	26.4	30.8	26.8	27.6
	4,000–8,000	27.3	24.9	24.0	22.5
	8,000–20,000	14.1	15.4	8.1	14.1
	>20,000	12.6	9.1	6.2	11.8
Occupation	Official	6.3	18.1	5.5	15.4
	Corporate employee	37.7	28.7	39.8	35.5
	Self-employed	12.3	7.7	5.3	5.2
	Farmer	5.5	1.5	4.8	3.3
	Retired/housewife/student	28.0	38.1	36.3	31.1
	Others	10.2	5.9	8.3	9.5

Lastly, the results of samples test of risk perception factors of survey 3 and survey 4 were a good comparison with the pattern drawn between survey 1 and survey 2 to some extent since the time between survey 3 and survey 4 was also about 6 months. The risk perception factors *acceptance* ($t = -8.38$, $p = 0.00$), *effect* ($t = -9.09$, $p = 0.00$) and *familiarity* ($t = -2.81$, $p = 0.00$) increased significantly, but *trust* ($t = 8.63$, $p = 0.00$) decreased, revealing an upward trend of public seismic acceptance and awareness, but a downward trend of government credibility during the half year period.

3.3 Risk acceptance of different demographic characteristic groups

People with different demographic characteristics usually hold different attitudes towards risks and may be affected by disasters in different degrees. The pattern shown in Table 4 was suggestive of group differences in acceptance and changes. The comparison between survey 1 and survey 2 demonstrated a significant increase in acceptance in survey 2 in most subgroups regarding age, education and income status. Moreover, the variation in risk acceptance from survey 2 to survey 3 was also examined. Females showed significant lower risk acceptance after the occurrence of Yushu earthquake. And other subgroups

Table 2 Results of factor analysis of four surveys

	Survey 1			Survey 2			Survey 3			Survey 4		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
V1[a]	−0.02	**0.81**	0.06	0.04	**0.68**	0.05	0.24	**0.68**	0.02	0.08	**0.83**	−0.03
V2[b]	**0.65**	0.28	0.12	**0.68**	0.14	−0.13	**0.59**	0.32	0.52	**0.82**	0.02	−0.04
V3[c]	0.20	**0.46**	−0.01	−0.42	**0.50**	−0.18	0.48	**0.66**	0.42	−0.03	**0.87**	0.05
V4[d]	**0.56**	0.27	−0.20	**0.70**	0.19	0.01	**0.78**	0.19	0.06	**0.81**	−0.11	−0.12
V5[e]	0.37	**0.50**	−0.07	0.22	**0.63**	0.07	−0.06	**0.58**	−0.07	−0.07	**0.85**	0.00
V6[f]	0.19	−0.21	**0.75**	0.12	0.22	**0.68**	0.37	0.07	**0.58**	−0.15	0.06	**0.84**
V7[g]	**0.80**	−0.07	0.10	**0.66**	−0.03	−0.36	**0.77**	0.30	0.15	**0.78**	−0.08	−0.06
V8[h]	−0.12	0.30	**0.67**	−0.02	−0.13	**0.69**	0.18	0.07	**−0.72**	−0.03	0.00	**0.87**
V9[i]	**0.68**	0.02	−0.23	**0.49**	−0.05	0.11	**0.55**	−0.06	0.13	**0.44**	0.15	−0.10

|Factor pattern| >0.40 is in boldface type

[a] Newness, "Do you think the earthquake is a rare risk or a common risk?"

[b] Immediacy, "Are the effects of earthquake immediate, or will they take place in the future?"

[c] Knowledge, "How much do you know about earthquake?"

[d] Dread, "Is earthquake a common risk or a terrible risk?"

[e] Familiarity, "Are you familiar with earthquake risk?"

[f] Controlability, "Do you think that you can avoid the earthquake risk by self-efforts?"

[g] Effect, "How many people do you think are affected by the impact of the earthquake?"

[h] Trust, "To what degree do you trust in the government?"

[i] Benefit, "Have you got any benefit from earthquake?"

Table 3 Samples *t* test of risk perception factors of each two surveys

		△Mean	SD	t	Sig
Survey 1 versus Survey 2	Acceptance 1–acceptance 2	−0.89	1.73	−7.53	0.00
	Effect 1–effect 2	0.61	1.47	6.14	0.00
	Familiarity 1–familiarity 2	−1.27	1.40	−13.12	0.00
	Trust 1–trust 2	−0.60	1.22	−7.11	0.00
Survey 2 versus Survey 3	Acceptance 2–acceptance 3	0.26	1.66	2.57	0.01
	Effect 2–effect 3	−0.86	1.33	−10.30	0.00
	Familiarity 2–familiarity 3	0.66	1.21	8.82	0.00
	Trust 2–trust 3	−0.85	1.19	−11.50	0.00
Survey 3 versus Survey 4	Acceptance 3–acceptance 4	−0.79	1.50	−8.38	0.00
	Effect 3–effect 4	−0.56	0.96	−9.09	0.00
	Familiarity 3–familiarity 4	−0.19	1.07	−2.81	0.00
	Trust 3–trust 4	0.67	1.25	8.63	0.00

within which the acceptance decreased significantly after the earthquake included the age 16–20 group and the group of people with monthly income <2,000 yuan. The differences of risk acceptance of different demographic characteristics subgroups between survey 3 and survey 4 demonstrated a similar pattern as differences between survey 1 and survey 2 that most subgroups exhibited a significantly higher level of risk acceptance in the later survey. It should be noted that since few respondents have education level less than primary school, the comparison among subgroups "no formal education" and "primary school" may be lack of statistical significance.

3.4 Results of regression models

The regression results of four surveys were all demonstrated in Table 5. It could be observed that for survey 1 and survey 2 that were conducted after Wenchuan earthquake, the three risk perception factors *effect*, *familiarity* and *trust* showed significant impact on risk acceptance. In survey 1, the public risk acceptance was negatively influenced by *effect* ($B = -0.16$, $p = 0.00$) and had positive relationships with *familiarity* ($B = 0.13$, $p = 0.02$) and *trust* ($B = 0.22$, $p = 0.00$), suggesting a higher level of acceptance when people have more knowledge about earthquake and have more confidence in government to protect them from the damage of earthquake. While in survey 2, the risk perception factors *effect* ($B = -0.22$, $p = 0.00$) and *trust* ($B = 0.21$, $p = 0.02$) had remained their sign effect on risk acceptance, but factor *familiarity* ($B = -0.27$, $p = 0.00$) showed an opposite sign effect on acceptance comparing with the result of survey 1, which indicated that people who are less familiar with earthquake, perceive less effect, and have more confident in government are more willing to accept the seismic risks. Moreover, in survey 3, which was conducted after the Yushu earthquake, it was evident that the public seismic risk acceptance were mainly determined by demographic variables *age* ($B = 0.14$, $p = 0.09$), *education* ($B = 0.26$, $p = 0.00$) and perception factor *effect* ($B = -0.49$, $p = 0.00$). It revealed that the group of elder people and more educated people are easier to accept the risk of earthquake and a higher perceived effect of earthquake leads to a lower acceptance towards it. However, one year later, all these three factors turned out no longer to be the predominant factors of public earthquake risk acceptance in survey 4. The regression result exhibited a positive relationship between

Table 4 Comparison analysis of acceptance towards earthquake risk of different demographic groups

Demographic characteristic	Classification	Acceptance (survey 1–survey 2) △MEAN(SD)	Acceptance (survey 2–survey 3) △MEAN(SD)	Acceptance (survey 3–survey 4) △MEAN(SD)
Gender	Male	−1.38*(1.81)	0.04(1.72)	−0.62*(1.51)
	Female	−1.48*(1.70)	0.45*(1.81)	−1.02*(1.47)
Age	16–20	−1.28*(1.84)	0.76*(1.40)	−1.08*(1.24)
	20–39	−0.98*(1.78)	−0.14(1.82)	−0.62*(1.58)
	40–60	−1.68*(1.90)	0.15(1.61)	−0.64*(1.42)
	>60	−1.37*(2.02)	0.23(2.42)	−1.00*(1.36)
Education	No formal education	–	–	–
	Primary school	−2.00(1.00)	0.66(2.30)	–
	Middle school	−0.86*(1.50)	0.40(1.79)	−1.00*(1.49)
	High school	−1.14*(1.89)	0.31(1.79)	−1.16*(1.43)
	College	−1.06*(1.73)	−0.17(1.71)	−0.54*(1.49)
	Graduate	−1.57*(1.80)	0.42(0.97)	0.00(1.29)
Income (yuan per month)	<2,000	−1.23*(1.66)	1.02*(1.73)	−1.56*(1.32)
	2,000–4,000	−1.72*(1.90)	0.32(1.82)	−0.97*(1.62)
	4,000–8,000	−1.17*(1.73)	−0.16(1.76)	−0.41*(1.54)
	8,000–20,000	−1.51*(1.84)	−0.08(1.94)	−0.33(1.67)
	>20,000	−0.52(1.56)	0.00(1.53)	−0.85*(1.55)

* Difference is statistically significant at $p \leq 0.05$

acceptance and perception factors *familiarity* ($B = 0.16$, $p = 0.04$) and *trust* ($B = 0.23$, $p = 0.00$).

4 Discussions

4.1 Changes in public risk perception factors due to earthquake effects

In order to explore the variations of public earthquake risk perception, samples *t* test of each perception factor was conducted between two consecutive surveys. The comparison results of survey 1 and survey 2 gave a pattern that the public perceived seismic risk acceptance, familiarity and government trust increased and perceived earthquake effect decreased about 6 months after the Wenchuan earthquake, which may thank to the efforts of government. The Chinese government seemingly has taken a long period of active actions after the Wenchun earthquake, such as the psychological counselling and post-disaster reconstruction project, which helped to rebuild the public confidence and eases the public anxiety.

Unexpectedly, the Yushu earthquake occurred after survey 2. Although the government had taken precautions, the sudden earthquake still caused huge loss of life and property, which caused enormous psychological blow to public, decreasing the risk acceptance and increasing the perceived earthquake effect. However, the prompt and effective emergency actions right after the earthquake were laudable and increased public confidence in government.

Survey 4 was conducted about 6 months after the Yushu earthquake. The changes of public perception factors between survey 3 and survey 4 revealed that with the passage of time, the public familiarity, acceptance and perceived effects towards earthquake

Table 5 Regression results of four surveys

	Survey 1		Survey 2		Survey 3		Survey 4	
	B	*t*	*B*	*t*	*B*	*t*	*B*	*t*
(Constant)	1.81	3.31	4.60	5.97	3.20	5.67	2.60	3.97
Gender[a]	−0.20	−1.56	−0.01	−0.02	−0.19	−1.50	−0.05	−0.54
Age[b]	−0.03	−0.27	−0.08	−0.88	0.14*	1.65	−0.13	−1.58
Education[c]	−0.01	−0.25	−0.06	−0.77	0.26***	3.65	−0.02	−0.35
Income[d]	0.03	0.70	−0.06	−0.95	0.02	0.48	0.00	−0.01
Effect	−0.16***	−2.72	−0.22***	−2.80	−0.49***	−6.82	−0.00	−0.01
Familiarity	0.13**	2.20	−0.27***	−2.95	−0.10	−1.34	0.16***	2.06
Trust	0.22***	3.31	0.21**	2.31	0.06	0.91	0.23***	3.68

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Variable categorization: [a]male = 1, female = 2; [b]16–20 = 1, 20–39 = 2, 40–60 = 3, > 60 = 4; [c]no formal education = 1, primary school = 2, middle school = 3, high school = 4, college = 5, graduate = 6; [d]<2,000 = 1, 2,000–4,000 = 2, 4,000–8,000 = 3, 8,000–20,000 = 4, >20,000 = 5

increased, but the trust in government decreased. A possible explanation is that although the Yushu earthquake has also caused huge loss of life and property and has tremendous impact in the country, it raised far less international concern than the Wenchuan earthquake. The government might have some slack in the reconstruction work after the Yushu earthquake, which to some extent caused the loss of public confidence, the decline in trust in government and the increase in perceived effect. This should be an alarm for the government to serve the public with due diligence all the time, since the reconstruction of public trust after loss will be a very long and difficult process. Additionally, it is worth noting that the regression result of survey 4 showed no relationship between perceived earthquake effect and public risk acceptance; therefore, although the perceived influence of earthquake increased in survey 4, the public risk acceptance still increased. We tried to explain this phenomenon that with the passage of time, public started to realize that earthquakes are irresistible but small probability events.

Moreover, this study investigated the earthquake risk acceptance of different demographic characteristic groups and the changes between each two surveys. The pattern firstly revealed that women always have lower level of risk acceptance than men, but show a higher increase in risk acceptance when time passed after two severe earthquakes. This finding was supported by many former outcomes that females are more vulnerable to natural hazards than males (Brenkert-Smith et al. 2012; Granger et al. 1999; Granger and Hayne 2001), and some researchers have demonstrated that women are better able to come together to support each other and recover more quickly than males (Fordham 2000).

Secondly, due to the Yushu earthquake happened between survey 2 and survey 3, the comparison between them uncovered the influence of severe earthquake on different demographic characteristics people's risk acceptance. A significant decrease in risk acceptance was discovered in demographic subgroups females, age 16–20, and monthly income <2,000 yuan, which was quite reasonable that people with such features such as being a woman, being a teenager or having a low salary are usually considered to be the vulnerable groups, and tend to be more sensitive to natural disasters. The impact of demographic characteristics such as gender, age, income on earthquake vulnerability and willingness to take precautions was also found by Lindell et al. (2009). In addition,

Kellens et al. (2011) discovered significant differences of public risk vulnerabilities with different gender, age or income status in the study of Belgian coastal flood risk perception.

Lastly, generally speaking, there was an upward slope of risk acceptance in time series after two severe earthquakes among most demographic characteristic groups. This phenomenon could be explained that time may to some extent relieve the public fear towards seismic risks after a severe catastrophe has taken place.

4.2 Analysis of earthquake risk acceptance determining factors

The regression models employed to give insight into the earthquake public risk acceptance determining factors have demonstrated several interesting patterns. Perception factor *effect* was found to have significantly negative influence on public *acceptance* in survey 1, survey 2 and survey 3, and perception factor *trust* was found to have significantly positive effect on *acceptance* in survey 1, survey 2 and survey 4. The higher perceived effect of earthquake damage was sure to lead to the lower level of seismic risk acceptance, which was supported by Coles and Hodgkinson (2008) who also discovered that the perceived seriousness and frequency of risk control the individual judgment. Moreover, the positive relationship between government trust and risk acceptance revealed that government can increase public risk acceptance by living up to their responsibilities and setting a good image. Similarly, in many risk studies, trust was often identified as an important factor in influencing public risk judgment (Huang et al. 2010; Slovic et al. 2004). Perception factor *familiarity* was found to have significantly positive effect on *acceptance* in survey 1, survey 4, and negative effect on *acceptance* in survey 2, the multi-effect of familiarity on risk acceptance was always controversial among researchers. Goodfellow et al. (2011) have discovered that the public are more willing to accept nuclear power plants if they are informed by more knowledge of nuclear power and recognized the safety. Slovic (1987) also stated that the positive relationship between risk acceptance and familiarity may result from the public fear towards unknown risks. However, a pesticide risk study in Taiwan conducted by Fu et al. (1999) found that greater familiarity usually lead to lower acceptance and higher willingness to pay for risk reduction. Tucker and Napier (1998) stated in their article that increased familiarity with or understanding of a particular hazard situation may reduce perceived risk if it provides information on controlling or mitigating potential risks or losses, while increased familiarity would not be expected to reduce perceived risks in cases where new dangers are disclosed and the probability of loss cannot be reduced.

In addition, it was worth noting that the regression pattern of survey 3 was quite different from others, where demographic characteristics *age* and *education* had significant positive relationship with public *acceptance*. Survey 1 and survey 3 were both conduced right after the severe earthquakes, but the determining factors of public seismic acceptance were discrepant. One possible explanation was that the sudden Wenchuan earthquake caused concern among all residents, while after experiencing such a disaster, the Yushu earthquake exerted more threat to vulnerable populations such as children or less educated residents. Generally, risk perception factors had more significant effect on risk acceptance than demographic characteristics. This might be because that earthquake is a kind of catastrophic risk, and the risk tolerance of such kind of risks is mainly contributed to the subjectively perceived level of risk influence. These results were consistent with previous risk perception studies, which have found similar results indicating that the characteristics measured based on the knowledge, dread or fear, and exposure scale are important factors in explaining perceived risk across a wide range of hazards (McCaffrey et al. 2011;

Slovic 1987; Vassanadumrongdee and Matsuoka 2005; Zhai and Suzuki 2008). Dogaru et al. (2009) and Shi and He (2012) also found no statistically significant relationship between mining pollution perception and gender variable, and they explained that both men and women are exposed in the same environment and affected by the closure of mines.

These results discussed above were suggestive for government to not only fulfil the emergency responses and long-term reconstruction works to enhance the public confidence, but also to improve the public risk education and communication to raise the public risk acknowledgement and relieve the public anxiety.

5 Conclusions

This study conducted four surveys twice each after the Wenchuan and Yushu earthquakes to explore the impact of a severe earthquake on public risk perception on different time scales, and built regression models to find the risk acceptance determining factors. The results showed that after two severe earthquakes, the public seismic risk acceptance increased over time, and the comparison between pre- and post-Yushu earthquake illustrated that the severe disaster had more impact on vulnerable populations such as females, children and low-income people. Moreover, in the aspect of risk acceptance determining factors, we discovered that the public risk perception factors had significant impact on public seismic risk acceptance; especially the acceptance had negative relationship with perceived earthquake effect and had positive relationship with government trust.

Nevertheless, some limitations of sampling still exist in current studies. The sample size of each survey may be insufficient, and the sample selection may be lack of continuity. Furthermore, the role of many social and individual demographic variables has not been sufficiently studied. All of these issues should be considered in future studies.

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