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Community Disaster Resilience and Risk Perception in Earthquake-Stricken Areas of China

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Original Research

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Abstract

Objective: The purpose of this study is to further deepen our understanding of the relationship between community resilience and disaster risk perception of residents, so as to provide beneficial enlightenment for the construction of community resilience disaster prevention system and disaster risk management.

Methods: This study surveyed 327 rural households in four counties of Sichuan Province, China, that were affected by the Wenchuan and Lushan earthquakes. Community disaster resilience was divided into five dimensions: connection and caring, resources, transformative potential, disaster management, and information and communication. Residents' disaster risk perception was divided into three dimensions: possibility, threat, and worry. This study analyzed the characteristics of community disaster resilience and residents' disaster risk perceptions. Ordinary least squares (OLS) methods were used to explore the correlations between these factors.

Results: The results show that (1) Residents' overall disaster risk perception was at a moderate level, and the community's overall disaster resilience were above the moderate level. (2) Community connection and caring has a positive significant correlation with the possibility perception of disaster occurrence; transformative potential has a negative significant correlation with the possibility perception of disaster occurrence; the overall community disaster resilience has negative significant correlations with the possibility and the overall residents' perception of disaster risk occurrence.

Conclusions: The implication for the local government is that the government should appropriately increase its contact with external institutions/organizations, especially some Non-Governmental Organization, to strengthen the resilience and disaster prevention capacity of the community. Establish and improve information and communication networks to ensure the timely and effective transmission of effective disaster information, and strengthen the supervision of the dissemination of false information to reduce the losses caused by false information to residents. Attention should be paid to psychological counseling for people in disaster-hit areas to reduce the psychological trauma of the disaster.

1. Introduction

In recent years, with global environmental change and social and economic development, the frequency of disasters has increased, greatly reducing the well-being of community members.[1–5] For example, in 2018, 830 400 people were affected by earthquakes worldwide and 87 900 people died as a result of earthquakes.[6] In this context, many scholars and institutions have focused on disaster risk management, and a need to strengthen national and community resilience has been pointed out.[7–9] In regions vulnerable to disasters, the more knowledgeable individuals are in disaster prevention and the more resilient communities are to disasters, which greatly reduce their impacts and the community's losses.[10] However, as different countries (regions) have different socioeconomic and cultural backgrounds and disaster types, there is no unified standard for measuring community disaster resilience in the academic world.[11] Many studies even only mention community disaster resilience in the paper but do not define and measure it. It is necessary to further strengthen the empirical research on community disaster resilience measurement around the world.[11] In general, though, local governments have gradually realized the importance of building resilient disaster prevention systems in communities. However, throughout the research on community disaster resilience, the academic community has focused on developed countries such as Europe and America.[12,13] In China, this concept has only recently been recognized by the academic community, and there are few empirical studies based on the socioeconomic and cultural background of China.[10,14] By the end of 2017, only 4 Chinese cities were included in the global 100 Resilient Cities project proposed by the

Rockefeller Foundation.[15,16] Sichuan is a region that typifies the co-occurrence of geological disasters and poverty. Eight seismic belts occur across 4 major poverty-stricken areas.[2] Among them, the Longmen mountain fault zone is most well-known. It extends from the northeast to the southwest along the edge of Sichuan Basin and includes the counties of Qingchuan, Beichuan, Mao, Wenchuan, Dayi, and Baoxing, and the cities of Pengzhou and Lusha. The 2008 Wenchuan earthquake and the 2013 Lushan earthquake were both located in the Longmen Mountain fault zone. These 2 earthquakes caused 446 600 and 13 200 casualties, respectively, and direct economic losses of 856.79 billion and 67.14 billion Yuan.[17] However, relatively little research has been done on building resilient communities in China, especially in poor rural areas where disasters and poverty are intertwined. Therefore, relevant research is urgently needed.[18,19] Therefore, the key problems to be solved in this study are (1) What are the characteristics of community disaster resilience and residents' disaster risk perception? (2) What is the correlation between community disaster resilience and disaster risk perception?

2 Literature Review and Research Hypotheses

2.1 Literature Review

Community disaster resilience was the core independent variable investigated in this study. It refers to (1) adaptation to a disaster-prone environment over a long period of time, (2) having good prediction and early warning systems, and (3) having a coordinated response capability that does not greatly rely on external rescue; rather, the environment and social structure can be restored to a pre-disaster state in a self-sufficient manner.[20–24] "Resilience" was introduced into disaster risk management research and widely accepted by the academic community in the 2005 World Conference on Disaster Risk Reduction.[14] Its research objects include individuals, families, communities, and even larger regions.[11] As the smallest social organization unit at the grass-roots level, community plays an important role in the occurrence of disasters. Therefore, after the concept of resilience was proposed, many disaster risk reduction projects and studies focused on the resilience capacity building and improvement of communities[25–27] and believing that community disaster resilience is the foundation of post-disaster reconstruction and recovery.[28] Since then, more and more scholars began to pay attention to the measure of community disaster resilience and its application in disaster risk reduction, and proposed the measure system of community disaster resilience from different angles. For example, Kafle[29] used process and outcome indicators to measure the community disaster resilience of the Indonesian community; Orencio and Fujii[30] measured the community disaster resilience of the Filipino community from the environmental and natural resource management, health and well-being, sustainable livelihoods, social protection, financial instruments, physical protection, and planning regimes 7 dimensions; Mayunga[31] measured the community disaster resilience of the American community from social, economic, human and physical these 4 dimensions; Ostadtaghizadeh et al.[11] introduced the models and tools for community disaster resilience assessment in the review system of community disaster resilience and further pointed out that the measurement of community disaster resilience should include social, economic, institutional, physical, and natural 5 domains. These studies provide useful inspirations for the research of community disaster resilience and disaster risk reduction. However, Chinese research on community resilience and disaster prevention capacity building has focused on post-disaster recovery and reconstruction. For example, from the perspective of architecture, some scholars have proposed strategies for ensuring community security by means of technological progress (eg, Li and Xu[32]). From the perspective of social relations, some scholars believe that the communities should change from having government administration to having coordinated and bottom-up grass-roots participation (eg, Jin and Lu[33]). Generally speaking, there is no short-term recovery after a disaster, and communities need to rely on their own resource endowment (eg, savings) and outside resources (eg, outside financial and human assistance) for post-disaster reconstruction.[14,34] It can be seen from the situations of several recent major earthquakes in Sichuan Province that after an earthquake, many communities do not have the resilience and disaster prevention capacity to complete post-disaster reconstruction. Instead, they need to make extensive use of external forces.[35] However, for disasters as serious as earthquakes, 72 hours is the optimal time-limit for rescue, but the intervention of external forces will often take longer than this, resulting in further losses of life and property.[36] Therefore, knowing how to strengthen the resilience of communities to disasters is crucial. However, at present, the building of disaster resilience in Chinese communities is still at the initial stage, and much research is needed. At the same time, there are only a few studies on community disaster resilience in China, although Cui et al.[14] made some useful explorations on the basis of Joerin et al.,[37] Orencio and Fujii,[30] Ostadtaghizadeh et al.,[11] measuring community disaster resilience in China's earthquake-stricken areas from 5 dimensions: connection and caring, resources, transformative potential, disaster management and information and communication, and exploring the relationship between community disaster resilience and disaster risk reduction. However, the research area only focuses on 1 county, and whether the community disaster resilience measurement index is still feasible for the vast earthquake-stricken areas in China still needs to be further verified. In addition, the correlation between community disaster resilience and residents' disaster risk perception has not been explored in China. As individuals in the community, residents are the direct victims of the disaster and the direct participants in the post-disaster reconstruction. The strength of community disaster resilience is bound to affect the residents' disaster risk perception level, and then affect their decision of disaster prevention and reduction. Therefore, it is necessary and extremely important to explore the correlation between community disaster resilience and residents' disaster risk perception, and relevant studies are urgently needed.

Disaster risk perception refers to residents' subjective evaluations and judgments of the risk of events, as well as their associated attitudes and decision-making tendencies. It covers the whole process of perception, understanding, memory, evaluation, and response to risks.[38,39] At present, the development of community disaster resilience is insufficient. One important reason is residents perceive disaster risk to be low.[40,41] The disaster risk perception of residents in disaster-threatened areas and its driving mechanisms have been a focus of academic research. Existing studies have mostly examined residents' disaster risk perception in terms of personal characteristics (eg, gender, age, level of education), disaster experience (eg, experience of disasters, disaster severity), hazard proximity and hazard education programs,[42–47] and household socioeconomic characteristics (eg, income, population, whether to have children, older people, building structure).[48–54] This provides a basis for us to understand the disaster risk perception of residents in disaster-threatened areas. However, few studies have

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focused on the impacts of community disaster resilience on residents' disaster risk perception.

2.2 Research Hypotheses

Community disaster resilience and residents' disaster risk perception and its influences have been a focus of academic research. Researchers believe that the relationship between community disaster resilience and disaster occurrence is complex and involves many social, economic, political and physical factors, and is characterized by temporal and spatial changes.[27,35,55–57] For communities with high overall community disaster resilience, residents may have "survivor bias,"[54,58,59] and believe that their community has strong disaster resilience in all aspects and, thus, the residents have a relatively low level of disaster risk perception. For example, residents generally believe that disasters are unlikely to happen and not be too severe, so they are not very concerned about them. Based on this, the study proposes research hypothesis H1.

H1:. The overall community disaster resilience is negatively related with residents' overall disaster risk perception and various risk perception dimensions.

The stronger the community connection and caring, the greater residents' sense of belonging. Residents are full of hope for the future development of the community. In daily life, mutual helping and a harmonious community environment can further reduce residents' disaster threat perception and worry.[14] High-magnitude earthquake disasters have low frequency, so residents generally think their possibility of occurrence is relatively low. For residents living in communities where residents help each other and neighbors live close to each other, disaster-related information will be timely and accurate, which is conducive to a better understanding of earthquake disasters. As a result, the more connected the community, the less likely are residents to think that a disaster is likely to occur. Based on this, we propose research hypothesis H2.

H2:. There is a negative correlation between community connection and caring and residents' overall disaster risk perception and various risk perception dimensions.

The better the resource endowment of the community, the better the community is able to solve the problems faced by development. There are special support measures for families, and resource-rich communities can reduce residents' awareness of the threat and worry of disasters.[60,61] For communities with effective leadership and good welfare policies, even in the event of a natural disaster, residents can unite to deal with the losses caused by the disaster. As a result, residents consider disasters less likely. Based on this, we propose research hypothesis H3.

H3:. There is a negative correlation between community resource and residents' overall disaster risk perception and various risk perception dimensions.

Strong community transformative potential, planning for community development, and the ability of residents to negotiate and solve problems can further reduce residents' perception of the possibility and threat of disasters.[62] With the continuous improvement of community infrastructure, residents believe that the threat of disasters is relatively low. Communities with a consultative democracy that can pool the wisdom and efforts of all residents have the ability to guarantee the safety of life and property after a disaster. Therefore, the higher the transformative potential of community, the lower the worry of disaster. Based on this, we propose research hypothesis H4.

H4:. There is a negative correlation between the community transformative potential and residents' overall disaster risk perception and various risk perception dimensions.

The better a community's disaster management system, the better the group monitoring and mass prevention system (disaster evacuation and relocation plan). Communities with positive disaster preparedness measures can reduce residents' perception of the possibility of disaster and their worry.[63] With the advancement of science and technology, communities can receive early warning within tens of seconds before the onset of a major earthquake, and residents believe that their threat is relatively low. Therefore, the more comprehensive the community's disaster management system, the lower the residents' perceived threat of disaster. Based on this, we propose research hypothesis H5.

H5:. There is a negative correlation between community disaster management and residents' overall disaster risk perception and various risk perception dimensions.

Community information and communication are smooth, and residents are told relevant disaster prevention information and scientific disaster prevention measures by means of media. Moreover, residents believe that the information released by the community is authoritative, which further reduces their disaster awareness and worry (Tierney et al. 2006).[64] Unimpeded communication of information to communities is conducive to residents' comprehensive and scientific understanding of disasters. As a result, residents of communities with better access to information may perceive disasters to be less likely. Based on this, we propose research hypothesis H6.

H6:. There is a negative correlation between community information and communication and residents' overall disaster risk perception and various risk perception dimensions.

3 Research Design

3.1 Data Sources

The objective of this study is to explore the correlation between residents' disaster risk perception and community disaster resilience. Considering the typicality and representativeness of the Longmen mountain seismic belt, the research group conducted a questionnaire-based survey and interviews in the 4 counties of the seismic belt in July 2019. The surveys and interviews were conducted on one-on-one basis in households, and the average length of each questionnaire was about 1.5 hours. The questionnaires and interviews investigated farming families' situations, residents' disaster risk perception, and community disaster resilience. The sample selection was mainly determined by stratified equal probability random sampling. The specific sampling process is detailed in Xu et al.[3–5,18,54] After data cleaning, 327 valid questionnaires were obtained—an effective recovery rate of 97%. See Figure 1 for maps of the sample county and town locations.

3.2 Selection of Model Variables

Community disaster resilience is the core independent variable of this study. By referring to Cui et al.,[14] Cutter et al.,[65] Han et al.,[66] Pfefferbaum et al.,[67] and Ungar,[68] community disaster resilience was divided into the following 5 dimensions in this

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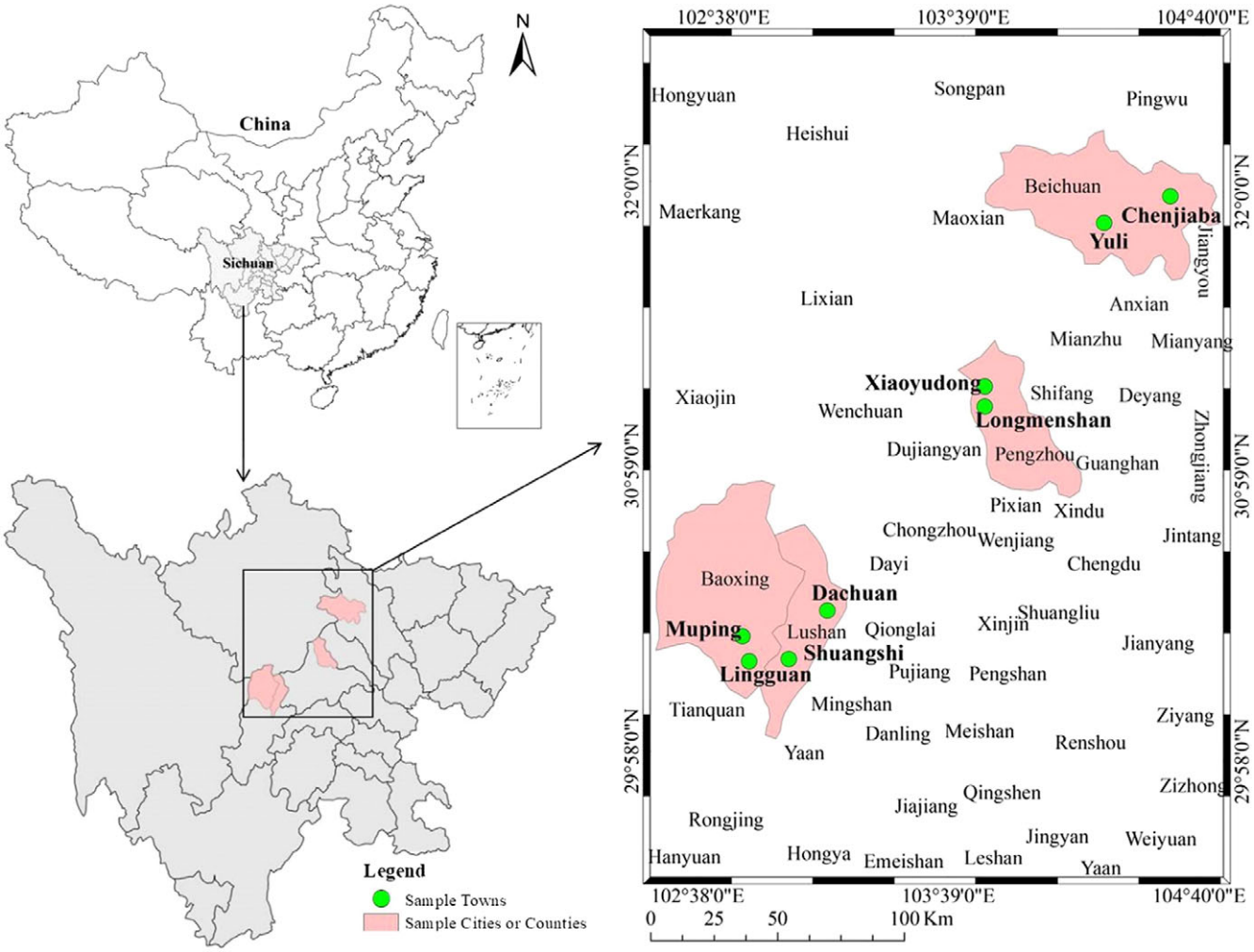

Figure 1. Map of sample county and town location.

study: *connection and caring*, *resources*, *transformative potential*, *disaster management,* and *information and communication*. To better reflect the situation in the study region, a total of 24 indicators were used (Table 1). The Cronbach's alpha test values of *connection and caring*, *resources*, *transformative potential*, *disaster management*, *information and communication,* and *total community disaster resilience* are 0.77, 0.68, 0.82, 0.79, 0.72, and 0.92, respectively. It shows that the internal consistency of the community disaster resilience measurement index adopted in the study is good and can be further analyzed.

Disaster risk perception was the dependent variable used in this study. As for the measurement of *disaster risk perception*, referring to the studies of Chandra et al.[69] and Xu et al.,[2,18,54,70] this study divided this variable into 3 dimensions: *possibility*, *threat,* and *worry*. Some terms were designed to measure each dimension (Table 2).

In order to improve the explanatory power of the model, referring to the studies of Lawrence et al.,[71] Lo and Cheung,[58] Peng et al.,[72,73] Xu et al.,[70] and Yu et al.,[74] variables that may affect residents' disaster risk perception were added as control variables. These mainly included the socioeconomic characteristics of respondents and their families, including age (years), gender (0 = male, 1 = female), years of education (years), nationality (0 = else, 1 = Han), occupation (0 = farmer; 1 = else), residence time (years), income (annual cash income of farmers' families in 2018, Yuan), housing structure (0 = else, 1 = civil structures), and so forth.

3.3 Analytic Strategy

As the dependent variable, *disaster risk perception* was the result of factor analysis; it is the computation of scale scores by summing over multiple items that produce a symmetric, unimodal distribution that is likely to approximate a normal distribution. Based on the distribution characteristics of the dependent variables, ordinary least square (OLS) was used to explore the correlation between community disaster resilience and residents' disaster risk perception. The simple expression of the model is as follows:

$$Y_i = \alpha_0 + \beta_{1i} \times CR_i + \beta_{2i} \times Control_i + \varepsilon_i$$

In the formula, Y_i represents residents' disaster risk perception, which can be divided into 4 indicators: *possibility*, *threat*, *worry,* and *overall disaster risk perception*; CR_i represents community disaster resilience, which can be divided into 6 indicators: *connection and caring*, *resources*, *transformative potential*, *disaster management*, *information and communication,* and *overall community disaster resilience*. $Control_i$ represents the control variables; α_0, β_{1i}, and β_{2i} represent the model parameters to be estimated;

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Table 1. Definition and descriptive statistics of the model variables

Category	Variable	Definition and measure [a]	Mean	SD [b]
Connection and caring	B1	Villagers have a sense of belonging.	4.32	0.78
	B2	Villagers work hard to improve the welfare of the village.	4.16	0.85
	B3	Villagers are optimistic about the future development of the village.	4.02	1.04
	B4	Villagers help each other in daily life.	4.48	0.72
Resources	B5	The village's leading cadres are efficient and capable.	3.86	1.08
	B6	The village has the resources/capacity to solve its problems.	3.42	1.17
	B7	In the village, everyone knows where to go and whom to ask for help.	4.24	0.82
	B8	The village has support programs for children and families.	3.55	1.25
Transformative potential	B9	The village works with external organizations/institutions to solve its problems.	3.24	1.31
	B10	Villagers can communicate with village cadres very well regarding village problems.	3.94	1.09
	B11	Everyone is concerned about the village's problems and aims to solve them together.	4.21	0.80
	B12	All villagers negotiate and communicate to solve the village's problems.	3.96	1.03
	B13	People share their experiences and lessons on the success or failure of village development.	3.50	1.12
	B14	The village has taken measures to prevent/control disasters.	3.89	1.08
	B15	During a disaster, the village can provide timely disaster relief services.	3.98	0.98
	B16	The village has goals and plans for future development.	3.41	1.25
Disaster management	B17	In the event of a disaster, the village has policies in place to help people rebuild.	3.84	1.05
	B18	Faced with the possibility of future disasters, the village has disaster preparedness measures.	3.92	1.00
	B19	If a disaster occurs, the village can provide information and direction to people.	4.12	0.95
	B20	The village has a system of group testing and mass defense system construction.	3.38	1.26
	B21	The village has a systematic disaster evacuation/reflow/relocation plan.	3.43	1.22
Information and communication	B22	The village can use telephone/radio/cadre communication and other means to inform villagers of relevant information.	4.13	0.99
	B23	People in the village have great faith in the government's decisions.	4.28	0.88
	B24	I can get information from the village to help my family work and live better.	3.63	1.19
Connection and caring		The mean score of B1 to B4	4.25	0.66
Resources		The mean score of B5 to B8	3.77	0.78
Transformative potential		The mean score of B9-B16	3.77	0.72
Disaster management		The mean score of B17-B21	3.74	0.81
Information and communication		The mean score of B22-B24	4.01	0.81
Overall community disaster resilience		The mean score of B1 to B24	3.91	0.63

Notes:
[a]1 = totally disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = totally agree
[b]SD = standard deviation.

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Table 2. Earthquake disaster risk perception measurement

Entry code	Dimension	Item [a]	Mean	SD [b]
A1	Possibility	In the next 10 years, disasters may occur near your home.	2.83	1.12
A2		You always feel that disaster will come someday.	3.08	1.32
A3	Threat	In the next 10 years, if there is a disaster, your home and land may be affected.	3.84	1.14
A4		In the next 10 years, if a disaster occurs, it will affect your life and that of your family.	3.35	1.31
A5	Worry	When you think about earthquakes, mudslides, landslides, and other disasters, you get scared.	3.91	1.32
A6		You worry about the impact of natural disasters such as earthquakes, mudslides, and landslides on village families.	4.19	1.12
Possibility	Residents' overall perception of the possibility of disaster.		2.96	1.07
Threat	Residents' overall perception of disaster threat.		3.59	1.08
Worry	Residents' overall perception of disaster occurrence is of worry.		4.05	1.01
Total perception	Residents' overall perception of disaster risk perception.		3.53	1.05

Notes:
[a]1 = totally disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = totally agree
[b]SD = standard deviation.

ε_i is the residual term. All data analysis processes use SPSS 23 (IBM Corp, Armonk, NY).

3.4 Data Characteristics

In terms of the personal characteristics of the interviewees, the male to female ratio was about equal (54% male), ages were mainly middle and old (mean = 53.44 years), and the average length of education was low (mean = 6.29 years). In terms of the characteristics of the respondents' building structure, the dwellings were made of reinforced concrete (48%) or brick and tile (37%), with the remaining 15% being a civil structure, which means a house made of wood and clay. In addition, the average annual cash income of the respondents was 66 191 Yuan.

4 Results

In this section, the results of this study are mainly presented in 2 parts. The first part comprises the descriptive statistical analysis results of the core variables. The second part comprises the results of the correlations between community resilience and residents' disaster risk perception.

4.1 Descriptive Statistical Analysis

Table 1 shows the descriptive statistics for the independent variable *community disaster resilience*. In terms of the overall resilience of the community, the average score of *community disaster resilience* was 3.91, which is moderate. In terms of the dimension of *connection and caring*, the mean score was 4.25, indicating that each community invested more in connection and caring, with the question "villagers help each other in daily life" having the highest score of 4.48. The mean score for the *resource* dimension was 3.77, indicating that each community is not good at resource adequacy; "the village has the resources/capacity to solve its problems" had the lowest score of only 3.42. In terms of the *transformative potential*, the mean score was 3.77, indicating that the development of each community in its transformative potential was average; the lowest score was 3.24 for "the village works with external organizations/institutions to solve its problems." In terms of *disaster management*, the mean score was 3.74, indicating that the construction of disaster management in each community was mediocre, among them, the index of "the village has a system of group testing and mass defense system construction" scored the lowest, with only 3.38 points. In terms of *information and communication*, the average score was 4.01, indicating that each community invested more in information and communication, among which "people in the village have great trust in the decision-making of the government" scored the highest at 4.28.

As shown in Table 2, the overall score of residents' disaster risk perception was moderate (mean = 3.53). Among them, the mean total worry index was 4.05, indicating that rural households are worried about the impact of disasters. The average of the total probability index was 2.96, indicating that the probability of disaster was relatively low. In order to carry out a follow-up analysis, factor analysis was used to reduce the dimensionality of residents' *disaster risk perception*. Before the factor analysis, we first tested the reliability of the entries representing residents' *disaster risk perception*. Then, factor analysis was used to reduce the dimensionality of each entry, and 3 dimensions were obtained: *possibility*, *threat,* and *worry*. Among them, the Kaiser-Meyer-Olkin statistic was 0.75, and Bartlett's sphericity test was significant at $P < 0.001$. Both results indicate that the correlation matrix was suitable for factor analysis.

4.2 Model Results

Table 3 shows the correlation coefficient matrix between the core variables of the model. As shown in Table 3, except for the correlation coefficient between *overall community resilience* and some community resilience components being higher than 0.8, all of the correlation coefficients in Table 3 are $r < 0.80$, indicating that there was no serious multi-collinearity between the independent variables of the model. Meanwhile, *worry* is significantly negatively correlated with *resources*, *transformative potential,* and *overall community resilience*; *possibility* is significantly negatively correlated with *transformative potential, disaster management*, *information and communication,* and *overall community resilience*; *threat* is significantly negatively correlated with *information and communication*.

Table 4 shows the correlation between *community disaster resilience* and residents' *disaster risk perception*. Models 1 and 2 take the

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Table 3. Model relates to the correlation coefficient matrix of core variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Worry	1									
2. Possibility	0.00	1								
3. Threat	0.00	0	1							
4. Connection and caring	-0.06	0.02	-0.07	1						
5. Resources	-0.18*	-0.09	-0.10	0.48**	1					
6. Transformative potential	-0.16**	-0.22**	-0.07	0.50**	0.72**	1				
7. Disaster management	-0.08	-0.19**	-0.07	0.49**	0.64**	0.74**	1			
8. Information and communication	-0.03	-0.11*	-0.13*	0.57**	0.63**	0.65**	0.69**	1		
9. Overall community resilience	-0.11*	-0.15**	-0.107	0.76**	0.84**	0.87**	0.87**	0.86**	1	
10. Experience severity	0.17**	0.11	0.11*	-0.02	-0.10	-0.14*	-0.01	-0.07	-0.08	1
11. Age	-0.04	0.20**	-0.08	0.10	-0.06	-0.12*	-0.08	0.01	-0.04	-0.02
12. Gender	0.14*	-0.06	-0.06	-0.10	-0.04	-0.05	-0.03	-0.09	-0.07	0.00
13. Education	-0.14*	-0.18**	-0.03	0.01	0.02	0.13*	0.07	0.01	0.06	-0.04
14. Nationality	0.00	-0.07	-0.09	0.09	-0.07	-0.00	-0.01	-0.04	-0.01	-0.04
15. Occupation	0.02	0.12	0.01	-0.04	-0.12*	-0.18**	-0.16**	-0.05	-0.14*	0.03
16. Residence	0.01	0.17**	0.00	0.19**	-0.03	-0.06	-0.00	0.05	0.03	-0.03
17. Ln(income)	0.00	-0.14*	-0.13*	0.13*	0.17**	0.19**	0.21**	0.15**	0.21**	0.13*
18. House	-0.11*	-0.10	-0.12*	0.03	0.06	0.09	0.10	0.04	0.08	0.01

	11	12	13	14	15	16	17	18
11. Age	1							
12. Gender	-0.21**	1						
13. Education	-0.50**	-0.14*	1					
14. Nationality	-0.00	-0.06	0.18**	1				
15. Occupation	0.27**	0.10	-0.37**	-0.05	1			
16. Residence	0.52**	-0.27**	-0.34**	-0.04	0.16**	1		
17. Ln(income)	-0.23**	0.04	0.26**	0.04	-0.26**	-0.13*	1	
18. House	-0.13*	0.04	0.26**	0.12*	-0.15**	-0.23**	0.28**	1

Notes: ** $P < 0.01$, * $P < 0.05$.

possibility of disaster as the dependent variable. Among them, Model 1 describes the regression of the *possibility of disaster* onto the 5 dimensions of *community disaster resilience* and the control variables, while Model 2 describes the regression of the *possibility of disaster* onto the *overall community disaster resilience*. The results of Models 3 to 8 are presented in a similar manner. The test statistics (F-values) of all models were significant at the level of 5%, and the explanatory power of each model varied from 0.072 (Model 4) to 0.128.

As shown in Models 1 and 2 in Table 4, *connection and caring* was positively related with the *possibility perception of disaster occurrence*, *transformative potential,* and *overall community disaster resilience* was negatively related with *possibility perception of disaster occurrence*, while there was no significant correlation between the remaining 3 indicators (*resources*, *disaster management,* and *information and communication*) and *possibility perception of disaster occurrence*. Specifically, when other conditions were kept constant, the *possibility perception of disaster occurrence* increased by 0.23 units on average for every unit increase in *connection and caring*, and the *possibility perception of disaster occurrence* decreased by 0.29 and 0.19 units on average for every unit increase in *transformative potential* (Model 1) and *overall community disaster resilience* (Model 2). In addition, all the control variables were not significantly related with *possibility perception of disaster occurrence*.

As shown in Model 3 and Model 4, all concerned core independent variables (*connection and caring*, *resources*, *disaster management*, *information and communication,* and *overall community disaster resilience*) were not related with *threat perception of disaster occurrence*. In addition, the control variables *severity*, *age,* and *income* were related with *threat perception of disaster occurrence*, while the other control variables were not.

As shown in Model 5 and Model 6, all concerned core independent variables (*connection and caring*, *resources*, *disaster management*, *information and communication,* and *overall community disaster resilience*) were not related with *worry perception of disaster occurrence*. In addition, the control variables *severity* and *education level* of the experienced disasters were related with the *worry perception of disaster occurrence*, while the other control variables were not.

As shown in Model 7 and Model 8, *overall community disaster resilience* was negatively related with *overall disaster risk perception*, and the 5 indicators of *community disaster resilience* were not related with it. Specifically, with other conditions remaining unchanged, for every unit increase in *overall community disaster resilience*, *overall disaster risk perception* decreased by 0.35 units on average. In addition, the control variables *nationality* and *residence time* were related with *overall disaster risk perception*, while other control variables were not.

5 Discussion

Compared with the existing studies, the marginal contribution of this study is: (1) Verify the rationality of the measure index of

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Table 4. Regression of *disaster risk perception* onto *community disaster resilience* and control variables

	Possibility		Threat		Worry		Total score	
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Connection and caring	0.23*		0.05		-0.01		0.03	
	(0.11)		(0.11)		(0.11)		(0.17)	
Resources	0.14		-0.10		-0.11		-0.02	
	(0.10)		(0.11)		(0.11)		(0.17)	
Transformative potential	-0.29*		0.08		-0.25		-0.25	
	(0.13)		(0.13)		(0.13)		(0.21)	
Disaster management	-0.15		0.06		-0.00		0.02	
	(0.11)		(0.11)		(0.11)		(0.18)	
Information and communication	-0.05		-0.19		0.19		-0.12	
	(0.10)		(0.10)		(0.10)		(0.17)	
Overall community resilience		-0.19*		-0.13		-0.14		-0.35*
		(0.09)		(0.09)		(0.09)		(0.14)
Experience severity	0.12	0.14	0.15	0.15*	0.18*	0.20**	0.16	0.18
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.12)	(0.12)
Age	0.01	0.01	-0.01*	-0.01*	-0.01	-0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender	-0.07	-0.07	-0.20	-0.19	0.22	0.21	-0.26	-0.25
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.19)	(0.19)
Education	-0.02	-0.02	-0.02	-0.01	-0.04*	-0.05*	-0.00	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Nationality	-0.17	-0.14	-0.22	-0.19	0.13	0.13	-0.60*	-0.58*
	(0.14)	(0.14)	(0.15)	(0.14)	(0.14)	(0.14)	(0.24)	(0.23)
Occupation	-0.02	0.01	-0.02	-0.04	-0.12	-0.09	0.10	0.10
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.20)	(0.19)
Residence	0.00	0.00	0.00	0.00	0.00	0.00	-0.01*	-0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Ln(income)	-0.08	-0.07	-0.12*	-0.13*	0.03	0.03	0.03	0.03
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.10)	(0.10)
House	-0.02	-0.02	-0.15	-0.14	-0.19	-0.19	-0.34	-0.33
	(0.11)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.19)	(0.19)
Constant	0.47	0.61	2.14*	2.20**	0.13	-0.10	0.78	0.69
	(0.83)	(0.83)	(0.85)	(0.84)	(0.84)	(0.83)	(1.36)	(1.34)
Observations	327	327	327	327	327	327	327	327
R-squared	0.13	0.09	0.08	0.07	0.11	0.09	0.08	0.08
Adjusted R-squared	0.09	0.06	0.04	0.04	0.07	0.06	0.04	0.05
F-ratio	$F_{14,312} = 3.26$	$F_{10,316} = 3.13$	$F_{14,312} = 2.02$	$F_{10,316} = 2.44$	$F_{14,312} = 2.80$	$F_{10,316} = 3.10$	$F_{14,312} = 2.07$	$F_{10,316} = 2.82$

Notes: Standard errors in parentheses; ** $P < 0.01$, * $P < 0.05$.

community disaster resilience in China with the survey data from a larger area (4 districts, 8 counties, 16 villages, and 8 towns in the Wenchuan earthquake and Lushan earthquake stricken areas); and (2) the correlation between *community disaster resilience* and residents' *disaster risk perception* is systematically analyzed, which has important enlightenment significance for guiding residents' disaster prevention and mitigation behavior decision from the micro level. The research design ideas and measurement indexes of this study can provide reference for the measurement and practice of resilience of communities in other countries.

Community disaster resilience influences residents' disaster *risk perception*. The results are consistent with research hypothesis H1 and Sim et al.[75] There was a negative effect of *overall community disaster resilience* on *overall residents' disaster risk perception*. In other words, as the *overall community disaster resilience* increases, residents' *overall disaster risk perception* decreases. However, the *overall community disaster resilience* had no effect on 2 dimensions of residents' *disaster risk perception* (*threat* and *worry of disaster occurrence*). The possible reasons are that the communities where respondents are now living are not resilient enough to prevent

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disasters and the strong destructiveness of earthquakes, and the fact that community residents who have generally experienced 2 or more large earthquakes have left them with deep and painful memories, which have increased their concern for and threat perceptions of disasters. The results are not consistent with hypothesis H2. Antronico et al.[76] found that *community connection and caring* was significantly negatively correlated with risk perception of landslide disaster, and the possible reason was that compared with an earthquake, a landslide disaster was more predictable and technically monitored. This study found that there was a positive correlation between *community connection and caring* and *possibility perception of disaster occurrence*. The possible reason is that the area where the respondents were located is disaster-prone. There was no correlation between *community connection and caring* and *overall disaster risk perception* and its 2 dimensions (*threat* and *worry perception of disaster occurrence*). The likely reason is that a large number of young people in the sampled communities work outside the home, while the elderly and children live in the communities year-round. Therefore, neighbors can only provide limited help when disasters occur. Sadeka et al.[77] found that the stronger the community resource endowment, the higher the risk perception of residents, and the stronger the willingness to take behavioral measures to avoid disaster. The results are inconsistent with hypothesis H3, and there was no correlation between *community resource* and residents' *overall disaster risk perception* and its 3 dimensions. The possible reason is that due to the influences of geographical location and educational level, the impact of *community resource* on residents' resistance to earthquakes was relatively limited. Islam et al.[78] found that the *transformative potential* is one of the main factors to reduce the possibility, threat, and worry of residents' disasters. The results are not completely consistent with hypothesis H4, and there was a negative correlation between the *transformative potential* and the *possibility perception of disaster occurrence*. However, there is no significant correlation between the *transformative potential* and residents' *overall disaster risk perception*, *worry,* and *threat perception of disaster occurrence*. The possible reason is that the *transformative potential* plays a greater role after the disaster than before the disaster, and the time span of the disaster is longer, so some residents are not sensitive to the risk perception. Bonanno et al.'s[79] studies found that disasters would cause severe psychological trauma to residents, and *community disaster management* could help reduce residents' disaster exposure. The results are inconsistent with hypothesis H5, and there was no correlation between *community disaster management* and residents' *overall disaster risk perception* and its 3 dimensions. The possible reasons are that the community group monitoring and mass prevention mechanism are not sound, the numbers of evacuation drills are few, the community economic foundations are weak, earthquake early-warning equipment has not been introduced, and relatively backward systems of monitoring and early warning are still used. Therefore, *community disaster management* was not related with residents' overall cognition of disaster risk and its 3 dimensions. Hyvärinen and Vos[80] found that *community information and communication* can be used as a network to connect resilient communities, and effective and smooth information communication channels can reduce residents' panic in the face of unknown disasters. The results are inconsistent with hypothesis H6, and there was no correlation between *community information and communication* and residents' *overall disaster risk perception* and its 3 dimensions. The possible reason is that the interviewees were older and less educated, so they could not fully understand the available natural disaster information.

Interestingly, there are some differences between the correlation coefficient results of this study (see Table 3) and regression analysis results (see Table 4). For example, In Table 3, the probability of occurrence of a hazard is negatively and significantly related to *transformative potential*, *disaster management*, *information and communication,* and *residents' overall disaster risk perception*, while in Table 4, *connection and caring* was positively related with the *possibility perception of disaster occurrence*, *transformative potential,* and *overall community disaster resilience* was negatively related with *possibility perception of disaster occurrence*, while there was no significant correlation between the remaining 3 indicators (*resources*, *disaster management,* and *information and communication*) and *possibility perception of disaster occurrence*. The possible reason is that the correlation coefficient only looks at the relationship between 2 variables, while the regression result is the partial regression coefficient after adding other core variables and control variables. The regression coefficient between variables may be influenced by other variables.

Based on the above research results, this study has strong policy implications. For example, respondents believed that community development was insufficient (for example, some of the residents generally believed that the village could not unite village organizations/institutions to help solve the problems in the village). This suggests that the local government should moderately increase its institutional/organizational contact with the outside world, especially with some nongovernmental organizations, and strengthen community disaster resilience. At the same time, it was found that *information and communication* was negatively related with *disaster threat perception*, which suggests that the local government should improve information communication networks to ensure the timely and effective transmission of disaster information, and also increase the supervision of false information to reduce its effects. In addition, the study found that *the severity of disaster experiences* was positively related with the *threat and worry of disasters*, which suggests that the local government should attach importance to psychological counseling for people exposed to disasters to reduce psychological trauma.

Compared with existing studies, this study focused on the correlation between *community disaster resilience* and *disaster risk perception* from the perspective of community disaster resilience. This research perspective is relatively new and can deepen our understanding of the correlation between *community disaster resilience* and *disaster risk perception* to inform disaster risk management policy. However, it is noted that there are still some deficiencies in this study, which could be explored in future studies. For example, this study only focused on the correlation between *community disaster resilience* and *disaster risk perception*, but did not consider decision-making in residents' disaster avoidance behavior. Second, this study only sampled rural households in the Wenchuan and Lushan earthquake-stricken areas. Whether the research conclusions are applicable to other earthquake-stricken areas and other disaster types remain to be verified.

6 Conclusions

Using survey data from 327 rural households in areas affected by the Wenchuan and Lushan earthquakes in the Sichuan Province, this paper analyzed the characteristics of *community disaster resilience* and *residents' disaster risk perception*. It used OLS regression to explore the correlation between these variables. The following 2 conclusions are drawn.

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(1) The *overall disaster risk perception* of residents was moderate. The highest score was related to *worry* and the lowest was for the *possibility of disaster*. The *overall community disaster resilience* was above the middle level. *Community connection and caring* and *information and communication* scored highly, while *resources*, *transformative potential* and *disaster management* scored slightly lower than the other 2 indicators.
(2) There was a correlation between *community disaster resilience* and *disaster risk perception*. Among them, the higher the score of *community connection and caring*, the higher the *probability perception of disaster occurrence*. The higher the dimension of *transformative potential score*, the lower the *possibility of disaster occurrence*. The higher the *overall community disaster resilience* score, the lower the *possibility perception of disaster occurrence* and the lower the overall residents' *perception of disaster risk occurrence*.

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