Community Resilience Assessment under Public Health Emergencies: Based on Collaborative Governance

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Abstract: This paper embeds collaborative governance into the community resilience study of normalized prevention and control of public health emergencies. Taking the typical epidemic prevention and control community in Chengdu as the research unit, Drawing on the PSR model and constructing the community resilience evaluation system embedded in collaborative governance, using the entropy method to quantify the resilience level of the sample communities at the beginning of 2020, the end of 2020, and the middle of 2021, then exploring the evolution of the resilience of the original Covid-19 infected communities in the post epidemic period, proposing feasible paths and improvement strategies for optimizing community resilience embedded in collaborative governance. The results show that: During the study period, the resilience fluctuation of most sample communities shows a trend of "rising first and then decreasing" or "falling first and then rising". The resilience of a small number of communities fluctuates slightly. Overall, 19 sample communities in Chengdu have improved to a certain extent.

1 INTRODUCTION

The mutation of COVID-19 in 2021 warns mankind to face the persistent challenges and threats of the epidemic. The normalization prevention and control of public health emergencies represented by the epidemic situation of infectious diseases have become the top priority of social governance. As the basic unit of social governance, the community is the first position of "defense from the outside and rebound from the inside". At the same time, as micro-level social governance, community governance has the internal requirements of collaborative governance. (Hu, 2016) Facing the escalation of epidemic challenges, how to promote the formation of collaborative governance patterns, improve the ability of the community in resilient governance, and improve the resilience of human society in the face of public health emergencies has become the key link to deal with public emergencies in China.

As the focus of social governance shifts downward, community resilience has gradually become the frontier of social system research. In the earliest research on community resilience, community resilience is "the ability of the system to respond to external shocks and still maintain its main structure and function in the event of a crisis". (Holling, 1973) At the beginning of the 21st century, K Magis extended resilience to the adaptability, self-organization and learning capabilities of the community, and paid more attention to the role of multi-party collaboration in crisis response. (MAGIS, 2010) In recent research, Lan Yuxin, a Chinese scholar, defined community resilience as "the ability of communities to actively respond to risk disturbances and obtain more sustainable capabilities in the future through adaptive and stress response". (LAN, Zhang. 2020).

Collaborative governance under public crisis means that with the support of information technology, the government, social organizations, enterprises, individual citizens and other social elements participate in cooperation and coordination, and take a series of control actions at different stages of crisis development for potential and current crises, in order to effectively prevent, handle and

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eliminate crises, Finally, the purpose of safeguarding and promoting public interests to the greatest extent is achieved. (He, 2008) Among them, collaborative governance includes three types: collaboration between governments, the collaboration between governments and civil society, and collaboration between civil society. (Sha, Xie. 2010).

Since the outbreak of COVID-19, there has been an explosive growth trend in the study of public emergencies. Combining resilience theory and collaborative governance theory has become a new research direction. However, there are currently few empirical studies focusing on resilience under collaborative governance, and the integration of collaborative governance theory into the construction of community resilience needs further research. On the basis of comprehensive previous studies, this paper takes the typical epidemic prevention communities in Chengdu as the research object. Collect data from the beginning of 2020, the end of 2020, and the middle of 2021, and build a resilience evaluation index system under collaborative governance from three aspects: pressure, state, and response to the disturbance of public health emergencies. Analyze the evolution process of community resilience embedded in collaborative governance, and propose an optimized path for resilient community governance under the disturbance of public health emergencies.

2 SURVEY OF RESEARCH OBJECTS

From the outbreak of the COVID-19 epidemic in early 2020 to August 2021, Chengdu has encountered three rounds of epidemics at the beginning of 2020, the end of 2020, and the middle of 2021. Therefore, this paper takes all the communities in Chengdu that have been disturbed during the study period as empirical objects to explore the timing evolution of community resilience in response to public health emergencies, and then explore the process of community governance embedded in collaborative governance. There are 19 sample communities, specifically: Lianhua Community, Shuangbai Community, Shuanglin Community, Wangping Street Community, Wangcong Community, Gaodian Community, Jindu Community, Pengzhen Guangrong Community, Yifu Community, which were disturbed by the epidemic in early 2020 Communities, Tiaodenghe Community, Taiping Village, Yong'an

Village, Pineapple Community, Jinqiao Community, Xichi Community, Babuqiao Community that were disturbed by the epidemic at the end of 2020, Qingshuihe Community, Shengxing Community, Americas Garden Community that were affected by the epidemic in 2021 Garden community.

3 DATA AND EVALUATION METHOD

3.1 Data Source

The data used in this paper are set in three-time gradients: at the beginning of 2020, the end of 2020, and the middle of 2021. The data used to establish the indicators were obtained from the government websites such as the Chengdu Municipal Comprehensive Service Supervision Platform for Grassroots Publicity, the Chengdu Municipal Public Enterprises, and Institutions Office Disclosure Platform, the official website of the Chengdu Municipal Health and Health Commission, the official website of the Chengdu Municipal Bureau of Statistics, the official websites of the people's governments of each district and their communities, as well as the residents' questionnaires and the offline interviews with community party-mass service centers and community hospitals.

3.2 Construction of Index System

The PSR model consists of three types of indicators: pressure, state, and response. This paper uses the PSR model to decompose the community resilience, and combines the resilience assessment model and the collaborative governance model to construct a community resilience assessment index system from the perspective of public health emergencies, which then reflects its collaborative governance ability in response to public health emergencies.

Based on this, this paper defines "stress resilience" as the community system, especially the governance system, is adversely affected by public health emergencies and may be harmed, "state resilience" as the situation and development direction of community system, especially community governance system, in resisting public health emergencies, and "response resilience" as the ability of communities under collaborative governance to prevent public health emergencies, mitigate damage, and recover from adaptation.

The community resilience evaluation index system constructed in this paper refers to the assessment framework and indicators of community resilience and collaborative governance at home and abroad, and finally identifies eight specific indicators at the domain level: "stress resilience" includes environmental and demographic risks, reflecting the impact on the community in the face of public health emergencies. it reflects the impact of community response to public health emergencies. The "state resilience" includes medical resource status, the state of medical resources, socio-economic state, and community organization state, reflecting the current situation of community governance system reflecting the development of the community governance system; the "response resilience" is influenced by early warning capability, recovery capability, and learning and adaptive capability, reflecting the community governance system's ability to respond to public health emergencies. The factors of "response resilience" are early warning capacity, recovery capacity, and learning adaptation capacity, which reflect the ability of the community governance system to mitigate shocks in response to public health emergencies. Based on the characteristics of each domain and the actual situation of the sample communities, we determines the specific indicators of 24 index layers and finally constructed the community resilience assessment index system embedded in collaborative governance.

3.3 Determine the Weights of Indicators at All Levels

3.3.1 Measurement Method Selection-entropy Method

Based on the community resilience evaluation index system of this paper, to quantitatively evaluate the resilience level of sample communities with multiple indicators, it is necessary to unify the units and dimensions of each evaluation index, and standardize the data. The determination of the index weight will directly affect the accuracy of the evaluation results. Therefore, the entropy method in the objective weighting method is used to determine the index weight.

3.3.2 Construct the Original Matrix

Construct a matrix of 19 (community samples) * 24 (indicators). Record the value of the jth index of the i-th community as a formula.

3.3.3 Data Standardization Processing

Since the measurement units of the various indicators in the construction of the indicator, system is not uniform, and both positive indicators and negative indicators are included (the higher the positive indicator value, the better, the lower the negative indicator value, the better). Therefore, it is necessary to standardize and dimensionless the data first, that is, convert the absolute value of the index into relative value, and homogenize different indicators. The specific method is as follows:

Positive indicators:

$$x'_{ij} = \frac{x_{ij} - \min\{x_{1j,\cdots,}x_{nj}\}}{\max\{x_{1j,\cdots,}x_{nj}\} - \min\{x_{1j,\cdots,}x_{nj}\}} (i=1,2\ldots,n;j=1,2,\ldots,m) \tag{1}$$

Negative indicators:

$$x'_{ij} = \frac{\max\{x_{1j,\cdots,}x_{nj}\} - x_{ij}}{\max\{x_{1j,\cdots,}x_{nj}\} - \min\{x_{1j,\cdots,}x_{nj}\}} (i=1,2\ldots,n;j=1,2,\ldots,m) \tag{2}$$

3.3.4 Calculate the Entropy Value of the jth Indicator

$$P_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{n} x'_{ij}} (i=1,2\ldots,n;j=1,2,\ldots,m) \tag{3}$$

$$e_j = -k \sum_{i=0}^{n} p_{ij} ln(p_{ij}) (i=1,2\ldots,n;j=1,2,\ldots,m) \tag{4}$$

Among $k=1/ln(n)>0$, $e_j \geq 0$

3.3.5 Calculate the Entropy Redundancy

$$d_j = 1 - e_j (j=1,2,\ldots,m) \tag{5}$$

3.3.6 Calculate the Weights of Each Index

$$W_j = \frac{d_j}{\sum_{j=1}^{m} d_j} (j=1,2,\ldots,m) \tag{6}$$

Finally, using the data from all sample communities, the weights of the indicators for the resilience assessment of the sample communities were calculated. (Table 1)

Table 1: Evaluation index system of resilience of sample community and its weight value.

Process	Domain layer	Index layer	Attributes	Comprehensive weight
Stress	Environmental characteristic risk	The degree of automatic monitoring of risk pressure	+	0.0331
		Average number of community public managers per 10,000 people	+	0.0857
		Average daily passenger flow of surrounding large passenger transportation centers	-	0.0104
	Demographic risk	Mobile population share	-	0.0247
		Population density	-	0.0121
		Degree of Aging	-	0.0183
		Resident outbreak awareness	+	0.0262
Status	Medical information Index	Medical Information Technology Index	+	0.0316
		Number of public hospitals within 5 km	+	0.0681
		Percentage of second-class hospitals and above within 15-minute living circle	+	0.0201
	Socioeconomic status	Percentage of three no compounds	+	0.0295
		Completeness of public construction facilities	+	0.0239
		Number of small and micro enterprises per square kilometer in the jurisdiction	+	0.0904
	Social organization status	Information level of community organizations	+	0.0244
		Average number of social organizations per 10,000 people	+	0.0967
		Percentage of resident volunteers	+	0.0877
Response	Early warning capability	Early Warning System Sensitivity and Accuracy	+	0.0591
		Frequency of daily updates of public health information	+	0.0638
		Grid-based governance effectiveness	+	0.0209
	Recovery Capability	Resident participation	+	0.0324
		Quarterly average financial income	+	0.0619
	Learning adapt ability	Training informatization and accessibility of output devices	+	0.0155
		Emergency education and training effectiveness	+	0.034
		Governance system iteration efficiency	+	0.0297

4 EVALUATION RESULTS AND ANALYSIS

According to the above calculation steps, the data of the 19 sample communities at the beginning of 2020, the end of 2020, and the middle of 2021 are processed to determine the weight under the entropy method, while using it to calculate the resilience level and ranking of each sample community, as shown in Table 2.

At the beginning of 2020, Shuanglin community in Chenghua District has the highest comprehensive resilience level, with a score of 0.0926, including 0.0111 for the pressure layer,

0.0718 for the state layer, and 0.0098 for the response layer. The 2nd and 3rd places are American Garden community and Taiping Village respectively. The Jindu, Gaodian, and Xichi communities with poor resilience in response to public health emergencies ranked the last 3 in the comprehensive resilience score.

At the end of 2020, the ranking of the resilience levels of the sample communities has changed to some extent from the beginning of 2020, but the overall fluctuations are relatively small. Except that the ranking of Qingshuihe community dropped from 6th to 14th, and the ranking of Wangcong, Gaodian, Jinqiao, Babuqiao, and Yifu communities fluctuated

slightly, the ranking of other communities remained unchanged.

In the middle of 2021, the resilience level of each sample community fluctuated greatly on the basis of the end of 2020. Only Wangcong community and Babuqiao community did not change the status layer score ranking from the end of 2020 to the middle of 2021, while the pressure layer and response layer score rankings level of Shuanglin community has decreased significantly. This is because the impact of external disturbance on resilience has gradually diminished, and a complete governance system has not been established within the community, which cannot guarantee the steady growth of community resilience in the post epidemic era.

The communities whose comprehensive resilience level showed " falling first and then rising "were: Qingshuihe Community, Shengxing Community, Shuangbai Community, Wangcong Community, Pineapple Community, Jinqiao Community, and Yifu Community. Among them, the Shengxing community has been affected by the epidemic, and its resilience level has increased significantly from the middle of 2021 compared to the beginning of 2020. Specifically, the scores of indicators such as "residents' awareness of the epidemic situation", "residents' participation" and "effectiveness of emergency education and training" have been greatly improved. This shows that even if it had COVID-19 cases in the central area of 2021, over the past year, the community has vigorously launched online and offline emergency education and training, which has effectively enhanced residents' awareness of prevention and self-consciousness and improved the cohesion and enthusiasm of community residents. Thanks to this, when the community responded to COVID-19, the resilience level of the Shuang Lin community has not risen, and it has withstood the test of public health emergencies to the community governance system.

In addition, the resilience of Tiaodenghe Community and babuqiao community has been decreasing during the study period. Among them, the response resilience of the Tiaodenghe community declined significantly from the beginning of 2020 to the end of 2020, while the pressure resilience decreased significantly from the end of 2020 to the middle of 2021. This is because the Tiaodenghe community has COVID-19 cases in its jurisdiction at the end of 2020, the pressure on the community to respond to public health emergencies has increased, and the community governance system and governance capabilities are not yet complete, which

made it unable to fully and effectively respond to disturbances. Specifically, the scores of indicators such as "the number of social organizations per 10,000 people" and "the proportion of permanent volunteers" have dropped significantly. It can be seen that the community can not effectively respond to the disturbance of public health emergencies and reduce the impact of disturbance without the joint participation of multiple subjects such as government, autonomous organizations, and residents. Therefore, for the construction of resilient communities, collaborative governance with the participation of multiple subjects is indispensable. In addition, the resilience of Yongan village and Pengzhen Guangrong community grew steadily during the study period, and their pressure resilience, state resilience and response resilience fluctuated less. It can be seen that although both Yongan Village and Pengzhen Guangrong Community have been disturbed by public health emergencies, their community resilience was less impacted by the disturbance and can be slightly improved, indicating that their community governance system has sufficient capacity to response to disturbances to maintain the stable development of the community.

5 POLICIES AND SUGGESTIONS

Based on the PSR model, this paper constructs a resilience assessment index system embedded in collaborative governance from the perspective of responding to public health emergencies and conducts resilience assessment and empirical analysis on sample communities disturbed by the COVID-19 epidemic in Chengdu from 2020 to 2021. Studies have shown that the main influencing factors that cause the differences in resilience fluctuations of sample communities are: the coordination situation of the government, social organizations, residents, and other diverse subjects participating in community resilience governance, and the effectiveness of the governance system to resist public health emergencies by relying on information technology. Therefore, this paper believes that the main link to improve community resilience is the improvement of the community governance system. The key measure to strengthen the effectiveness of community governance is to build a multi-subject collaborative governance mechanism. The effective way to improve the collaborative level of the governance system is to attach importance to intelligent construction.

Table 2: Composite resilience score and ranking of sample communities.

	Early 2020		End of 2020		Mid-2021	
	Toughness score	Ranking	Toughness score	Ranking	Toughness score	Ranking
Qingshuihe Community	0.0569	6	0.0403	14	0.0508	11
Shengxing Community	0.0474	12	0.0430	12	0.0533	8
Americas Garden Community	0.0854	2	0.0964	2	0.0863	1
Lianhua Community	0.0495	11	0.0535	6	0.0522	10
Lianhua Community	0.0495	10	0.0466	9	0.0508	12
Shuanglin Community	0.0927	1	0.0994	1	0.0790	2
Jumping Stomp River Community	0.0657	5	0.0610	5	0.0577	6
Wangping Community	0.0677	4	0.0721	4	0.0717	3
Wangchong Community	0.0357	16	0.0348	17	0.0361	17
Taiping village	0.0683	3	0.0727	3	0.0562	7
Yong'an village	0.0516	8	0.0517	8	0.0524	9
Pineapple Community	0.0549	7	0.0525	7	0.0591	5
Gaodian Community	0.0335	18	0.0342	19	0.0333	18
Jinqiao Community	0.0426	14	0.0392	15	0.0445	14
Xichi Community	0.0298	19	0.0342	18	0.0302	19
Babuqiao Community	0.0379	15	0.0368	16	0.0363	16
Yifu Community	0.0513	9	0.0439	11	0.0635	4
Jindu Community	0.0343	17	0.0412	13	0.0374	15
Pengzhen Guangrong Community	0.0453	13	0.0463	10	0.0492	13

Based on the above conclusions and from the perspective of dealing with the disturbance of public health emergencies, this paper puts forward the following recommendations for the optimization of community resilience governance:

5.1 Establish and Improve the Community Governance System to Ensure the Steady Growth of Resilience

As the basic unit of grassroots governance, the community should establish and improve the "one core and three governance, collaboration participation and common interests", the meaning is a sound urban and rural grassroots governance system led by the Chinese Communist Party that combines autonomy, rule of law, and rule of virtue, which can lead to effective community resilience to public health emergencies and improve the community's ability to recover from emergencies, thereby ensuring smooth growth in resilience.

5.1.1 Strengthen the Leadership of Party Building and Promote the Participation of Diverse Subjects in Community Governance

With the continued impact of the COVID-19 epidemic New Crown Pneumonia, how communities can achieve a combination of normalized governance and abnormal governance has become a key issue in resilient community building. And through the firm leadership of the Communist Party of China to improve the community governance system will become an important measure for resilient communities to achieve. The reason is that the community grassroots government governance unit has been transformed from a neighborhood committee and others to a community public management unit integrated with the party-mass service center, and the leadership of the Communist

Party of China building has become the foundation of the community governance system and played its leading core role to strengthen with the connection between community public management units and residents, enterprises and social organizations by taking the Party branch of multiple subjects as the node. Meanwhile resilient community under the leadership of party-building will drive multiple subjects in the community to deal with emergencies collaboratively in the face of public health emergencies and fully bring into play exemplary vanguard role of Party Members among the masses to lead the masses in fighting against the impact of public health emergencies, realizing the sinking of power and improving the resilience of the community while increasing the effectiveness of governance.

5.1.2 Improve the Effectiveness of Griddization Governance and Strengthen the Collaborative Governance of Multiple Subjects

At present, there is a general lack of professional management personnel to carry out community governance work and professional griddization management in the community, and most of the community residents serve as grid members. And the lack of professional social worker talents and other phenomena, causing the community to encounter emergencies that cannot be effectively responded to. Therefore, the key to improving community resilience lies in building grid management personnel while strengthening the professional capacity training, and building a collaborative governance mechanism for multiple subjects to guide and absorb multiple subjects from within the community to participate in community governance.

5.2 Strengthen Community Intelligent Construction and Improve the Effectiveness of Community Governance

Under the attack of the COVID-19 epidemic, information technology has played an important role in the fight against the epidemic, so that intelligent community is an important means of effectively combining normalization and abnormal governance in communities and comprehensively improving community resilience. The construction of an intelligent community not only requires the community to fully and rationally apply various information resources, optimize community resilience from the physical level, and improve the effectiveness of the community governance system; But also requires the construction of a sharing platform with the community public management organizations as the core, closely linking with community residents, autonomous organizations and other multiple subjects and promoting the active participation of multiple subjects in community governance. Especially in the face of public health emergencies, it can effectively and timely mobilize the power of multiple subjects to relieve the impact of public emergencies on the community. For example, under the normalization of epidemic prevention and control, big data technology is embedded in epidemic prevention and control, and the community also uses information platforms such as "Sichuan E-Zhi Cai" and residential WeChat groups to require multiple subjects to participate in dynamic monitoring of the community, so as to efficiently carry out epidemic prevention and control. At the same time, intelligent communities as a means of governance should effectively make the community governance process open and transparent, enhance social supervision, strengthen the effectiveness of community governance through risk monitoring, financial revenue and expenditure disclosure, etc. and improve community resilience.

In summary, this paper uses the PSR model to disassemble the details of the community response to the three epidemic situations in Chengdu from 2020 to 2021, determine the sample community by using the full sample method, and analyze the improvement methods of community resilience embedded in collaborative governance, which is comprehensive and scientific. However, due to the lack of time-series research, more analysis cannot be made on time series, which can't further predict the specific development direction of community resilience.

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