Urban Social Vulnerability Assessment in China Associated with Public Health Emergency

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Abstract: This article intends to assess the urban social vulnerability associated with public health emergencies in some provinces and cities of China, in order to provide decision-making reference for regional emergency management and scientific early warning. Method: Refer to the HOP model to construct an evaluation index system of urban social vulnerability associated with public health events, use the CRITIC-entropy method to determine the index weight, and evaluate the urban social vulnerability of 29 provinces (cities) evaluation units. According to the different impacts of sensitivity and coping ability on urban social vulnerability, the evaluation area is divided into five categories: highly sensitive, sensitive, balanced, lacking in coping ability, and highly lacking in coping ability. The results show that there is a big gap in the urban social vulnerability index between different regions; compared with the coping ability, the socio-economic sensitivity fluctuates more drastically.

1. Introduction

A public health emergency is a major infectious disease epidemic, mass disease of unknown cause, major food poisoning and occupational poisoning, and other events that seriously affect public health that occur suddenly and cause or may cause serious damage to the public health [1]. A city is an area with a high density of population and social wealth. Any public health emergency may cause huge casualties and economic losses. As the population flow rate and the process of urbanization continue to accelerate, various public health emergencies occur more and more frequently, bringing more and more serious negative effects on human health and urban development. The outbreak of the COVID-19 at the end of 2019 caused huge casualties and property losses in a short period of time, causing Wuhan in China and other cities to be closed down for a time, exposing the society of modern urban systems disturbed by public health emergencies Vulnerability. In this context, the assessment of the urban social vulnerability of the city and the adjustment of the social system to reduce social vulnerability have become an important support for reducing the adverse social impact of public health emergencies.

The concept of vulnerability originated from the study of natural disasters [2-4]. Early scholars focused on natural vulnerability from the perspective of natural attributes, that is, concerned about hazards and disaster-pregnant environments, and ignored the research on the internal structural characteristics of social systems. At the end of the 20th century, relevant scholars put forward research on the social dimension of vulnerability, focusing on the vulnerability of populations and social systems at risk. They regarded vulnerability as determined by both external disturbances and internal characteristics of the social structure, and gradually expanded from the field of natural disasters. To public health, sustainability science, climate change and many other fields [5-8]. After the outbreak of the COVID-19, Qiu Jian and others established a spatiotemporal model of the epidemic spread for the cities that caused the epidemic to couple spatially with the vulnerability of the city [9]. This article believes that urban social vulnerability is one of the dimensions of vulnerability. It is a social system exposed to disturbances by natural or man-made factors. The system is negatively affected or damaged due to its own sensitivity characteristics and lack of ability to cope with adverse disturbances [10]. From the perspective of vulnerability, the degree of risk impact of public health emergencies depends on the hazard of public health emergencies and urban social vulnerability. Among them, the hazard of infectious disease public health emergencies

is the hazard of infectious diseases; and urban social vulnerability can be decomposed into two major aspects: sensitivity and adaptability.

This article mainly analyzes the urban social vulnerability of the city itself under the disturbance of public health emergencies, and plans to study the urban social vulnerability of 29 provincial-level units under the disturbance of public health emergencies: (1) Try to analyze the sensitivity and The city's ability to respond to public health emergencies should construct a urban social vulnerability evaluation index system for public health emergencies; (2) Identify the influencing factors of urban social vulnerability under the disturbance of public health emergencies, with a view to regional prevention Disaster mitigation planning and scientific early warning provide reference for decision-making.

2. Data Sources and Research Methods

2.1 Research Unit and Data Sources

Based on the actual development level, this paper selects 29 evaluation units in 22 provincial-level units, 4 municipalities and 2 autonomous regions of Inner Mongolia Autonomous Region and Ningxia Hui Autonomous Region, except Taiwan Province, to comprehensively evaluate the urban social vulnerability of public emergencies in the overall study area. The socio-economic and demographic data used in this article are all derived from the provincial statistical yearbooks compiled by the provincial statistical bureaus in 2018 and the "China Population and Employment Statistical Yearbooks" compiled by the China Statistics Bureau.

2.2 Research Methods

2.2.1 Constructing an Indicator System

This paper draws on the HOP conceptual model proposed by Cutter[6], and follows the principles of scientificity, comprehensiveness, comparability, availability, and combination of absolute numbers and relative numbers, and refers to the selection of urban social vulnerability indicators by domestic and foreign scholars. Under the premise, according to the two dimensions of the sensitivity and vulnerability of the socio-economic system to public health emergencies, a total of 11 indicators were selected to establish an evaluation index system for urban social vulnerability associated with public health emergencies (see Table 1). Under normal circumstances, the stronger the sensitivity, the higher the urban social vulnerability of public health emergencies, the stronger the ability to respond, and the lower the urban vulnerability of public health emergencies. Sensitivity indicators and coping ability indicators have different effects on urban social vulnerability, so this article adopts the range method to standardize and homogenize the original data.

Table 1 Urban Social Vulnerability Index System under Public Health Emergencies

Target layer	Criterion layer	Index code	Index layer	Correlation	Index explanation
Urban social vulnerability of public health emergencies	Sensitivity	X1	Urban population density	+	High population density has allowed the virus to spread exponentially
		X2	Proportion of urban population aged 65 and over	+	Reflecting the age structure of the population, the elderly are susceptible to diseases and their ability to resist diseases is weak
		X3	Proportion of urban population under 15	+	It also reflects the age structure of the population, and the younger population is susceptible to diseases
		X4	Proportion of urban female population	+	Women take on more family responsibilities, and it is harder to recover from the epidemic than men

		X5	Population mobility intensity	+	Population movement will greatly increase the infection rate of infectious diseases
	Coping ability	X6	Per capita disposable income of urban residents	-	Reflect the living standards of local residents
		X7	GDP per capita	-	Reflect the level of regional economic development
		X8	General budget revenue of local finance per capita	-	Reflect the ability of local finance to respond to emergencies
		X9	Urban basic medical insurance participation rate	-	Reflect the level of individual health input and social security level
		X10	Number of beds in medical institutions per 10,000 people in the city	-	Reflect the degree of guarantee that social medical and health services provide to residents
		X11	Number of urban licensed (assistant) physicians per 10,000 people	-	Reflect the degree of guarantee that social medical and health services provide to residents

2.2.2 Critic-Entropy Weight Method Combination Weight Model

The CRITIC method is a method to measure the objective weight of indicators by evaluating the contrast strength and conflict of the indicators, where the contrast strength is expressed by the standard deviation, and the conflict is expressed by the correlation coefficient [12]. The entropy method is a method to determine the objective weight of an indicator based on the variability between indicators. The comprehensive use of CRITIC method and entropy weight method can reflect the weight of the index more objectively. This paper chooses to use the combined weight of CRITIC and entropy weight to calculate the weight of urban social vulnerability index [13].

2.2.3 Calculation Model of Urban Social Vulnerability Index

The standardized data has the same direction, so the following formula can be used to calculate the urban social vulnerability index of regional public emergencies:

$$SVI = \sum_{i=1}^{n} x_i \times w_i$$

Where: SVI is the urban social vulnerability index of the region; x_j is the standardized data of the i-th index of a certain evaluation unit, and w_i is the combined weight of the i-th index. The larger the SVI value, the higher the urban social vulnerability of the evaluation unit. In the actual calculation process, take $i \in [1, 5]$ to get the sensitivity index A, and take $i \in [6, 11]$ to get the coping ability index B. It should be noted that the larger the coping ability index here, the higher the urban social vulnerability.

3. Results and Analysis

3.1 Urban Social Vulnerability Assessment Results

The urban social vulnerability index is calculated by SVI, and the sensitivity index, response capacity index and urban social vulnerability index of the urban social vulnerability of public health emergencies of each provincial evaluation unit under the combined weight of 2018 are obtained, as shown in Table 2.

Table 2 the Sensitivity Index, Response Capability Index, and Social Vulnerability Index in Each Provincial Evaluation Unit under the Combined Weights in 2018

Evaluation unit	Sensitivity Index (A)	Coping Ability	Social vulnerability

		Index(B)	index(SVI)
Beijing	0.30	0.11	0.41
Tianjin	0.31	0.32	0.63
Hebei Province	0.30	0.31	0.62
Shanxi Province	0.28	0.25	0.53
Inner Mongolia Autonomous Region	0.19	0.22	0.41
Liaoning Province	0.21	0.24	0.45
Jilin Province	0.21	0.25	0.47
Heilongjiang Province	0.31	0.26	0.57
Shanghai	0.42	0.14	0.55
Jiangsu Province	0.21	0.22	0.43
Zhejiang Province	0.22	0.19	0.42
Anhui Province	0.25	0.31	0.57
Fujian Province	0.21	0.26	0.47
Jiangxi Province	0.31	0.29	0.60
Shandong Province	0.28	0.27	0.54
Henan Province	0.32	0.22	0.54
Hubei Province	0.22	0.26	0.48
Hunan Province	0.30	0.20	0.50
Guangdong Province	0.21	0.26	0.47
Guangxi Zhuang Autonomous Region	0.20	0.32	0.52
Hainan	0.23	0.24	0.47
Chongqing	0.24	0.28	0.52
Sichuan Province	0.26	0.28	0.54
Guizhou Province	0.27	0.25	0.52
Yunnan Province	0.22	0.25	0.47
Shaanxi Province	0.26	0.28	0.54
Gansu province	0.24	0.30	0.54
Qinghai Province	0.23	0.24	0.47
Ningxia Hui Autonomous Region	0.23	0.29	0.53
Overall study area	7.46	7.31	14.77

According to Table 2, it can be seen that there is a big gap in the social vulnerability index between different regions. For example, Beijing's social vulnerability index for public health emergencies in 2018 was 0.41, while Tianjin's social vulnerability index reached 0.63. Based on the above results, each region can be classified as follows according to the value of the social vulnerability index (Table 3).

Table 3 Classification of Social Vulnerability Intensity

category	Social vulnerability value	Included units
High urban social vulnerability	[0.41,0.45]	Beijing, Inner Mongolia Autonomous Region, Zhejiang Province, Jiangsu Province, Liaoning Province
Urban social vulnerability of medium-sized cities	[0.47,0.57]	Jilin Province, Qinghai Province, Fujian Province, Guangdong Province, Hainan Province, Yunnan Province, Hubei Province, Hunan Province, Chongqing City, Guizhou Province, Guangxi Zhuang Autonomous Region, Ningxia Hui Autonomous Region, Shanxi Province, Sichuan Province, Henan Province, Shaanxi Province, Gansu Province, Shandong Province, Shanghai, Anhui Province, Heilongjiang Province,
Low urban social vulnerability	[0.60,0.63]	Jiangxi Province, Hebei Province, Tianjin City

3.2 Analysis of the Influencing Factors of Urban Social Vulnerability under the Disturbance of Public Health Emergencies

The differences in urban social vulnerability in different regions are caused by many factors, so this article analyzes the following influencing factors.

According to Table 2, calculate the proportions of the sensitivity index A and the coping ability

index B in the urban social vulnerability index, denoted as a and b. Calculate the difference between a and b. The larger the difference, the higher the sensitivity index is than the coping ability index, which means that the sensitivity has a greater impact on urban social vulnerability; the smaller the difference, the greater the coping ability index is than the sensitivity index. The higher the value, the greater the impact of coping ability on urban social vulnerability. According to the size of the difference, the influencing factor-oriented classification of each evaluation unit can be obtained as follows (Table 4):

Table 4 Guided Classification Table of Factors Affecting Urban Social Vulnerability under the Disturbance of Public Emergencies in 2018

Classification	Included units	Condition (a-b belongs to the interval)
Highly sensitive	Beijing, Shanghai, Henan, Hunan	$(0.15, \infty)$
Sensitive	Shanxi Province, Heilongjiang Province, Zhejiang Province	$(0.05, 0.15]$
Balanced	Tianjin City, Hebei Province, Jiangsu Province, Jiangxi Province, Shandong Province, Hainan Province, Sichuan Province, Guizhou Province, Shaanxi Province, Qinghai Province	$[-0.05, 0.05]$
Lack of coping ability	Inner Mongolia Autonomous Region, Liaoning Province, Jilin Province, Anhui Province, Fujian Province, Hubei Province, Guangdong Province, Chongqing City, Yunnan Province, Gansu Province, Ningxia Hui Autonomous Region	$[-0.15, -0.05)$
Highly lacking coping ability	Guangxi Zhuang Autonomous Region	$(-\infty, -0.15)$

In a highly sensitive area, take Shanghai as an example, the urban population density is relatively high, the elderly population is above average, and the intensity of population mobility is at the highest level. In contrast, Shanghai's per capita disposable income, per capita GDP, and fiscal budget revenue , Medical conditions are at a relatively high level, so Shanghai is highly sensitive and has a strong coping ability; in areas with high coping capabilities, although the proportion of the population under the age of 15 is high in Guangxi Zhuang Autonomous Region, population density and other sensitive indicators are at a high level. At the same time, per capita GDP, per capita disposable income, financial support, and medical income are far below the average level. Therefore, as far as the Guangxi Zhuang Autonomous Region is concerned, the impact of sensitivity on urban social vulnerability is much lower than the lack of coping capacity Impact on urban social vulnerability. With reference to the above, it is possible to analyze the influencing factors of urban social vulnerability under the disturbance of public emergencies in other areas, sort out key variables, maximize strengths and avoid weaknesses to reduce the vulnerability of urban social systems.

4. Conclusions

Based on the theory of urban social vulnerability and the analysis of disturbance factors of public emergencies, this paper constructs the framework of the urban social vulnerability index system of public emergencies, collects data from 29 provinces (municipalities), and uses the combination of CRITIC and entropy methods to calculate weights. Based on the SoVI model, a comprehensive measurement of the urban social vulnerability index of public health emergencies in 29 provincial units in China, and using this as a benchmark to analyze the factors affecting urban social vulnerability in terms of socio-economic sensitivity and socio-economic response capacity. According to the degree of impact of sensitivity and response ability on urban social vulnerability, urban social vulnerability under the disturbance of public health emergencies in different regions is divided into five categories: highly sensitive, sensitive, balanced, lack of response ability, Highly lacking coping ability. According to the type of target area, it is urgent to analyze and improve the weak links to reduce the negative impact of public health emergencies on the city.

The vulnerability of urban society under the disturbance of public health emergencies reflects the

state of urban social systems that are vulnerable to injury and the ability to resist injury when resisting public health emergencies. Today, when public health emergencies occur frequently, the assessment of urban social vulnerability under such disturbances is useful for understanding the degree of vulnerability, understanding the weak links that lead to vulnerability, reducing the vulnerability of the social system, and conducting regional emergency management. Very important meaning.

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