The Assessment of Social Vulnerability to Public Health Emergency in China

----- A Case Study of Epidemic Situation of Infectious Disease

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***Abstract*---- In this paper, social vulnerability to public health emergency is studied in order to analyze the capability to overcome infectious disease emergencies in different regions with distinctive economies. According to the hazards-of-place model of vulnerability, a evaluation model for social vulnerability is developed. Based on the data of 31 regions of China, this paper evaluates social vulnerability of two epidemics emergencies（2003SARS and 2009H1N1 Influenza），the result is shown that social vulnerability is relatively higher in the western than in the middle and eastern regions, and as the key factors to reduce social vulnerability by providing emergency funds, commercial health insurance plays a most important role, followed by social medical insurance, the influence of government finance is the minimum.**

Key words--- Infectious Disease Emergency; Social Vulnerability; Assessment

I INTRODUCTION

In the 21st century, public health emergencies frequently occur, especially epidemics emergencies, which have brought about serious threat to public health and economic development, such as the U.S. mail anthrax case, the British mad cow disease, the China SARS and the global H1N1 Influenza epidemics and other events. So more and more attention is given to public health emergency management, but when the frequency of the epidemics or the absolute loss inflicted by disaster is the first priority to be considered, the capability of regions to overcome epidemics emergency is ignored.

In this paper, social vulnerability is used to evaluate the capability to overcome infectious disease emergencies of different regions with distinctive social and economic conditions. Based on the characteristics of infectious disease emergency, using "The Hazards-of-Place Model of Vulnerability", social vulnerability evaluation index system is constructed to quantify social vulnerability in this paper, and further the evaluation index is respectively analysed to seek the key factors which effectively reduce social vulnerability. The ultimate goal of this article is, according to analyze social vulnerability and its influencing factors, to make suggestion for reducing loss of disasters and improving the capability of regions against infectious disease emergencies in China.

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II THE ASSESSMENT MODEL OF SOCIAL VULNERABILITY

A. The Analysis of Social Vulnerability

Since the 90s of last century, the vulnerability has become an important part of disaster research, International Strategy for Disaster Reduction Committee defines the vulnerability is a status, as a result of human activities, which describes the impact of disaster on society and the degree of social self-protection. Specifically, vulnerability is a social condition, a measure of societal resistance or resilience to hazards (Blaikie et al., 1994); and the integration of potential exposures and societal resilience with a specific focus on particular places or regions (Kasperson, and Turner, 1995; Cutter, Mitchell, and Scott, 2000). In 1996, Susan L. Cutter putted forward "The hazards-of-place model of vulnerability", which analyzed the components of place vulnerability. It shows the social and biophysical vulnerabilities interact to produce the overall place vulnerability. In this paper, we examine only the social vulnerability portion of the conceptual model.

B. The Assessment Indexes of Social Vulnerability to epidemics emergency

Social vulnerability mainly includes two parts, one is social fragility, another is social capability to resist disaster and absorb loss. There is a general consensus about some of the major factors that influence social vulnerability，such as resources (including professional personnel, material, funds), social capital, beliefs and customs, frail and physically limited individuals, and type and density of infrastructure and population (Cutter, 2003). Based on these factors, the two parts of social vulnerability may be mainly reflected from population, environment and economy three aspects. Thus, index system to evaluate social vulnerability is established by the characteristics of epidemics emergency in this paper (TABLE I).

1) Social fragility

As discussed earlier, social fragility can be reflected by following indexes. Firstly, most countries in the world have entered aging of population, elderly population groups, together with children, have lower immunity and high mortality, they are all susceptible population. Meanwhile, population quality and disaster cognition are the important factors affecting social vulnerability, so we choose the old and youth population proportion(X1) and the illiterate

proportion(X2) as two population vulnerability indexes. Secondly, the degree of population concentration is increased with the process of population urbanization, resulting in faster spread of infectious disease; under the trend of economic globalization, population flow and trade tourism make the possibility of infection increasing greatly, so tourism liveness (X3) and population density(X4) are chosen as two indexes of environmental vulnerability. Thirdly, when infectious disease emergency occurs, the possible of people going shopping, dining and accommodation decreases greatly, it may cause huge economic loss to wholesale and retail industry and catering industry. Therefore, we choose per capita gross product of wholesale and retail industry and catering industry(X5) as a measure of economic vulnerability. The above five indexes reflect the social fragility of regions, when epidemics outbreaks, these indexes are positively correlated with social vulnerability, so take positive value.

2) Social capability to resist infectious disease emergency

Social anti-disaster capability may be involved in many aspects, such as medical and health institutions equipped with facilities and personnel, emergency material and funds guarantee, the completeness and operability of contingency plans and so on. Therefore, based on the principle that evaluation index is systematic, quantifiable, and easy to obtain, we choose the medical staff number per thousand persons(X6), the health institutions beds number per thousand persons(X7), government health expenditure accounted for the proportion of financial expenditure(X8), per capita of Ministry of Civil Affairs medical aid expenditure(X9), residents health expenditure accounted for the proportion of consumer spending(X10), commercial personal insurance density(X11) and social medical insurance fund density(X12), these seven indexes describe the capacity that the specific areas deal with infectious disease emergency, respectively from the density of professional personnel allocation, the medical health investment in facilities and emergency funds safeguard. They have inverse relation with social vulnerability, and take negative value.

C. Methods and Results

At present, the assessment of social vulnerability is mostly concentrated in natural disasters; the research on social vulnerability assessment to public health emergencies is limited. Related articles could be consulted only two, one paper is to evaluate the community vulnerability, mainly using Delphi method; another is to evaluate the social vulnerability of Beijing which aimed at the infectious diseases---bacillary dysentery, and the main method to use is analytic hierarchy process (AHP). Delphi method and AHP are a combination of qualitative and quantitative methods; they are usually used on the premise of lack of historical data, which have strong subjectivity. The factor analysis is a quantitative analysis method, which uses relatively few independent variables reflecting the main information of raw data to instead of the original variables. Advantage of factor analysis is to ensure the objectivity of the evaluation results, so it usually is used in social vulnerability assessment of natural disasters.

From TABLE I we can see that this paper mainly selects quantitative indicators, so factor analysis is chosen. Based on the statistical data of 31 regions in China, this paper aims at two epidemics emergencies (2003 SARS and 2009 H1N1 Influenza) to evaluate. Data resource is from "China Statistical Yearbook", "Chinese Health Statistics Yearbook" and "China Insurance Yearbook" in 2004 and 2010. The calculation process of statistical data is completed by software SPSS17.0, and the calculation results are shown in Figure 1. Social vulnerability scoring displays the level of social fragility and social capability to resist disasters, the greater the score is, and the higher social vulnerability is. The score less than zero, it indicates the level of social vulnerability is below the average, that is to say, social vulnerability is low and anti-disaster capability is strong, such as in 2003SARS, social vulnerability scoring of Beijing is -2.09, is the lowest level of social vulnerability in China.

As Figure 1 shows, regional scoring of social vulnerability in 2003SARS and 2009 H1N1 Influenza is basically the same. In the middle and eastern regions in China, social vulnerability is relatively low, and compared to 2003SARS, it decreases in 2009; while in the western and southwestern, social vulnerability is high, and rising.

TABLE I The Assessment Index System of Social Vulnerability to Infectious disease Emergency

		Index: Concept and Description
Social Vulnerability	Social Fragility	X1: the old and youth population proportion (%)：0-14 years old youth population and above 60 years old population with the entire population ratio
		X2: the illiterate proportion of more than 15 years old(%)
		X3: tourism liveness(%)：proportion of visitors
		X4: population density: the number of people per square kilometers
		X5: per capita gross product of wholesale and retail industry and catering industry(yuan/person)
	Social Capability	X6: the medical staff number per thousand persons(‰)
		X7: the health institutions beds number per thousand persons(‰)
		X8: government health expenditure accounted for the proportion of financial expenditure （%）
		X9: per capita Ministry of Civil Affairs medical aid expenditure(yuan/person)
		X10: residents health expenditure accounted for the proportion of consumer spending （%）
		X11：commercial personal insurance density(yuan/person)： premium income / total population of region
		X12：social medical insurance fund density(yuan/person) : fund income / total population of region

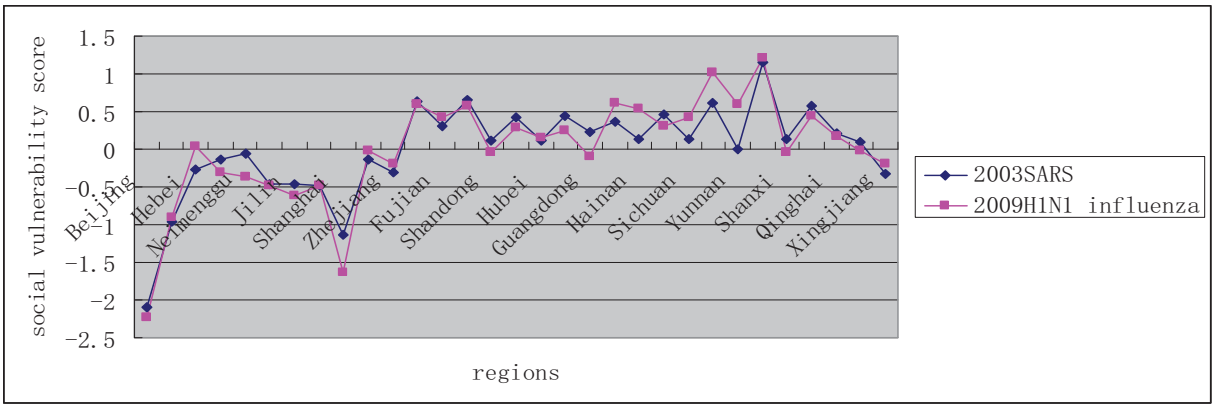

Figure 1 Region social vulnerability scoring

TABLE II Significant Testing

Epidemics emergency	dependent variable	independent variable	F-statistics	Testing results
2003 SARS	Y_1	Social vulnerability score	21.520	$F > F_{0.05}(1,29)$, significant
	Y_2	Social vulnerability score	4.331	$F > F_{0.05}(1,29)$, significant
2009 H1N1 Influenza	Y_1	Social vulnerability score	0.868	$F < F_{0.05}(1,29)$, not significant
	Y_2	Social vulnerability score	4.333	$F > F_{0.05}(1,29)$, significant

Specifically, Beijing, Shanghai, Tianjin tend to have the lowest social vulnerability, and Tibet, Guizot, Anhui seem to be the highest regions.

D. Verifying the Rationality of Assessment

In order to test the rationality of social vulnerability assessment results, we take the actual morbidity rate (Y1)[①]and mortality rate(Y2) in 2003SARS and 2009 H1N1 Influenza as dependent variables, social vulnerability scoring as independent variable, further to do regression analysis(TABLE II).

Morbidity and mortality of infectious disease emergency are important measures of the degree of harm; the size of the index value is closely linked with both the characteristics of the disease itself and the impact of surrounding economic and social environment. Therefore, social vulnerability scoring should have a close relationship with the actual morbidity and mortality. In the 95% level of significance, the results of regression analysis show a significant relation between social vulnerability scoring and morbidity and mortality of 2003SARS epidemics, and social vulnerability scoring has a significant relation with 2009 H1N1 Influenza mortality, but not significant with 2009 H1N1 Influenza morbidity.[②] On the whole, social vulnerability scoring is significantly correlated with the actual morbidity and mortality. It shows that the result of social vulnerability assessment is consistent with the actual situation, the evaluation indexes and methods this paper selects are reasonable and feasible.

III THE KEY FACTORS AFFECTING SOCIAL VULNERABILITY

Despite the 12 indexes in the assessment system of the social vulnerability are all important, but the role of each index to reduce social vulnerability and improving emergency response capabilities is different.

With the development of society and economy, the values of X1, X3 and X5 tend to increase social vulnerability; the indexes X2, X4, X6, X7, X10 respectively reflect the regions population quality, the basic situation of the environment, local medical and health conditions, health level and health consciousness of residents, and the change of these indexes depend on a lot of infrastructure construction, providing medical and health personnel, as well as increasing income and enhancing health awareness of residents. Therefore, although these indexes are important to affect social vulnerability, but in a short time it is difficult to change these indexes values. That is, it is difficult to reduce social vulnerability and enhance anti-disaster capacity through changing these indexes. While the indexes X8, X9, X11, X12 mainly reflect the capability against infectious disease emergencies from the perspective of financial guarantee, the values of these indexes can be increased in the short term by increasing the investment of government finance and improving medical insurance system, so they effectively

① A ratio between the numbers of new cases of a disease in a certain area in a certain period of time and the numbers of the local population. It's usually expressed in permillage.

② Although the incidence of epidemics emergency could be impacted by social factors, but it more be controlled by the biological characteristics of pathogens. So the incidence of 2009H1N1 influenza was no significant to social vulnerability is possible, this does not affect the results in this article.

enhance the social ability of overcoming epidemics and absorbing disasters losses.

Further, to analyze the significant between above four indexes and social vulnerability, this paper takes the indexes X8, X9, X11, X12 as independent variables, the social vulnerability scoring is dependent variable, selects data of 2003SARS and 2009 H1N1 Influenza to do multiple regression analysis by software SPSS17.0. The results as follows:

a) 2003 SARS

R^2=0.755, F=20.082, regression equation is significant. S represents social vulnerability scoring.

$$S = (-0.257) \times X8 + (-0.188) \times X9 + (-0.813) \times X11 \quad (1)$$

b) 2009 H1N1 Influenza

R^2=0.759, F=20.526, regression equation is significant.

$$S = (-0.107) \times X9 + (-0.504) \times X11 + (-0.408) \times X12 \quad (2)$$

As "(1)" and "(2)" show, Firstly, commercial personal insurance (represents by X11) has the most significant affection on the social vulnerability. Its regression coefficient was respectively -0.813 and -0.504 in 2003SARS and 2009H1N1, and it's per unit change has an affect on social vulnerability is far greater than other indexes. Secondly, social medical insurance (represents by X12) influence on social vulnerability is more strengthened in 2009 than in 2003, its regression coefficient was not significant in 2003, but significant in 2009, the value was -0.408. This indicates that with the reform of Chinese medical insurance system in 2009, the coverage of medical insurance is continuously increasing, more and more people can enjoy the guarantee of primary medical treatment charge, then it can effectively enhances social ability to absorb disasters losses when epidemics out breaking. Thirdly, from 2003SARS to 2009 H1N1 Influenza, the degree of government health expenditure(X8, regression coefficient was from -0.257 in 2003 to not significant in 2009) and Ministry of Civil Affairs medical assistance expenditures(X9, its regression coefficient reduced from -0.188 in 2003 to -0.107 in 2009) effect on social vulnerability was a clear downward trend. It means, compared with commercial personal insurance and social health insurance, government finance plays at the most a minor role in enhancing the social capability to resist disasters and absorb losses, and this role is still in decreased. According to the above analysis, commercial personal insurance is the most key factor affecting social vulnerability, followed by social medical insurance, once again, is the government finance.

IV CONCLUSION

Social vulnerability analysis provides a scientific base for the policy making of public health emergency preparedness. Although developed regions in economy have many unfavorable factors to increase potential hazard, such as intensive population, high liquidity and so on, but its social vulnerability scoring is very low, this is because these regions always have better emergency preparedness and stronger ability to overcome disasters. Thus, the social vulnerability in east regions is lower than western regions in China, it is very important to strengthen emergency preparedness in the western regions. In this paper, we also analyze the factors which could effectively reduce social vulnerability in epidemics emergency management, and the result is shown that commercial health insurance plays a most important role, so in further work we will continue to discuss how to better play the role of commercial insurance in epidemics emergencies, it will be of great practical value to improving emergency management of regions in China.

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