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Influence of Objective Environmental Factors on Community Epidemic Prevention

Le Luo [1,*], Ruiying Ning [2], Shulin Xiang [3], Jiawei Wu [4]

[1] *Accounting of Sichuan Agricultural University, Dujiangyan, Chengdu, Sichuan, China*
[2] *Asset Assessment of Sichuan Agricultural University, Dujiangyan, Chengdu, Sichuan, China*
[3] *Asset Assessment of Sichuan Agricultural University, Dujiangyan, Chengdu, Sichuan, China*
[4] *Accounting of Sichuan Agricultural University, Dujiangyan, Chengdu, Sichuan, China*
**Corresponding author.Email:841817368@qq.com*

ABSTRACT

In this paper, all communities in Chengdu that had an epidemic at the beginning of 2020 were selected as a sample to explore the influence of objective environmental factors on community epidemic prevention. In terms of the explanatory variables of environmental factors by referring to relevant literature and combining with specific situations, four major factors were selected as the measurement indicators to comprehensively examine the influence of environmental disturbances on community epidemic prevention. The results showed that the distance of the community from the nearest large passenger transportation center was the primary variable influencing community epidemic prevention, and based on the results of this analysis, reasonable suggestions were made for community epidemic prevention based on the characteristics of objective environmental pressure in the community.

Keywords : *environmental factors，interference degree，community epidemic prevention*

1. INTRODUCTION

Under the background of normalized prevention and control of novel coronavirus in China, the community is the first line to face the pressure of epidemic prevention. The residential community is the main environment for residents' social activities. The activities carried out by the residential community include general education, commuting and treatment of common diseases. It is urgent to explore the impact of objective environmental factors on community epidemic prevention[1]. In this paper, the communities with epidemics in Chengdu in early 2020 were selected as samples. Based on the entropy method model, the influence of four objective environmental factors on community epidemic prevention was compared, and the strongest interference factor was obtained, which should be monitored and managed in future epidemic prevention work. Because of the characteristics of objective environmental pressure in the community, new ideas and new perspectives are put forward for community epidemic prevention.

2. DATA SOURCE AND SAMPLE SELECTION

2.1. Data Source

In this paper, we selected a sample of communities in Chengdu that had an epidemic in early 2020， containing a total of eight communities (hereafter referred to as C1,C2,C3,C4,C5,C6,C7 and C8 respectively), to explore the influence of objective environmental factors on community epidemic prevention. Empirical data were collected through field surveys, telephone interviews, and online communication, and the entropy method and other methods were used to further explore the relationships among variables. In terms of specific environmental factors explanatory variables by referring to relevant literature and taking into account the specific situation, four major factors were selected as the measurement indicators.

2.2 Sample Selection Basis

The reasons for selecting communities in Chengdu that had an outbreak in early 2020 as the sample were as follows: early 2020 was the time of the first outbreak of the novel crown epidemic, and no corresponding preventive measures and response plans were available everywhere, so the disparity in epidemic prevention in each community was mainly caused by local objective factors, which largely reduced the interference of human subjective factors. In terms of environmental factors explanatory variables, this paper selects four objective factors that are more disruptive to the environment, which can further be grouped into two categories: transportation and demographic factors.

The first is the distance between the community and the nearest large passenger transport center and the daily average passenger flow of the surrounding large passenger transport center. As an environmental traffic factor, if the community is closer to the large passenger transport center and the daily average passenger flow of the surrounding passenger transport center is larger, the flow of personnel will be larger, and it is more likely to find novel coronavirus infect passengers. At the same time, the population range that may be infected by the epidemic is wider, so it is more vulnerable to the interference of the epidemic, which is not conducive to community epidemic prevention.

Secondly, population factors, the first is the proportion of the floating population, if the proportion of the local floating population is much larger than the household population, it is not conducive to community staff to carry out the epidemic investigation and daily epidemic report work. The second is population density. The higher the population density of the community is, the higher the possibility of an outbreak in the community is. At the same time, the impact of the spread of novel coronavirus will be more serious.

3. VARIABLE DEFINITION

3.1. A_1 Distance From The Nearest Large Passenger Transport Center (Km)

The large passenger transport centers referred to in this paper include highway, railway and air transport. Usually, the farther the distance from the community to the passenger transport center is, the smaller the impact of outsiders is, and the smaller the environmental pressure is. On the contrary, the environmental pressure is greater.

Due to the difference in the distance between each boundary of the community and the passenger transport center, to avoid the error caused by different statistical standards of distance, this paper takes the party service center of each community as the starting point of distance calculation, and A1 refers to the distance between the location of the party service center of the community and the passenger transport center.

3.2. A_2 Daily Passenger Flow Of Surrounding Large Passenger Transport Centers（Million People）

Daily passenger flow in passenger transport centers is an important factor affecting community environmental pressure. The greater the passenger flow is, the stronger the disturbance is. To avoid the influence of passenger flow changes in special periods such as festivals and seasons, and truly reflect the degree of disturbance of the community by the passenger flow of the passenger transport center, the daily average passenger flow of the passenger transport center in this paper adopts the daily average passenger flow in 2020.

$A_2 = F\ /\ 365$,（F is annual passenger flow）

3.3. A_3 Floating Population (%)

The proportion of the floating population in this paper refers to the ratio of the number of people in a community who leave their domicile and live elsewhere for work and living purposes to the total population living in that community. Usually, the higher proportion of the floating population in a certain region, the more complex the origin and composition of its population, the higher the possibility of being disturbed by epidemics, the greater the environmental pressure in the region. Conversely, the lower the environmental pressure.

$$A_3 = {N'}/{N},$$

（N' is the number of floating population in the community，N is the number of community residents）

3.4. A_4 Population Density (Person / Km^2)

The population density refers to the population per unit area of land. The population density in this paper refers to the ratio of the population living in a community (person) to the area of the community (km2). Usually, the higher the population density is, the higher the environmental pressure is. Conversely, the lower the environmental pressure is.

$$A_4 = {N}/{S}$$

(N is the number of resident in the community，S is the area of the community district）

The above data come from the Chengdu grass-roots public integrated service supervision platform, news data access and community field visits. After finishing, see Table 1 below:

Table 1 Community environmental pressure factors

Sample Community	A_1 Distance from the nearest large passenger transportation center （km）	A_2 Average daily passenger flow of large passenger transportation center around（10000 persons）	A_3 Percentage of mobile population （%）	A_4 Population density （person/km^2）
C1	11.10	1.50	52%	25727.07
C2	19.90	4.50	51.54%	17727.27
C3	2.80	0.16	56.89%	23902.44
C4	5.60	17.90	33.33%	49420.00
C5	14.90	4.50	40.10%	45862.07
C6	3.80	4.50	40.38%	93734.21
C7	4.70	8.76	78.81%	26845.64
C8	7.30	8.76	33.33%	2996.25

4. MODEL CONSTRUCTION AND DATA ANALYSIS

4.1. Model Construction And Calculation

The entropy method is a mathematical method that uses entropy values to determine the dispersion degree of an index. The greater the dispersion degree of an index is, the greater the effective information provided by the sequence is, the smaller the uncertainty is, the smaller the entropy value is, and the greater the weight of the index in the final result is. On the contrary, the smaller the degree of dispersion, the greater the entropy value, the lower the weight value. To further explore the influence degree and action path of the above four factors on community environmental pressure, this paper uses the entropy method to determine the weight of the four pressure factors in the process of disturbance to the community environment. The specific steps are as follows :

(1) Constructing the original matrix

Construct the matrix of n (community) * m (index). Denote the value of the jth indicator of the ith community as x_{ij}.

(2) Standardized treatment of indicators

Since the measurement units of each index are not uniform, we need to standardize them before calculating the final results, to solve the homogenization problem of different quality index values. Due to the different meanings of the positive index and negative index (the higher the positive index value is, the better the negative index value is), we need to use different algorithms for data standardization.

Positive indicators :

$$x'_{ij} = \frac{x_{ij} - min\{x_{1i,\dots,}x_{nj}\}}{max\{x_{1i,\dots,}x_{nj}\} - min\{x_{1i,\dots,}x_{nj}\}} + 0.0001 \quad , \quad (i = 1,2 \dots, n; j = 1,2, \dots, m)$$

Negative indicators :

$$x'_{ij} = \frac{max\{x_{1i,\dots,}x_{nj}\} - x_{ij}}{max\{x_{1i,\dots,}x_{nj}\} - min\{x_{1i,\dots,}x_{nj}\}} + 0.0001 \quad , \quad (i = 1,2 \dots, n; j = 1,2, \dots, m)$$

(3) Calculate the proportion of the i community in indicator j

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

(4) Calculate the entropy value for indicator j

$$k = 1/\ln(n)$$

$$e_j = -k \sum_{i=0}^{n} P_{ij}\, ln(P_{ij}), \quad (i = 1,2 \dots, n; j = 1,2, \dots, m)$$

(5) Calculate the variance factors for indicator j

$$g_j = 1 - e_j \ , \ (j = 1,2, \dots, m)$$

For the j index, the smaller the entropy value is, the greater the difference coefficient is, and the greater the weight of the final result is.

(6) Calculate the indicator weight for item j

$$W_j = \frac{g_j}{\sum_{j=1}^{m} g_j} \ , \ (j = 1,2, \dots, m)$$

(7) Calculate the integrated environmental pressures in communities

$$Q = \sum_{j=1}^{m} W_j P_{ij}$$

4.2. Calculation Results

4.2.1. Weight of community environmental pressure factors

Table 2 Weight Table of Community Environmental Pressure Factors

Community environmental pressure factors	Entropy value	Variance factor	Weight	Ranking
A1	0.7786	0.2214	0.4870	1
A2	0.9231	0.0769	0.1693	3
A3	0.9201	0.0799	0.1758	2
A4	0.9236	0.0764	0.1680	4

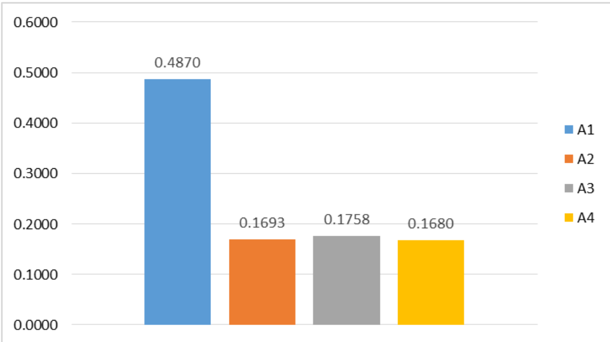

Figure 1 Weight histogram of community environmental pressure factors

4.2.2. Comprehensive environmental pressure of communities

Table 3 Sample Community Integrated Environmental Pressure

Pressure factors / Sample community	A1	A2	A3	A4	Comprehensive environment pressure	Ranking
C1	0.084735	0.029969	0.019304	0.024637	0.158645	3
C2	0.174557	0.024487	0.019636	0.027535	0.246215	1
C3	0.000017	0.032417	0.015784	0.025298	0.073517	6
C4	0.028597	0.000003	0.032745	0.016055	0.077400	5
C5	0.123522	0.024487	0.027871	0.017344	0.193224	2
C6	0.010224	0.024487	0.027666	0.000003	0.062381	7
C7	0.019411	0.016704	0.000003	0.024232	0.060350	8
C8	0.045949	0.016704	0.032745	0.032871	0.128268	4

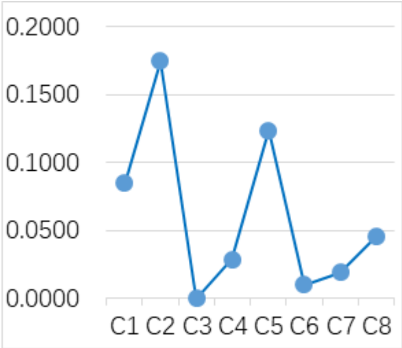

Figure 2 Pressure line chart of sample community A1 indicators

Figure 3 Pressure line chart of sample community A2 indicators

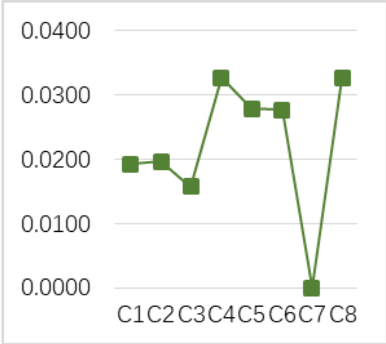

Figure 4 Pressure line chart of sample community A3 indicators

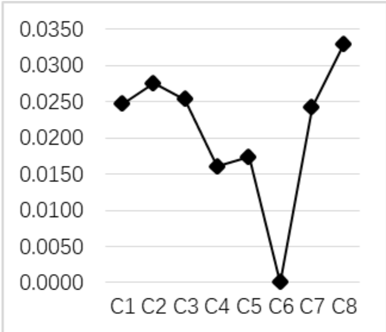

Figure 5 Pressure line chart of sample community A4 indicators

5. CONCLUSIONS

Firstly, according to the above results, it can be seen that among the four objective factors, the influence degree of specific factors from large to small is: the distance from the nearest large passenger transport center (A1), the proportion of floating population (A3), the daily average passenger flow of surrounding large passenger transport centers (A2), and the population density (A4). "Distance from the nearest large passenger transport center (A1) "index has the highest weight and is the most important environmental factor. The indicator" distance to the nearest large passenger center (A1)" has the highest weight and is the most important environmental factor. It is initially speculated that this may be since large passenger centers are transportation hubs, where foreign populations gather and disperse, with frequent population movements and complex personnel structures.

Secondly, the four objective environmental factors all have a significant influence on the environmental pressure of community prevention, but there is a strong internal logic among the four factors: namely " traffic-population flow" . The core of "the distance from the nearest large passenger transport center" and "the average daily passenger flow of the surrounding large passenger center" is the inter-regional mobility of the population, and " the proportion of floating population" is the result of this core. The greater the population density is, the easier it is for the novel coronavirus to spread widely, and the greater the environmental pressure.

Comprehensively analyzing, the modern traffic flow is the main source of community epidemic prevention environmental pressure. In the process of epidemic prevention and control, we should pay attention to the cross-regional transmission of viruses caused by traffic factors, and focus on monitoring and management of communities close to passenger stations.

6. RELEVANT RECOMMENDATIONS

First, because of the characteristics of community environmental pressure during the epidemic period, grassroots communities need to improve their environmental pressure monitoring systems. Touched by the novel coronavirus, the effectiveness and performance of community governance not only penetrate the life practice of each community resident, but also have a significant impact on the transfer of attention of theoretical research [2]. A large number of research results triggered by major public health crisis events have provided a great deal of useful experience for the improvement of the community governance system[3]. From the perspective of the objective environment of the community, this paper puts forward the following recommendations for environmental monitoring in the process of community governance: First, we should summarize the distance of each community from large passenger transportation centers, and focus on communities that are closer to passenger transportation stations during the epidemic prevention period. Finally, major public health crises are characterized by the mass spread of rapidly spreading pathogens through cities with relatively dense populations[4]. Therefore, communities should increase the frequency of statistical screening of the total and flow populations, and focus on targeted surveillance in communities with high mobile and dense populations.

Second, establish and improve the database of objective community environmental information. The micro-practices of the community are specifically reflected in the community grid management， the general standard system of urban public services, and the comprehensive governance information platform of the street[5]. Combined with the community micro- practice activities, we fully utilize the human and material tools such as community grid workers， volunteers, big data, and cloud computing to establish a comprehensive information database covering all aspects of community traffic flow, population characteristics, and personnel flow.

Third, considering the overall interests of residents, the community can require residents to make more “power transfer” and policy responses under the background of normalization of the epidemic[2]. Firstly, it is necessary to guide residents to consciously comply with the requirements of epidemic prevention and make “power transfer”. At the same time, we should mobilize the residents’ subjective initiative and respond positively to the epidemic prevention policies. Although the shortboard of residents' management in the community governance system is amplified by the epidemic, it is difficult to say that the administrative trend in the operation of community governance [6], the lack of independent participation of community residents, and other issues have been well responded before the epidemic[7]. Therefore, at any stage, attention should be paid to the coordination between residents' autonomy and community management, community staff need to do a good job at the grassroots level to timely and accurately convey public opinion and sentiment to higher authorities.

FUND PROJECTS

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Appendix (Please hide the name of the community when officially published):

C1 Community - Lianhua Community in Shuangliu District of Chengdu City

C2 Community - Shuangbai Community, Pidu District, Chengdu City

C3 Community - Shuanglin Community in Chengdu Chenghua District

C4 Community - Wangping Street Community, Chengdu Chenghua District

C5 Community - Gao Dian Community, Pidu District, Chengdu City

C6 Community - Yifu Community in Chengdu Chenghua District

C7 Community - Chengdu Shuangliu District Near Du Community

C8 Community - Peng Zhen Glorious Community, Shuangliu District, Chengdu City

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