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Original Article

Evaluating the Governance Ability of Urban Public Health Using EM–AHP–TOPSIS Method: A Case Study in China

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Abstract

Background: Evaluating the governance capacity of urban public health is the key to improving the level of urban public health. We aimed to evaluate the governance ability of urban public health.

Methods: An index system of governance ability of urban public health was established. The governance ability of urban public health was evaluated, and major constraints against the ability improvement were analyzed through the EM (Entropy Method)–AHP (Analytic Hierarchy Process)–TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) model and data of urban agglomeration in Yangtze River Delta, China in 2023.

Results: Shanghai, Nanjing, Hangzhou, Suzhou, and Ningbo rank top 5 in terms of governance ability of public health, and they are in the first echelon. Hefei, Yancheng, Wuxi, Taizhou and Shaoxing rank 6–10, and they are in the second echelon. The remaining 17 cities are in the third echelon. Major sources of governance ability of urban public health and major factors that decrease governance ability are Medical Facility (A12), Health Improvement (A33), Medical Staff (A13), Government Ability (A11), and Health Loss (A34). For urban agglomeration in Yangtze River Delta, China, public health foundations, environmental exposure risks, public health performance, and public health emergencies all can influence the governance ability of public health.

Conclusion: Accurate evaluation of the governance ability of urban public health can provide guidance and policy propositions to improve the governance system of public health and improve the emergency coordination ability of the government.

Keywords: Urban public health; Governance ability; Urban agglomeration; China

Introduction

Currently, the management of urban public health encounters frequent occurrences of public health accidents, and this situation has attracted considerable attention from experts and scholars. If great urban public health emergencies are not handled timely and inaccurately, this situation often will develop into large-scale comprehensive public crises and disasters, which bring serious consequences (1). Therefore, many experts and scholars have studied the governance ability of urban public health systematically by using different research methods and integrating different

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disciplines, such as management engineering, laws, and politics. The complicated and diversified urban environment and high concentration of urban population in China have increased the frequency of occurrence of urban emergencies and increased the risk coefficient, which makes the rescue process complicated (2). Urban public health events greatly threaten social stability, people's property safety, and the lasting political stability of a country. According to the practice experiences of developed countries, urban economic level increases quickly and various emergency events occur continuously in the accelerated urbanization process. As a result, cities enter into the high-risk phase and become the "vulnerable" places. The governance ability of urban public health is closely related to people's life safety, property safety, and production safety (3). It is the foundation of social economic order and national safety (4). Therefore, evaluating the governance ability of urban public health and optimizing its governance mode can help urban managers cope with various urban public safety events accurately and effectively. It is important in decreasing casualties to the maximum extent, avoiding economic loss, and realizing sustainable sound, and stable development of cities.

Three main methods are used to measure public health, namely, the index method, the efficiency value method, and the establishment of a comprehensive evaluation index. Specifically, the index method mainly chose indexes related to physical health, and most indexes are negative ones, such as the number of death for disease of the respiratory system (5), total death rate (6-7), and number of outpatient and emergency treatments in oncology department (8). The efficiency value method mainly measures the regional public health level by its input-output efficiency. For example, the regional health production efficiency is measured with the DEA method by using the number of health technical personnel per 1,000 people, the number of beds in health institutions per 1,000 people, and the total health cost per capita as the input variables, with the average expected life as the output variable (9). Moreover, the health production efficiency of residents is measured dynamically with the DEA–Malmquist model by using the number of beds in health institutions per 1,000 people and the number of health technical personnel in 1,000 people as the input variables, with the maternal mortality rate, the perinatal mortality rate, and the incidence rate of infectious disease as the output variables (10). Relatively few studies are available on establishing a comprehensive evaluation index. For instance, the weighted mean of residents' expected life, birth rate, and death rate is used to build the health level index of residents for reflecting the health input effect of different regions (11). Alternatively, evaluation indexes are built from the perspective of individual education and income level (12-13), family harmonious atmosphere and health environment (14), social status, medical resource configuration, urbanization, and air pollution (15) on the social economic level.

With respect to the emergency capacity of urban public health, relevant studies have attracted wide attention since the SARS event in 2003. Owing to the chain effect, composition, and complexity of influences of the COVID-19 pandemic, the importance and urgency to strengthen the emergency management system and ability construction of public health are highlighted. In addition, close attention should be paid to the uniqueness of public health emergency management (16). The COVID-19 pandemic has proposed a great challenge to the emergency governance ability of public health. The application of big data should be promoted in the field of public health emergency management to improve the aforementioned ability (17). With respect to the evaluation index system for public health emergency ability, the indexes of resource guarantee ability, resource configuration ability, crisis processing capacity, and post-event dealing ability are scored by combining the Delphi method and the analytic hierarchy process (AHP) (18), which enables improving and determining the final ability index system. In summary, urban public health has been a key research area in the academic circle. Relevant studies emphasize on measuring urban public health and the ability to cope with emergency events related to urban public health. However, few systematic studies are available on the comprehensive evaluation of the governance ability of urban public health. Thus, fully disclosing the development level, highlighted problems and regional differences of governance ability of urban public health in China is difficult. On this basis, this study attempted to develop an evaluation index system for the governance ability of urban public health based on the explicit connotation of urban public health theory and explicit logics. Then, the public health governance ability of urban agglomeration in Yangtze River Delta, China was measured scientifically by combining EM (Entropy Method), AHP (Analytic Hierarchy Process), and TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution). The development level of public health governance ability and the multi-dimensional influencing factors of urban agglomeration were investigated systematically. Conclusions can provide decision-making support to improve urban public health.

Methods

The governance ability of urban public health was evaluated by using EM–AHP combined weighting and the TOPSIS method. The weights of indexes were calculated through EM–AHP combined weighting before using the TOPSIS method.

Combined weighting model

At present, the control variables are mostly ranked through the Delphi or questionnaire survey method. However, ranking results often have very strong subjectivity and cannot be changed according to the relative changing degree of control variables. As a result, evaluation results lack objectivity and reasonability. Evaluation indexes were ranked by the EM–AHP combined weighting method according to importance, which guaranteed objectivity and reasonability of the evaluation of governance ability of urban public health.

EM method

The EM method is an objective weighting method to determine the statistical dispersion degree of indexes. When little information is available, the greater uncertainty leads to the higher entropy. When such information is provided, the entropy decreases with the decline in uncertainty. The weights of evaluation indexes are determined according to entropy. The index with greater relative changes has higher weights. The general process of the entropy method can be divided into the following steps:

1) Calculate the ratio (γ_{ij}) of x_{ij} , where

$$\gamma_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, (i = 1, 2, 3, \cdots, m, j = 1, 2, 3, \cdots, n) \quad [1]$$

2) Calculate the entropy value (ρ_j) of the jth index, where

$$\rho_j = -k \sum_{i=1}^{m} \gamma_{ij} \ln \gamma_{ij}, (i = 1, 2, 3, \cdots, m, j = 1, 2, 3, \cdots, n)$$

, $k = \frac{1}{\ln m}$ (m is the sample size) [2]

3) Calculate the difference coefficient (μ_j) of the jth index, where $\mu_j = 1 - \rho_j$ [3]

4) Calculate the weight (w_j) of the jth index, where $w_j = \frac{\mu_j}{\sum_{j=1}^{n} \mu_j}$ [4]

5) Determine the weight $W = (w_1, w_2, \cdots, w_n)$ of indexes at the outer layer in the index system according to the abovementioned steps. Calculate the sum of the weights of the indexes in the lower layer to obtain the weights of the indexes in the upper layer.

6) Rank the evaluation indexes of governance ability of urban public health in China in terms of importance according to the weight vector $W = (w_1, w_2, \cdots, w_n)$, which generates the total sequence of indexes.

AHP method

In the hierarchical structural model, the bottom layer is usually the factor layer, and various recognized fundamental risk factors are used as the level-2 indexes for risk evaluation. The middle layer is the criterion layer, and risk factors are classified as level-1 indexes for risk evaluation. The top layer is the target layer, that is, the decision target that has to be reached in risk quantification. After the evaluation goal, plan, standards, and indexes are determined, a hierarchical model of the system can be built to recognize and analyze risk factors comprehensively. According to the built risk hierarchical structure, a pairwise comparison of factors is conducted.

The product of matrix elements a_{ij} is determined according to row calculation, which yields a new vector M_i:

$$M_i = \prod_{j=1}^{n} a_{ij} (i, j = 1, 2, 3 \cdots, n)$$

[5]

The n^{th} root of each element of the new vector M_i is calculated, which produces the vector r_i:

$$r_i = \sqrt[n]{M_i} \quad [6]$$

Subsequently, the weight vector (W_i), largest eigenvalue ($\lambda_{\max}$), consistency index (T), and consistency ratio (Q) are obtained through the normalization of r_i. The calculation formulas are shown in Eqs. [7]–[10]. Whether the matrix passes the consistency test is ascertained through the consistency ratio.

$$W_i = r_i / \sum_{i=1}^{n} r_i \quad [7]$$

$$\lambda_{\max} \approx \frac{1}{n} \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} (a_{ij} W_j)}{W_i} \quad [8]$$

$$T = \frac{\lambda_{\max} - n}{n-1} \quad [9]$$

$$Q = \frac{T}{K} \quad [10]$$

Determination of comprehensive weights

The subjective weight vector (α) and objective weight vector (β) are obtained using the EM method and the AHP method, respectively. The comprehensive weight is composed of two weights. The weights of different indexes in the evaluation process can be fully reflected through their complementarity. To ensure that the comprehensive weight (ω_i) of indexes is close to α_i and β_i as much as possible, the comprehensive weight (ω_i) is obtained through the principle of minimum distinguishing information. The target function is

$$\begin{cases} \min J(\omega) = \sum_{i=1}^{n} (\omega_i \ln \frac{\omega_i}{\alpha_i} + \omega_i \ln \frac{\omega_i}{\beta_i}) \\ s.t. \sum_{i=1}^{n} \omega_i = 1, \omega_i \geq 0 \quad i = 1, 2, \cdots, n \end{cases}$$

[11]

The comprehensive weight is obtained by solving the optimization model:

$$\omega_i = \frac{\sqrt{\alpha_i \beta_i}}{\sum_{j=1}^{n} \sqrt{\alpha_i \beta_i}} \quad [12]$$

The comprehensive weight vector is expressed as Eq. [13]:

$$\omega = [\omega_1, \omega_2, \cdots, \omega_n]^T \quad [13]$$

TOPSIS method

The TOPSIS method eliminates the dimensional influences of different indexes through the normalization and common trend processing of the initial data, which enables to reflect the real difference among schemes objectively. First, m objects (finite targets) and n attributes are considered. The evaluation value of experts to the j^{th} attribute of the i^{th} target is x_{ij}, and the initial judgment matrix (V) is

$$V=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

[14]

Given that indexes have different dimensions, the judgment matrix ($V^{'}$) is obtained through the normalization of the initial judgment matrix (V):

$$V'=\begin{bmatrix} x_{11}^{'} & x_{12}^{'} & \cdots & x_{1n}^{'} \\ x_{21}^{'} & x_{22}^{'} & \cdots & x_{2n}^{'} \\ \vdots & \vdots & \vdots & \vdots \\ x_{i1}^{'} & \cdots & x_{ij}^{'} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1}^{'} & x_{m2}^{'} & \cdots & x_{mn}^{'} \end{bmatrix}$$

[15]

where

$$x_{ij}^{'}=x_{ij}/\sqrt{\sum_{k=1}^{n}x_{ij}^{2}},\mathrm{i}=1,2\ldots\mathrm{m};\mathrm{j}=1,2\ldots\mathrm{n}$$

[16]

Next, the experts' information weight matrix (*B*) of attributes is acquired using the AHP method, which forms the weighting judgment matrix (*Z*):

$$Z=V^{'}B=\begin{bmatrix} x_{11}^{'} & x_{12}^{'} & \cdots & x_{1n}^{'} \\ x_{21}^{'} & x_{22}^{'} & \cdots & x_{2n}^{'} \\ \vdots & \vdots & \vdots & \vdots \\ x_{i1}^{'} & \cdots & x_{ij}^{'} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1}^{'} & x_{m2}^{'} & \cdots & x_{mn}^{'} \end{bmatrix}\begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1n} \\ w_{21} & w_{22} & \cdots & w_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ w_{i1} & \cdots & w_{ij} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ w_{m1} & w_{m2} & \cdots & w_{mn} \end{bmatrix}=\begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1n} \\ f_{21} & f_{22} & \cdots & f_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ f_{i1} & \cdots & f_{ij} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ f_{m1} & f_{m2} & \cdots & f_{mn} \end{bmatrix}$$

[17]

According to the weighted judgment matrix, the positive ideal solution (f_j^{*}) and the negative ideal solution ($f_j^{'}$) of the evaluation goal are obtained:

$$f_j^{*}=\begin{cases}\max(f_{ij}), j\in J^{*}\\ \min(f_{ij}), j\in J^{'}\end{cases}, j=1,2,\ldots,n$$

$$f_j^{'}=\begin{cases}\min(f_{ij}), j\in J^{*}\\ \max(f_{ij}), j\in J^{'}\end{cases}, j=1,2,\ldots,n$$

[18]

where $J^{'}$ is the cost index and J^{*} is the efficiency index. The Euclidean distance between target values and the ideal value is calculated according to Eq. [19].

$$S_i^{*}=\sqrt{\sum_{j=1}^{m}(f_{ij}-f_j^{*})^2}, j=1,2,\ldots,n$$

$$S_i^{'}=\sqrt{\sum_{j=1}^{m}(f_{ij}-f_j^{'})^2}, j=1,2,\ldots,n$$

[19]

Finally, the relative closeness (C_i^{*}) of different targets was calculated as follows:

$$C_i^{*}=\frac{S_i^{'}}{S_i^{*}+S_i^{'}} i=1,2,\ldots,m$$

[20]

The targets are ranked according to C_i^{*}.

Establishment of an evaluation index system

The level of urban public health was measured based on its explicit connotations. Based on previous analysis and relevant representative results, an evaluation index system for the governance ability of urban public health was built from four perspectives of public health foundation, environmental exposure risks, public health performance, and public health emergency by observing the principle of scientific validity, comprehensiveness, representativeness, balance, and operability (Table 1).

Table 1: Evaluation index system for the governance ability of urban public health

Level-1 indexes	*Signs*	*Level-2 indexes*	*Signs*	*Description of indexes*	*Index property*
Public health foundation	A1	Government Ability	A11	Per capita expenditures for fiscal medical care and public health (CNY)	Positive
		Medical Facility	A12	Number of health agencies per 10,000 people	Positive
		Medical Staff	A13	Number of doctors per 10,000 people (person)	Positive
		Dietary Nutrition	A14	Per capita consumption of aquatic products (kg)	Positive
Environmental exposure risks	A2	Ecological Environment	A21	PM2.5 annual average concentration (μg/m³)	Negative
		Built Environment	A22	Traffic jam condition (person/m²)	Negative
		Social Environment	A23	Urban registered unemployment rate (%)	Negative
		Open Environment	A24	Travel activeness (%)	Negative
Public health performance	A3	Health Literacy	A31	Basic health literacy of residents (person)	Positive
		Health Behaviors	A32	Health examination population density (person/km²)	Positive
		Health Improvement	A33	Survival rate of population (%)	Positive
		Health Loss	A34	Incidence rate of urban infectious diseases (1/100,000)	Negative
Public health emergency	A4	Prevention Stage	A41	Proportion of public health emergency staff (%)	Positive
		Process Control	A42	Handling time of public health emergency event (days)	Positive
		Efficacy Evaluation	A43	Supporting funds for public health emergency events (10,000 CNY / person)	Positive
		Recovery Measure	A44	Time for recovery and rebuilding (days)	Positive

Data source

The original data came from the China Statistical Yearbook, Statistical Bulletin of National Economic and Social Development, the official websites of the State Statistics Bureau, and the National Data Website in 2023. Indexes involving price changes were deflated based on the data in 2003.

Results

Determination of weights of indexes at different levels

Public health foundation, environmental exposure risks, public health performance, and public health emergency should be evaluated comprehensively to analyze the governance ability of urban public health in China. According to the TOPSIS evaluation model based on EM–AHP combined weighting, the weights of indexes were determined first by using the EM–AHP combination method. The weights of indexes at three levels were calculated (Table 2).

Table 2: Calculation results of EM–AHP combined weighting

Level-1 indexes	*Signs*	*Level-2 indexes*	*Signs*	*EM weight*	*AHP weight*	*Comprehensive weight*	*Ranks*
Public health foundation	A1	Government Ability	A11	0.0687	0.0943	0.1027	4
		Medical Facility	A12	0.1110	0.0737	0.1298	1
		Medical Staff	A13	0.1233	0.0533	0.1042	3
		Dietary Nutrition	A14	0.0363	0.0473	0.0272	14
Environmental exposure risks	A2	Ecological Environment	A21	0.0516	0.0492	0.0403	10
		Built environment	A22	0.0426	0.1005	0.0679	8
		Social environment	A23	0.0587	0.0357	0.0333	11
		Open environment	A24	0.0356	0.0525	0.0296	13
Public health performance	A3	health literacy	A31	0.0607	0.0768	0.0739	7
		Health behaviors	A32	0.0844	0.0167	0.0224	15
		Health Improvement	A33	0.0587	0.0941	0.0876	5
		Health Loss	A34	0.0699	0.0981	0.1088	2
Public health emergency	A4	Prevention Stage	A41	0.0572	0.0897	0.0813	6
		Process Control	A42	0.0464	0.0673	0.0495	9
		Efficacy Evaluation	A43	0.0592	0.0347	0.0325	12
		Recovery Measure	A44	0.0357	0.0160	0.0090	16

TOPSIS results

The TOPSIS method evaluates the relative advantages and disadvantages of evaluation objects by ranking their distances to the positive and negative ideal solutions. First, evaluation indexes were determined, and the positive trend of evaluation indexes was guaranteed (a higher value is preferred). The calculation results are shown in Table 3.

Table 3: Positive ideal solution and negative ideal solution

Terms	*Positive ideal solution A*	*Negative ideal solution A−*
A11	0.069	0.001
A12	0.112	0.001
A13	0.124	0.001
A14	0.037	0
A21	0.052	0.001
A22	0.046	0
A23	0.059	0.001
A24	0.036	0
A31	0.061	0.001
A32	0.087	0.001
A33	0.059	0.001
A34	0.071	0.001
A41	0.058	0.001
A42	0.047	0
A43	0.06	0.001
A44	0.036	0

The positive and negative ideal solutions in Table 4 were the middle process values when calculating the positive and negative distances (D+ and D−). They had small relative significance. The positive ideal solution A+ expresses the maximum of evaluation indexes, whereas the negative ideal solution A− was the minimum of evaluation indexes.

Table 4: Calculation results of TOPSIS evaluation

Terms	*Distance to the positive ideal solution D*	*Distance to the negative ideal solution D−*	*Relative closeness C*	*Ranking results*
Shanghai	0.381	0.866	0.695	1
Nanjing	0.418	0.689	0.622	2
Wuxi	0.64	0.478	0.428	8
Changzhou	0.731	0.394	0.351	16
Suzhou	0.483	0.624	0.564	4
Nantong	0.678	0.414	0.379	12
Yancheng	0.632	0.544	0.463	7
Yangzhou	0.761	0.384	0.335	21
Zhenjiang	0.718	0.417	0.368	13
Taizhou	0.771	0.438	0.362	14
Hangzhou	0.442	0.706	0.615	3
Ningbo	0.519	0.595	0.534	5
Wenzhou	0.753	0.388	0.34	19
Jiaxing	0.784	0.353	0.31	25
Huzhou	0.76	0.402	0.346	18
Shaoxing	0.681	0.43	0.387	10
Jinhua	0.738	0.406	0.355	15
Zhoushan	0.777	0.312	0.287	26
Taizhou	0.686	0.471	0.407	9
Hefei	0.582	0.543	0.483	6
Wuhu	0.777	0.396	0.337	20
Maanshan	0.795	0.401	0.335	22
Tongling	0.754	0.403	0.348	17
Anqing	0.708	0.443	0.385	11
Chuzhou	0.813	0.367	0.311	24
Chizhou	0.805	0.405	0.335	23
Xuancheng	0.859	0.304	0.261	27

In Table 4, D+ and D− represented the distances of the evaluation objects to the positive and negative ideal solutions, respectively. C expressed the closeness between the evaluation objects and the optimal scheme. The greater value of C indicated the closer distance to the optimal scheme. The urban agglomeration in Yangtze River Delta, China was used in the verification test. The public health governance ability of urban agglomeration in Yangtze River Delta, China was evaluated by the built model to verify the effectiveness of the model. According to analysis on evaluation results for public health governance ability of urban agglomeration in Yangtze River Delta, China, Shanghai, Nanjing, Hangzhou, Suzhou, and Ningbo ranked top 5 in terms of the governance ability of public health, and were in the first echelon. Hefei, Yancheng, Wuxi, Taizhou, and Shaoxing ranked 6–10, and they were in the second echelon. The remaining 17 cities were in the third echelon. However, Shanghai, which ranked first still had some relatively weak fields. For example, it still had some improvement spaces in the mental health and emergency field.

Discussion

The governance ability system of urban public health is a comprehensive strategy to solve public health problems and cope with human health challenges. Building the evaluation index system for urban public health governance ability is beneficial to recognize problems in urban public health governance. Based on the analysis framework of urban public health correlations, a comprehensive evaluation model for the governance ability of urban public health based on "multiple factors, multiple dimensions, and multiple scales" was built to evaluate public health governance ability of urban agglomeration in Yangtze River Delta. It concludes that five cities, including Shanghai, are in the first echelon in terms of the governance ability of public health. Moreover, five cities, including Hefei, are in the second echelon. Finally, the remaining cities are in the third echelon.

According to the research results, the combined weights of Medical Facility (A12), Health Improvement (A33), Medical Staff (A13), Government Ability (A11), and Health Loss (A34) rank in the top 5, and they are the core factors that influence the governance ability of urban public health. Specifically, cities in the third echelon have relatively weak medical infrastructure, insufficient medical technological strength, and inadequate medical technicians. Although patients are accepted in public conventional departments of many comprehensive hospitals, effective isolation and prevention cannot be realized due to the lack of relevant control facilities, and effective opportunities to discover and control infection sources are lost (1). Cities in the third echelon should strengthen management and improve public health governance ability from five perspectives Medical Facility (A12), Health Improvement (A33), Medical Staff (A13), Government Ability (A11), and Health Loss (A34).

This study is not for commending but shall recognize shortages and improve them. At present, public health governance ability management system of urban agglomeration in the Yangtze River Delta, China still has development imbalances among regions (19). The governance ability scores for public health of first-tier and second-tier cities are relatively high, while the scores of third-tier cities are relatively low, which deserves high concerns. Considering the lack of chain effect among cities, cooperation of public health governance based on economic and traffic advantages of urban agglomeration in Yangtze River Delta needs to be strengthened (20). In summary, the EM–AHP–TOPSIS method has simple principle, easy understanding, and intuitive1). Moreover, the construction health of public health hospitals should be increased. County hospitals in basic regions with weak ability can set up a single public health department first to control public health events effectively. Second, cities in the first echelon of urban agglomeration in Yangtze River Delta always rank top in terms of public health service accessibility. However, they need further efforts in refined migrant population management and input of maternal and child medical care resources. Cities in the third echelon have to improve residents' health level, especially maternal and child medical care level. Moreover, health consciousness and primary medical service ability of rural regions should be improved (5). Cities with high proportions of old population and migrant population, close foreign contacts, and a large migrant population should strengthen the construction of public health infrastructure and increase the effective coverage of public health. Public health infrastructures should be strengthened to ensure that residents can prevent and control the outburst of infectious diseases.

Conclusion

A comprehensive evaluation index system for the governance ability of urban public health is built from four perspectives of public health foundation, environmental exposure risks, public health performance, and public health emergency. Accurate positioning and measurement of public health governance ability of 27 cities in the Yangtze River Delta, China are conducted using EM–AHP combined weighting and the TOPSIS method. Moreover, key influencing factors are recognized. On this basis, accurate and high-efficiency planning intervention strategies are proposed, which have practical importance in improving the governance ability levels of urban public health.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The authors declare that there is no conflict of interests.

References

1. Shen JT, He LF, Wen QY, et al (2019). The difference between national and local healthy city indicator systems: a systematic review. *Chin J Evid Based Med*, 19(6): 694-701.
2. Long RY, Fang WQ (2019). Evaluation system design and empirical research of healthy cities. *Ecol Econ*, 35(6): 84-90.
3. Lu JT, Yang ND, Ye JF, Wu HR (2014). The influence paths of emotion on the occupational safety of rescuers involved in environmental emergencies-systematic review article. *Iran J Public Health*, 43(11): 1478-85.
4. Yang X, Geng L (2022). An integrated analysis of social, economic, and environmental indicators' effects on public health and health inequality globally: From the perspective of vulnerability. *Soc Indic Res*, 162(3): 1261-79.
5. Ramírez AS, Ramondt S, Van Bogart K, Perez-Zuniga R (2019). Public awareness of air pollution and health threats: challenges and opportunities for communication strategies to improve environmental health literacy. *J Health Commun*, 24(1): 75-83.
6. Hewitt CN, Ashworth K, MacKenzie AR (2020). Using green infrastructure to improve urban air quality (GI4AQ). *Ambio*, 49(1): 62-73.
7. Shafie SH, Mahmud M, Mohamad S, et al (2022). Influence of urban air pollution on the population in the Klang Valley, Malaysia: a spatial approach. *Ecol Process*, 11:3.
8. Zhang T, Chen Y, Xu X (2020). Health risk assessment of PM2.5-bound components in Beijing, China during 2013–2015. *Aerosol Air Qual Res*, 20(9): 1938-49.
9. Crouse DL, Pinault L, Balram A, et al (2019). Complex relationships between greenness, air pollution, and mortality in a population-based Canadian cohort. *Environ Int*, 128: 292-300.
10. Hickman AL, Baker CJ, Cai X, et al (2018). Evaluation of air quality at the Birmingham New Street Railway Station. *Proc Inst Mech Eng F J Rail Rapid Transit,* 232(6):1864-1878.
11. Choochuay C, Pongpiachan S, Tipmanee D, et al (2020). Impacts of PM2.5 sources on variations in particulate chemical compounds in ambient air of Bangkok, Thailand. *Atmospheric Pollution Research*, 11(9): 1657-67.
12. Abhijith KV, Kumar P (2019). Field investigations for evaluating green infrastructure effects on air quality in open-road conditions. *Atmos Environ*, 201: 132-47.
13. Berg CN, Deichmann U, Liu Y, Selod H (2017). Transport policies and development. *Journal of Development Studies*, 53(4): 465-80.
14. Cilluffo G, Ferrante G, Fasola S, et al (2018). Associations of greenness, greyness and air pollution exposure with children's health: a cross-sectional study in Southern Italy. *Environ Health*, 17(1): 86.
15. Ordu M, Demir E, Tofallis C, Gunal MM (2021). A novel healthcare resource allocation decision support tool: A forecasting-simulation-optimization approach. *Journal of the Operational Research Society*, 72(3): 485-500.
16. Liu H, Chen S, Liu M, Nie H, Lu H (2020). Comorbid chronic diseases are strongly corre-

lated with disease severity among COVID-19 patients: a systematic review and meta-analysis. *Aging Dis*, 11(3): 668-78.
17. Honardoost M, Janani L, Aghili R, Emami Z, Khamseh ME (2021). The association between presence of comorbidities and COVID-19 severity: a systematic review and meta-analysis. *Cerebrovasc Dis*, 50(2): 132-40.
18. Turner MC, Andersen ZJ, Baccarelli A, et al (2020). Outdoor air pollution and cancer: an overview of the current evidence and public health recommendations. *CA Cancer J Clin*, 10.3322/caac.21632.
19. Qin X, Wei YD, Wu Y, Huang X (2023). Regional development and inequality within city regions: A study of the Yangtze River delta, China. *Geographical Review*, 113(3): 359-85.
20. Chen Y, Peng L, Cao W (2021). Health evaluation and coordinated development characteristics of urban agglomeration: Case study of Fujian Delta in China. *Ecol Indic*, 121: 107149.
21. Li Z, He S, Su S, Li G, Chen F (2020). Public services equalization in urbanizing China:Indicators, spatiotemporal dynamics and implications on regional economic disparities. *Soc Indic Res*, 152: 1-65.