Preplanned Studies

Empirical Evaluation of Indicators for Public Health System Development in Primary and Secondary Schools — Beijing, China, 2025

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Summary

What is already known about this topic?

Localized tools for evaluating school public health systems in China remain limited.

What is added by this report?

This study converted a previously developed indicator system into a quantitative assessment tool. K-means cluster analysis identified three school types and demonstrated the system's discriminant validity, providing empirical support for classifying school public health systems.

What are the implications for public health practice?

Improving school public health systems requires coordinated action in governance, resources, and disease prevention and control. Tailored, dynamic assessment should replace uniform approaches, and routine monitoring should be integrated into daily management to support continuous improvement.

ABSTRACT

Introduction: This study aimed to empirically evaluate indicators for assessing public health systems in Beijing primary and secondary schools, determine their feasibility and practical applicability, identify key system gaps and improvement opportunities, and provide a scientific tool to guide system development.

Methods: Using stratified random sampling, we selected 42 primary and secondary schools in Fengtai District, Beijing, China. A self-designed questionnaire assessed school public health system development. K-means cluster analysis and one-way analysis of variance classified the schools, characterized the resulting groups, and evaluated the discriminant validity of the indicator system.

Results: The 42 schools had a mean public health system score of 98.86±11.487 points (total score: 135 points), indicating moderately high development. After excluding outlier schools, clustering classified schools as comprehensively advantaged (41.18%, 14/34), lagging in governance capacity (32.35%, 11/34), or comprehensively lagging (26.47%, 9/34). The three school types differed significantly in public health governance, common disease prevention and control capacity, and resource support (P<0.005), supporting the discriminant validity of the indicator system.

Conclusion: The indicator system effectively distinguished development levels across school types and showed good feasibility and applicability. Improvement requires coordinated governance, resource allocation, and disease prevention and control. Targeted guidance, tailored policies, and monitoring integrated into daily management may support continuous improvement.

In 2025, Beijing convened the Work Promotion Meeting on Deepening the High-quality Development of School Sports and Strengthening Pilot Work for Healthy School Construction. The meeting called for coordinated action in areas including disease prevention and health education to develop a replicable, scalable pilot model for school health systems. Evaluating the effectiveness of these pilots requires scientifically sound, operationally feasible tools.

Evaluating and developing school health systems have become shared priorities in public health and education worldwide. In 2021, the World Health Organization and the United Nations Educational, Scientific and Cultural Organization jointly published the Global Standards for Health-promoting Schools and Systems, setting out eight global standards to help countries strengthen governance and support effective operation of health-promoting schools.

A comparison of the health-promoting school framework across 24 European countries found

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substantial variation in implementation and distinct combinations of barriers and facilitators in each country (*1*). School health frameworks therefore cannot be adopted without adaptation. Developing and validating localized assessment tools is essential to advance evidence-based school health.

The indicator system previously developed using the Delphi method requires empirical validation (*2*). We converted the system into a quantitative assessment tool and administered it to sampled schools in Fengtai District, Beijing. We evaluated its feasibility and discriminant validity in school settings to provide evidence for refining the indicators and implementing targeted policies.

We selected Fengtai District, Beijing, for its representative educational resources, well-established student-centered health system, and strong interdepartmental collaboration. Using Statistical Overview of Beijing's Educational Development in the Academic Year 2024–2025, we drew a stratified random sample of 42 schools (40% of district schools), proportional to the numbers of primary, secondary, and combined schools. One school physician or health teacher per school completed the questionnaire between November and December 2025 (100% response rate). The study received ethics approval (No. Z2023SY093).

The quantitative questionnaire, which reflected school public health practice (*2*), had a maximum score of 135 points, comprising 100 points for basic and standardized requirements and 35 bonus points. This framework assessed the robustness of school public health system development. We retained the weights of the primary and secondary indicators but slightly adjusted the scores of selected tertiary indicators and their corresponding questions to improve scoring and analysis feasibility. These adjustments kept each dimension's score distribution consistent with the weights in the indicator system.

The questionnaire comprised six sections. The first collected basic school information, and sections 2–6 corresponded to the five primary indicators.

All analyses used Statistical Product and Service Solutions (SPSS) (version 26.0, IBM Corp., Armonk, NY, USA). Frequencies and proportions summarized school characteristics. Means, standard deviations, and score rates described dimensional indicator distributions. K-means cluster analysis identified potential school groups. Before clustering, schools with outlying values were excluded using a Z-score criterion of $|Z|>2$. After clustering, one-way analysis of variance, with school type as the independent variable and dimensional scores as the dependent variables, tested differences among the three school types across dimensions ($\alpha=0.05$) and assessed the discriminant validity of the indicator system. Cluster types were then characterized by their scoring patterns.

The analysis classified schools and evaluated the system at the primary-indicator level. The five primary-indicator scores served as clustering variables. Tertiary-indicator scores were used only for internal quality control; because they contributed little to the study's principal conclusions on school classification and discriminant validity, their individual scores are not reported.

Of the 42 schools, 23 were primary schools (54.76%, 23/42), 10 were secondary schools, including junior high, senior high, and comprehensive high schools (23.81%, 10/42), and 9 were 9-year or 12-year integrated schools (21.43%, 9/42). Most were single-campus schools (80.95%, 34/42) and day schools (92.86%, 39/42), and most enrolled fewer than 1,200 students (73.81%, 31/42).

The total score of 135 points was converted to a percentage scale using the quantitative scoring method and combined indicator weights. School public health system development was moderately high, with an overall score exceeding 70 points. Most schools scored 70–85 points (73.81%, 31/42), corresponding to moderate-to-good performance; few scored below 60 or above 90 points. This concentration suggests relatively balanced district development.

Table 1 presents the primary-indicator scores. Indicator 2 had the highest score rate (82.77%, 33.52/40.50) for public health emergency management and infectious disease prevention and control. Indicators 3 (80.37%, 28.13/35.00) and 4 (68.13%, 10.90/16.00) ranked second and third, respectively. Indicators 1 (64.58%, 16.79/26.00) and 5 (54.40%, 9.52/17.50) required further improvement. Public health resource support was the principal constraint on overall system development.

Overall, the sampled schools had a mean total score of 98.86/135.00 (score rate 73.23%), reflecting that the overall basic construction of the school public health system in the F area was relatively good.

Table 2 presents the secondary-indicator results. Indicator 2.2, monitoring and early warning, had the highest score rate (89.14%, 9.36/10.50) and a relatively small standard deviation, indicating consistently strong routine monitoring across schools: morning and afternoon health checks, registration of

TABLE 1. Primary-indicator scores for primary and secondary schools in Fengtai District.

Primary indicator	Maximum score, points (regular + bonus)	Minimum (points)	Maximum (points)	$\bar{x}\pm s$	Mean score rate (%)	Rank
1 Public health governance system	21.00 + 5.00	4.00	24.50	16.79±5.168	64.58	4
2 Public health emergency management and infectious diseaseprevention and control capabilities	40.50 + 0.00	26.50	38.00	33.52±3.346	82.77	1
3 Capacity for prevention and control of common diseases	24.00 + 11.00	14.50	33.00	28.13±3.716	80.37	2
4 Health education system	5.00 + 11.00	4.75	14.00	10.90±2.238	68.13	3
5 Public health resource support	9.50 + 8.00	4.50	13.00	9.52±1.893	54.40	5
Total points	100.00 + 35.00	63.95	117.50	98.86±11.487	73.23	

Note: Data are presented as mean ± standard deviation ($\bar{x}\pm s$).

TABLE 2. Secondary-indicator scores for primary and secondary schools in Fengtai District.

Secondary indicator	Maximum score, points	Minimum	Maximum	$\bar{x}\pm s$	Mean score rate (%)	Rank
1 Public health governance system						
1.1 Work system and mechanism	15.00	0.00	15.00	10.33±4.223	68.87	8
1.2 Healthy School	5.00	0.00	4.50	2.04±1.090	40.80	14
1.3 Cooperative education mechanism	6.00	2.50	6.00	4.42±0.942	73.67	7
2 Public health emergency management and infectious disease prevention and control capacity						
2.1 Emergency management	23.00	15.00	23.00	19.73±2.485	85.78	3
2.2 Monitoring and early warning	10.50	4.00	10.50	9.36±1.620	89.14	1
2.3 Routine prevention and control	7.00	3.50	6.50	4.44±0.445	63.43	11
3 Capacity for prevention and control of common diseases						
3.1 Monitoring of common diseases	13.00	7.50	13.00	11.20±1.190	86.15	2
3.2 Intervention for common diseases	9.50	4.00	9.00	7.23±1.055	76.11	6
3.3 Mental health services	12.50	3.00	12.00	9.70±2.164	77.60	5
4 Health education system						
4.1 Health education resources	7.00	1.75	7.00	4.71±1.570	67.29	10
4.2 Evaluation of health literacy	9.00	2.00	9.00	6.19±1.596	68.78	9
5 Public health resource support						
5.1 Development of school health rooms	6.00	1.00	5.50	3.69±1.018	61.50	12
5.2 Funding support for public health system development	3.00	0.00	1.50	0.36±0.647	12.00	15
5.3 Other infrastructure support	4.00	1.50	3.50	3.35±0.420	83.75	4
5.4 Technological support	4.50	0.00	4.50	2.13±1.164	47.33	13

Note: Data are presented as mean ± standard deviation ($\bar{x}\pm s$).

absences due to illness, verification of return-to-school certificates, and infectious disease early-warning systems. Indicator 3.1, monitoring of common diseases, ranked second (86.15%, 11.20/13.00), indicating strong collection and reporting of common disease information. Indicator 2.1, emergency management, ranked third (85.78%, 19.73/23.00), indicating that schools generally had emergency response plans, conducted drills, designated observation areas, and established infectious disease reporting procedures.

Indicator 5.2, funding support for public health system development, had the lowest score rate (12.00%, 0.36/3.00), indicating severe funding inadequacy or ineffective use of funds. Indicator 1.2, Healthy School development, an optional bonus indicator, ranked second lowest (40.80%, 2.04/5.00), suggesting that most schools remained at an early or

exploratory stage. Indicator 5.4, technological support, ranked third lowest (47.33%, 2.13/4.50), indicating limited use of artificial intelligence, big data, and related technologies in school public health and a need to strengthen digital capacity. Indicator 5.1, development of school health rooms, had a score rate of 61.50% (3.69/6.00), reflecting gaps in basic infrastructure, health room certification, and qualified health personnel. Indicator 2.3, routine prevention and control, had a score rate of 63.43% (4.44/7.00), the lowest within its primary dimension, indicating a need to strengthen implementation of these measures.

Common disease monitoring and public health emergency response were major strengths, whereas insufficient funding, limited Healthy School development, inadequate use of technology, weak health infrastructure, and poor implementation of routine prevention and control measures constrained overall system development.

Before clustering, we excluded 8 outlier schools (19.05%, 8/42) using the Z-score criterion of $|Z|>2$. The excluded schools represented multiple types and did not cluster within any single category, so their exclusion did not disproportionately affect any school type. The remaining 34 schools entered the K-means cluster analysis, which used the five primary indicators as clustering variables (Table 3 and Figure 1). One-way analysis of variance showed no significant differences among clusters for indicators 2 (P=0.935) and 4 (P=0.439). Indicators 1, 3, and 5 differed significantly among clusters (P<0.005), supporting the discriminant validity of the clustering solution.

The clustering solution identified three school types. Category 1 (9 schools; 26.47%, 9/34) was classified as comprehensively lagging: this type of school had two indicators at the lowest level, and one indicator at the

TABLE 3. Distribution of primary-indicator scores by school type in Fengtai District.

Indicator	Maximum score, points	Category 1, mean score (score rate, %)	Category 2, mean score (score rate, %)	Category 3, mean score (score rate, %)
Public health governance system	26.00	18.64 (71.69)	13.11 (50.42)	21.14 (81.31)
Public health emergency management and infectious disease prevention and control capabilities	40.50	34.22 (84.49)	34.09 (84.17)	34.50 (85.19)
Capacity for prevention and control of common diseases	35.00	26.44 (75.54)	30.00 (85.71)	30.29 (86.64)
Health education system	16.00	10.50 (65.63)	11.14 (69.63)	11.66 (72.88)
Public health resource support	17.50	8.39 (47.94)	9.95 (56.86)	10.75 (61.43)

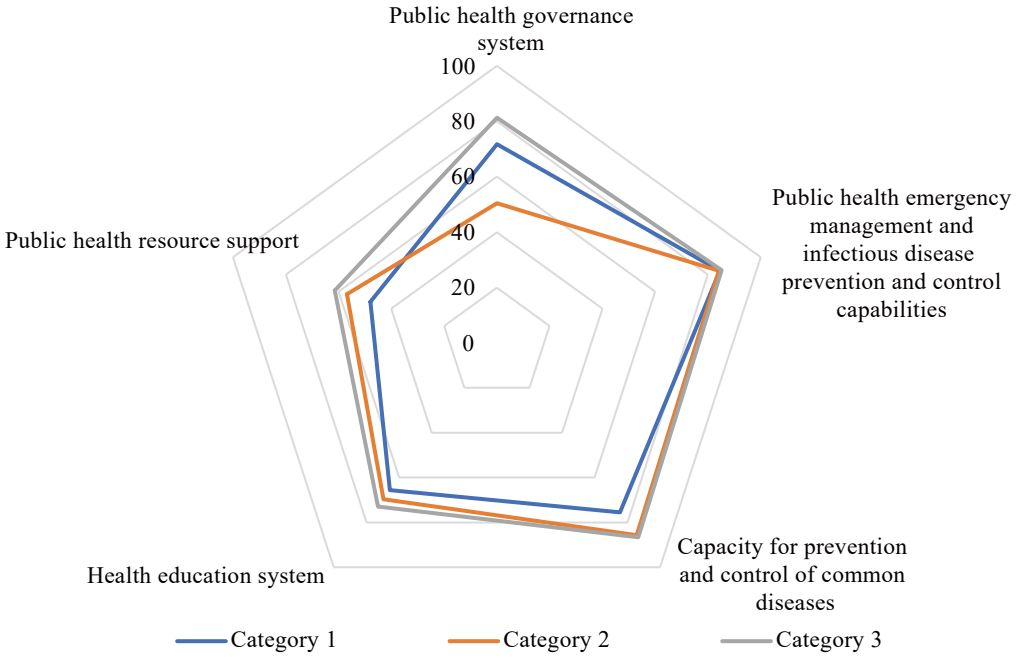


FIGURE 1. Radar chart of primary-indicator score rates for the three school types.
Note: Values are presented as percentages (%).

intermediate level (among the indicators where the clustering differences were significant). Category 2 (11 schools; 32.35%, 11/34) was classified as lagging in governance capacity: its governance score was substantially lower than those of the other two categories, whereas its common disease prevention and control capacity and resource support were relatively strong. Category 3 (14 schools; 41.18%, 14/34) was classified as comprehensively advantaged, with the highest scores across all indicators, indicating comparatively comprehensive capacity.

Removing the nondiscriminating indicators made differences in public health service capacity among the three school types more distinct. Category 3 showed the strongest and most balanced overall capacity. Category 2 performed well in common disease prevention and control and resource support, but its weak governance substantially constrained overall performance. Category 1 showed multiple deficiencies, particularly in common disease prevention and control and resource support; however, its governance score was not the lowest, suggesting that improvement should focus on translating its governance foundation into effective school health services. Overall improvement therefore requires stronger public health governance, more robust resource support, and enhanced capacity for common disease prevention and control.

DISCUSSION

Indicators 2 and 3 scored relatively high, possibly reflecting the institutionalization of epidemic prevention and control policies in recent years and continued prevention and control of common diseases policy implementation. By contrast, indicator 5 ranked fifth of the five primary indicators, and indicators 5.2 and 5.1 ranked 15/15 and 12/15 among the secondary indicators. These findings identify public health resource support as the most prominent weakness. Insufficient funding and substandard health rooms are the principal constraints.

Inadequate school health funding is common in China and internationally. Worldwide, nearly one-third of schools (31%) lack adequate drinking water and basic sanitation because of insufficient health funding and budget allocations, limiting protection of students' physical and mental health (*3*). In China, funding for health services in Tianjin primary and secondary schools rose in 2019–2021 but declined in 2021–2023, indicating a need for more stable funding (*4*). A survey of 17,205 primary and secondary schools in Guangdong Province found only 12.6% had health rooms larger than 40 m^2, 6.9% held medical institution licenses, and 39.1% employed full-time health personnel (*5*). These deficiencies in facilities and professional qualifications may reflect sustained underinvestment.

In October 2024, the National Disease Control Bureau issued the Standards for Health (Healthcare) Rooms in Primary and Secondary Schools (WS/T 10019-2024), which specifies requirements for facility design, personnel allocation, layout, infrastructure, basic equipment, and management systems (*6*). Implementing it requires sustained regional funding capacity. Education administrative departments should therefore work with health departments to incorporate health room development into school compliance management, define funding sources, and establish dedicated school public health budgets so that facilities and staffing meet national standards.

School public health systems varied substantially by type, underscoring the need for targeted guidance and tailored interventions. The cluster analysis supported this approach by classifying 34 schools into three types. The types differed significantly in governance, common disease prevention and control, and resource support (P<0.005). Capacity-building strategies should therefore address each school type's specific strengths and weaknesses.

Comprehensively advantaged schools can serve as demonstration sites and regional leaders. Education administrative departments should document their effective practices in governance, interdepartmental collaboration, and routine emergency management and convert them into replicable models. These schools should also support other schools and contribute to regional improvement. Schools lagging in governance capacity performed relatively well in common disease prevention and control and in emergency management. While maintaining these strengths, they should strengthen governance structures, coordination mechanisms, collaborative management, role definitions, and operational procedures. They should also improve resource support by standardizing health rooms and establishing dedicated budgets. Comprehensively lagging schools faced deficiencies in common disease prevention and control, and resource support; isolated interventions are therefore unlikely to reverse their overall disadvantage. Systematic assistance should first address essentials: compliant health room infrastructure, adequate funding, and qualified health

personnel. Subsequent efforts should strengthen common disease monitoring and intervention and build comprehensive capacity.

Beijing is promoting integrated Healthy School development across primary, secondary, and higher education institutions. The first cohort of 32 institutions was selected as national Healthy School development units. Targeted guidance should be incorporated into this initiative through school-type-specific standards and support plans.

This study has three limitations. First, the sample was limited to Fengtai District, Beijing; therefore, the findings should be generalized cautiously and are most appropriate as a regional reference. Second, the data derived primarily from self-administered questionnaires completed by school physicians or health teachers, and subjective judgment and self-reporting may have reduced assessment objectivity. Third, indicator weights determined using the Delphi method and analytic hierarchy process depended on expert judgment.

Experts with different backgrounds may assess indicator importance differently, potentially affecting weight allocation stability. Future studies should include larger and more geographically diverse samples, validate findings using multiple data sources, and explore weighting strategies that combine subjective and objective methods.

Conflicts of interest: No conflicts of interest.

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REFERENCES

1. Bartelink N, Van Assema P, Vennegoor G, Bessems K. Implementation of the health promoting school approach in Europe: a cross-sectional study among national representatives. J Sch Health 2024;94(10):975 – 84. https://doi.org/10.1111/josh.13499.
2. Hou XY, Gu M, Zhao JX, Yang J. Construction of evaluation indicators for the public health system in primary and secondary schools — Beijing, China, 2024–2025. China CDC Wkly 2026;8(1):15 – 21. https://doi.org/10.46234/ccdcw2026.004.
3. McGinnis SM, McKeon T, Desai R, Ejelonu A, Laskowski S, Murphy HM. A systematic review: costing and financing of water, sanitation, and hygiene (WASH) in schools. Int J Environ Res Public Health 2017;14(4):442. https://doi.org/10.3390/ijerph14040442.
4. Jiang JN, Liu ZH, Zhang XW, Song XL, Zhang YH, Dong ZQ, et al. Current status of regional school health work in Tianjin during 2019-2023. Chin J Sch Health 2024;45(5):620 – 5. https://doi.org/10.16835/j.cnki.1000-9817.2024163.
5. Jin ZG, Chen YC, Zhao Y, Zhang SX, Kakaer A, Tan KY, et al. Allocation of school health staff and clinics in primary and secondary schools in Guangdong Province. Chin J Sch Health 2024;45(12):1695 – 98,1703. https://doi.org/10.16835/j.cnki.1000-9817.2024372.
6. National Disease Control and Prevention Administration. WS/T 10019-2024 Regulation of clinical (healthcare) room in primary and middle schools. 2025. http://www.csres.com/detail/415689.html. (In Chinese).