Coverage of school health monitoring systems in China: a large national cross-sectional survey

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Summary

Background There is growing interest in the role that schools can play in promoting student health. The aim of this study was to describe the coverage of school health monitoring systems for infectious diseases, non-communicable diseases, and school physical environments in China, and to explore differences by geography, regional wealth, and school type.

Methods A cross-sectional study was performed using data from 2428 schools from 17 provinces in China in 2018. Data were collected using a questionnaire administered by the Ministry of Education through its monitoring system, and included infectious diseases (e.g., reporting system for student infectious diseases), non-communicable diseases (e.g., regular student health examinations), and school physical environments (e.g., monitoring of classroom light, microclimate and drinking water).

Findings Overall, the coverage rate of full school health monitoring systems was 16·6%. The coverage rates of school health monitoring systems for infectious diseases, non-communicable diseases, and school physical environments were 71·2%, 68·5%, and 24·9%, respectively. Coverage was higher in schools from urban rather than rural areas, in schools from areas with greater wealth, and in senior secondary schools rather than junior secondary and primary schools.

Interpretation Systems for monitoring infectious diseases in school students have been widely implemented in China. Systems for monitoring non-communicable diseases and physical environments need to be strengthened. Beyond greater attention in poorer and rural areas, increased investment in more comprehensive approaches to school health is indicated.

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摘要

背景: 学校在促进学生健康方面可以发挥的作用越来越引起关注。本研究旨在描述传染病，非传染性疾病和学校物理环境三方面的学校卫生监测制度在中国的覆盖情况，并探讨其在不同区域，地区经济发展水平和学校类型上的差异。

方法: 数据来源于2018年在中国17个省 (市, 区)2428所学校进行的一项横断面研究。使用中国教育部指导下设计的调查问卷，通过其在17省的监测站体系，收集了学校卫生监测制度的覆盖数据，包括传染病 (如学生传染病报告制度)，非传染性疾病 (如学生定期体检)和学校物理环境 (如教室采光照明，教室微小气候和生活饮用水的监测)三方面。

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结果: 总体上, 全面的学校卫生监测制度覆盖率仅为16.6%。针对传染病, 非传染性疾病和学校物理环境的学校卫生监测制度的覆盖率分别为71.2%, 68.5%和24.9%。针对传染病, 非传染性疾病和学校物理环境方面的制度覆盖率表现较为一致, 均呈现城市高于乡村, 经济发达地区高于欠发达地区, 高中高于初中和小学的情况。

解释: 在中国, 针对在校学生的传染病监测制度已被广泛实施.针对非传染性疾病和物理环境的监测制度尚需要得到强化。除了对贫困地区和乡村地区给予更多关注外, 还需要在更全面的学校卫生措施上增加投资。

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Research in context

Evidence before this study

There is growing awareness of the role of schools as sites for enhancing students' health and wellbeing as well as educational achievements.

For the first time, global standards for health-promoting schools have been recently developed by the World Health Organization (WHO) and the United Nations Educational Scientific and Cultural Organization (UNESCO), which include a standard on school health services, and attention to how schools' physical environments can promote health and wellbeing.

In China, the priorities for school-based preventive health services have expanded to strengthen the early detection and prevention of both infectious and non-communicable diseases, monitor the health status of students and improve student learning and living environments.

Added value of this study

We investigated the coverage of school health monitoring systems for infectious diseases, non-communicable diseases, and school physical environments, and explored differences between regions, by urban and rural areas, and by school type, across 17 Chinese provinces.

While schools in China had widely implemented a range of approaches to preventing and controlling infectious diseases, the coverage and scope of monitoring within school health systems for non-communicable diseases and school physical environments was much lower and much less comprehensive.

Overall, the coverage of school health services monitoring was higher in urban areas, in wealthier areas, and in senior secondary schools.

Implications of all the available evidence

Ensuring a better orientation of China's school health monitoring system to the rapidly-changing health issues of its children and adolescents should be a priority.

Immediate investment in rural and lower socio-economic status areas to improve their school health monitoring system is necessary.

Introduction

Universal health coverage (UHC), endorsed by the World Health Assembly in 2005, is now a core tenet of the United Nations (UN) Sustainable Development Goals (SDG) 3.[1] UHC means that all individuals and communities receive the health services they need without suffering financial hardship. It includes the full spectrum of essential, quality health services, from health promotion to prevention, treatment, rehabilitation, and palliative care across the life course.[2] Older children and adolescents are commonly viewed as healthy and perhaps for that reason have been relatively neglected in health service delivery.[3,4] However, more than 1·2 million children and adolescents aged 10-19 years old died worldwide in 2015, largely from preventable causes, with much less improvement over recent decades than in younger children.[5,6] There is also growing understanding that an investment focus on the first 1000 days of human development is necessary but insufficient, with provision of support to guide health and development across the next 7000 days also required for children and adolescents to achieve their full adult potential. This is particularly around three phases: the middle childhood growth and consolidation phase (5–9 years), the adolescent growth spurt (10–14 years), and the adolescent phase of growth and consolidation (15–19 years). [7]

Children and adolescents spend a large proportion of their waking hours at school and there is growing awareness of the role of schools as sites for enhancing health and wellbeing as well as educational achievements.[8] In 1995, the World Health Organization (WHO) launched its Global School Health Initiative with the purpose of encouraging the adoption of the health-promoting school approach worldwide. In 2021, the first global standards for health-promoting schools were developed by WHO and the United Nations Educational Scientific and Cultural Organization (UNESCO), which span eight domains: government policies and resources, school policies and resources, school governance and leadership, school and community partnerships, school curriculum, school social–emotional environment, school health services, and attention to how schools' physical environments can promote health and wellbeing.[8] These approaches extend beyond

treatment and management of health conditions, to address prevention and health promotion.[9,10] While inter-sectoral collaboration is required to make every school a health-promoting school, inadequate coordination between health and education sectors has been frequently reported.[8,11] In China, inter-sectoral collaboration around school health is largely concentrated around health services and the physical environment of schools.[12,13]

Policy that supports monitoring and rapid responses to infectious diseases has been a health priority in China since the outbreak of severe acute respiratory syndrome (SARS) in 2003 and the sudden emergence of a novel corona virus in 2019.[14-17] Over this time, China has also developed approaches to preventing infectious diseases through school health services[18,19] and policies and regulations around controlling infectious diseases are well established in primary and secondary schools throughout the country.[20] Yet China's rapid epidemiological transition has resulted in a health profile in children and adolescents that now extends beyond infectious diseases to include a set of similarly serious threats including chronic diseases such as obesity and mental health disorders, as well as risks for adult non-communicable diseases, such as hypertension.[11] For example, data from the Chinese National Survey on Students' Constitution and Health (CNSSCH) showed that the prevalence of overweight among Chinese children and adolescents aged 7 to 17 years increased from 4·3% in 1995 to 18·4% in 2014.[21] A systematic review also showed that the prevalence estimates of depressive symptoms among Chinese children and adolescents increased from 18·4% before 2000 to 26·3% after 2016.[22] Accordingly, the priorities for school-based preventive health services have expanded to strengthen the early detection and prevention of both infectious and non-communicable diseases, monitor the health status of students and improve student learning and living environments.[23] However, little is known about the current coverage of these services or the quality of monitoring across the country, which is essential for understanding their effectiveness. The current study aimed to investigate the coverage of school health monitoring systems for infectious diseases, non-communicable diseases, and school physical environments, and to explore differences between regions, by urban-rural areas and by school type, across 17 Chinese provinces. Our overarching goal was to identify how well school health services are reorienting their focus to both addressing the continuing challenge of infectious diseases while also tackling new problems related to chronic diseases and environmental health risks.

Methods

Participants and Data Collection

This cross-sectional study covered 28 monitoring stations (centres which are authorized by the Ministry of Education to collect health-related information of primary and secondary school students in their areas of responsibility) in 17 provinces (autonomous regions and municipalities) including Beijing, Shanghai, Jiangsu, Fujian, Guangdong, Inner Mongolia, Hubei, Chongqing, Liaoning, Hunan, Henan, Xinjiang, Shanxi, Tibet, Heilongjiang, Yunnan and Gansu (**Supplementary Figure 1**). Considering the sample representativeness, schools were selected from all primary and secondary schools within the administrative area of the 28 monitoring stations using stratified sampling by urban-rural location to select 50 schools for each stratum. When school numbers in a stratum were less than 50, all schools were included. When the number of schools within a monitoring station was less than 100, all schools were included. Judgment sampling was used by 12 monitoring stations with a large number of schools under their management to promote sampling diversity. In the remainder of monitoring stations, virtually all schools (70% to 100%) covered by their services were sampled. In total, 2428 schools were included.

Data were collected between May and June 2018. Trained professionals from each monitoring station completed a questionnaire that involved direct observation, review of school documents, checking school records, and interviewing relevant school officials. Questionnaire data were double entered using EpiData 3·0 software.

Survey

Since 2002, the Ministry of Education of China has gradually set up monitoring stations throughout the country to monitor the health status of primary and secondary school students and to investigate school health issues of concern. This survey was conducted nationally in all school types (primary and secondary, regular and boarding schools) in 2018 through the network of these monitoring stations. All data were collected using the *Monitoring Questionnaire for School Teaching and Living Facilities Health Status* administered in 2018 by the Ministry of Education of China. This included questions about the coverage of different aspects of school health monitoring. Relevant questions have been grouped into infectious diseases, non-communicable diseases, and school physical environments, as shown in **Supplementary Figure 2**.

Data Analysis

After excluding 110 schools due to missing data or inconsistencies, a total of 2318 schools were included. The missing rate was 4.1%; there was significantly more missing data in schools from urban or lower socio-economic status (SES) areas (**Supplementary Table 1**).

Urban and rural areas were differentiated according to the standards of the National Bureau of Statistics of

China.[24] The mean 2018 Gross Domestic Product (GDP) per capita of each surveyed province (autonomous regions and municipalities) was used to differentiate higher SES areas (an average GDP per capita US $≥9773, the national GDP per capita in 2018) from lower SES areas (GDP per capita US$<9773). China has seven school types, which were divided into three groups in the analysis: primary schools included primary schools, 9-year schools and 12-year schools; junior secondary schools included junior secondary schools and combined secondary schools; senior secondary schools included senior secondary schools and vocational high schools. Using location (urban, rural), SES areas, and school types as grouping variables, health monitoring indicators within each subgroup are presented as percentages. Differences in the proportion of health monitoring indicators between subgroups were analysed with logistic regression models, without adjusting for any other variables and adjusting for other subgroup variables and boarding variables (e.g., for urban-rural differences, adjusting for regional SES, boarding and school types). Adjusted odd ratio (OR) with 95% confidence interval (CI) and p-value from multiple logistic regression were obtained. In addition, population attributable risks (PARs) with 95% CI were calculated using rural and lower SES areas as the reference group to indicate the effect sizes for the significant difference in the coverage of school health monitoring systems. Models were conducted based on the logistic regression model using the regpar module for Stata adjusting for school type and boarding variables. The geographical distribution of the coverage of health services at subnational levels are shown using maps. All p-values <0·05 were considered statistically significant. All analyses were performed using SPSS 20·0, Stata 15·0, and ArcMap 10·5.

Role of the funding source

The funders had no role in study design, data collection, data analysis, data interpretation, or writing of the manuscript. The corresponding authors had access to all the data in the study and had final responsibility for the decision to submit for publication.

Ethics statements

This study investigated the implementation of school health monitoring systems and did not collect specific personnel information, without need for ethical review.

Results

General information

The final sample had a similar proportion of schools from urban and rural areas (50·4% vs. 49·6%), and from upper and lower SES areas (52·9% vs. 47·1%). Primary schools, junior secondary schools, and senior secondary schools accounted for 62.3%, 30.6% and 7.1% of the total schools, respectively. The proportion of boarding schools in rural areas was higher than in urban areas (44·3% vs. 23·4%), and was also higher in lower SES areas than in higher SES areas (41·3% vs. 27·0%) (**Supplementary Table 2**).

Coverage of school monitoring systems for infectious diseases

The proportion of schools with all infectious disease monitoring systems was 71·2%. Overall, infectious disease monitoring systems were established in more than 90·0% of schools. The exception was in the use of student enrolment inoculation cards, which were adopted by only 76·4% of schools. The use of enrolment inoculation cards requiring an inspection system varied by school type, being highest in primary schools (96·4%), followed by junior secondary schools (47·3%) and senior secondary schools (25·6%). There were few differences in the coverage of these systems between urban and rural areas or by SES. Except for the use of student enrolment inoculation cards, there were also few differences in the coverage of other systems by school type (**Table 1**, **2**). Similarly, there were few provincial differences in the coverage of infectious disease monitoring, with the exception of student enrolment inoculation cards (**Figure 1**).

Coverage of school monitoring systems for non-communicable diseases

The proportion of schools with all non-communicable disease monitoring systems was 68·5%. Regular health examinations were evident in more than 75·0% of schools. The proportion of schools in urban areas with a regular health examination system was higher than in schools from rural areas (93·6% vs 84·3%, $p < 0·05$). Similarly, the proportion of schools with regular health examinations was greater in areas of higher rather than lower SES (92·9% vs 84·6%, $p < 0·05$). Urban schools also performed better than rural schools in having a system to provide feedback to parents about the results of student health examination (82·2% vs 69·9%, $p < 0·05$; PAR: 4·89% [95%CI, 3·09% to 6·69%], $p < 0·05$), and schools in higher SES areas also performed better than those in lower SES areas (84·8% vs 66·3%, $p < 0·05$; PAR: 9·04% [95%CI, 7·20% to 10·87%], $p < 0·05$). Senior secondary schools performed better than junior secondary and primary schools in undertaking regular health examinations (94·5% vs 90·0% vs 87·9%, $p < 0·05$) and maintenance of student health examination records (95·7% vs 90·6% vs 89·1%, $p < 0·05$). Most schools (82·6%) conducted annual student health examinations. Typically, these consist of anthropometric measurements, general medical examination (such as blood pressure measurement, heart auscultation),

Items	Total	Urban-Rural				SES areas			
		Urban	Rural	OR (95% CI)[a]	P-value[c]	Higher	Lower	OR (95% CI)[b]	P-value[c]
Infectious diseases									
Student enrolment inoculation card (or certificate) inspection system	76·4	75·0	77·7	0·62 (0·50-0·77)	<0·0001 (0·12)	80·4	71·8	1·35 (1·10-1·66)	0·0044 (<0·0001)
Daily morning student health check system	96·3	96·7	95·9	1·11 (0·70-1·76)	0·65 (0·34)	98·3	94·0	3·48 (2·10-5·76)	<0·0001 (<0·0001)
Registration system for student absence due to illness	97·8	98·9	96·8	3·02 (1·56-5·83)	0·0010 (0·00087)	98·3	97·3	1·68 (0·94-3·01)	0·079 (0·12)
Monitoring system for student absence due to illness	92·6	94·6	90·5	1·65 (1·18-2·32)	0·0038 (<0·0001)	94·9	90·0	2·00 (1·44-2·78)	<0·0001 (<0·0001)
Reporting system for student infectious diseases	97·6	98·5	96·7	2·11 (1·15-3·85)	0·016 (0·0044)	98·7	96·4	2·66 (1·46-4·83)	0·0013 (0·00059)
Non-communicable diseases									
Regular student health examinations	89·0	93·6	84·3	2·15 (1·58-2·90)	<0·0001 (<0·0001)	92·9	84·6	2·24 (1·69-2·98)	<0·0001 (<0·0001)
Maintenance of student health examination records	90·0	93·8	86·3	1·82 (1·34-2·49)	<0·0001 (<0·0001)	92·2	86·8	1·81 (1·35-2·41)	<0·0001 (<0·0001)
Registration system for students with abnormal health examination results	80·9	85·9	75·8	2·19 (1·74-2·75)	<0·0001 (<0·0001)	88·9	71·9	3·52 (2·80-4·43)	<0·0001 (<0·0001)
Feedback of student health examination results to parents	76·1	82·2	69·9	1·76 (1·43-2·17)	<0·0001 (<0·0001)	84·8	66·3	2·80 (2·28-3·44)	<0·0001 (<0·0001)
Frequency of health examinations									
Less than once a year	10·7	6·4	14·9	0·48 (0·36-0·66)	<0·0001 (<0·0001)	6·8	14·9	0·44 (0·33-0·59)	<0·0001 (<0·0001)
Once a year	82·6	87·5	77·7	1·71 (1·35-2·16)	<0·0001 (<0·0001)	85·2	79·7	1·41 (1·13-1·77)	0·0024 (<0·0001)
Twice a year	6·7	6·1	7·4	0·85 (0·60-1·19)	0·35 (0·21)	7·9	5·4	1·51 (1·08-2·12)	0·017 (0·017)

***Table 1*: Coverage of school monitoring systems for infectious diseases and non-communicable diseases in different areas (%).**

Note

[a] Rural area as the reference group, adjusted for school types, boarding and regional SES.

[b] Lower SES area as the reference group, adjusted for school types, boarding and urban-rural areas.

[c] The raw p-values (without adjusting for any confounding variables) are shown in parentheses.

Items	Total	Primary schools[a]		Junior secondary schools[a]			Senior secondary schools[a]		
		Rate (%)	Reference	Rate (%)	OR (95% CI)[b]	P-value [c]	Rate (%)	OR (95% CI)[b]	P-value[c]
Infectious diseases									
Student enrolment inoculation card (or certificate) inspection system	76·4	96·4	1·00	47·3	0·03 (0·02-0·04)	<0·0001 (<0·0001)	25·6	0·01 (0·01-0·02)	<0·0001 (<0·0001)
Daily morning student health check system	96·3	97·4	1·00	93·9	0·43 (0·26-0·70)	0·00070 (0·00013)	97·0	0·78 (0·30-2·46)	0·64 (0·75)
Registration system for student absence due to illness	97·8	97·6	1·00	98·0	1·06 (0·54-2·18)	0·87 (0·57)	98·8	1·15 (0·30-7·56)	0·86 (0·36)
Monitoring system for student absence due to illness	92·6	92·7	1·00	92·1	1·00 (0·69-1·46)	1·0 (0·61)	93·3	1·03 (0·52-2·19)	0·94 (0·79)
Reporting system for student infectious diseases	97·6	97·7	1·00	97·0	0·92 (0·50-1·72)	0·79 (0·35)	99·4	3·89 (0·75-71·63)	0·20 (0·19)
Non-communicable diseases									
Regular student health examinations	89·0	87·9	1·00	90·0	1·77 (1·28-2·48)	0·00071 (0·15)	94·5	3·09 (1·55-6·89)	0·0027 (0·014)
Maintenance of student health examination records	90·0	89·1	1·00	90·6	1·76 (1·26-2·49)	0·0011 (0·31)	95·7	4·14 (1·95-10·25)	0·00067 (0·011)
Registration system for students with abnormal health examination results	80·9	79·1	1·00	83·1	1·15 (0·89-1·5)	0·29 (0·028)	87·2	1·11 (0·66-1·92)	0·71 (0·015)
Feedback of student health examination results to parents	76·1	75·4	1·00	77·2	1·40 (1·10-1·80)	0·0067 (0·37)	77·4	1·30 (0·85-2·04)	0·24 (0·57)
Frequency of health examinations									
Less than once a year	10·7	12·1	1·00	9·0	0·49 (0·35-0·69)	<0·0001 (0·032)	4·9	0·27 (0·12-0·56)	0·001 (0·0077)
Once a year	82·6	81·4	1·00	83·7	1·49 (1·14-1·96)	0·0035 (0·19)	89·0	2·32 (1·37-4·13)	0·0028 (0·017)
Twice a year	6·7	6·5	1·00	7·3	1·17 (0·79-1·71)	0·44 (0·48)	6·1	1·00 (0·45-2·03)	1·00 (0·84)

***Table 2*: Coverage of school monitoring systems for infectious diseases and non-communicable diseases in different school types (%).**

Note

[a] Primary schools include primary schools, 9-year schools and 12-year schools; Junior secondary schools include junior secondary schools and combined secondary schools; Senior secondary schools include senior secondary schools and vocational high schools.

[b] Adjusted for urban-rural areas, boarding and regional SES.

[c] The raw p-values (without adjusting for any confounding variables) are shown in parentheses.

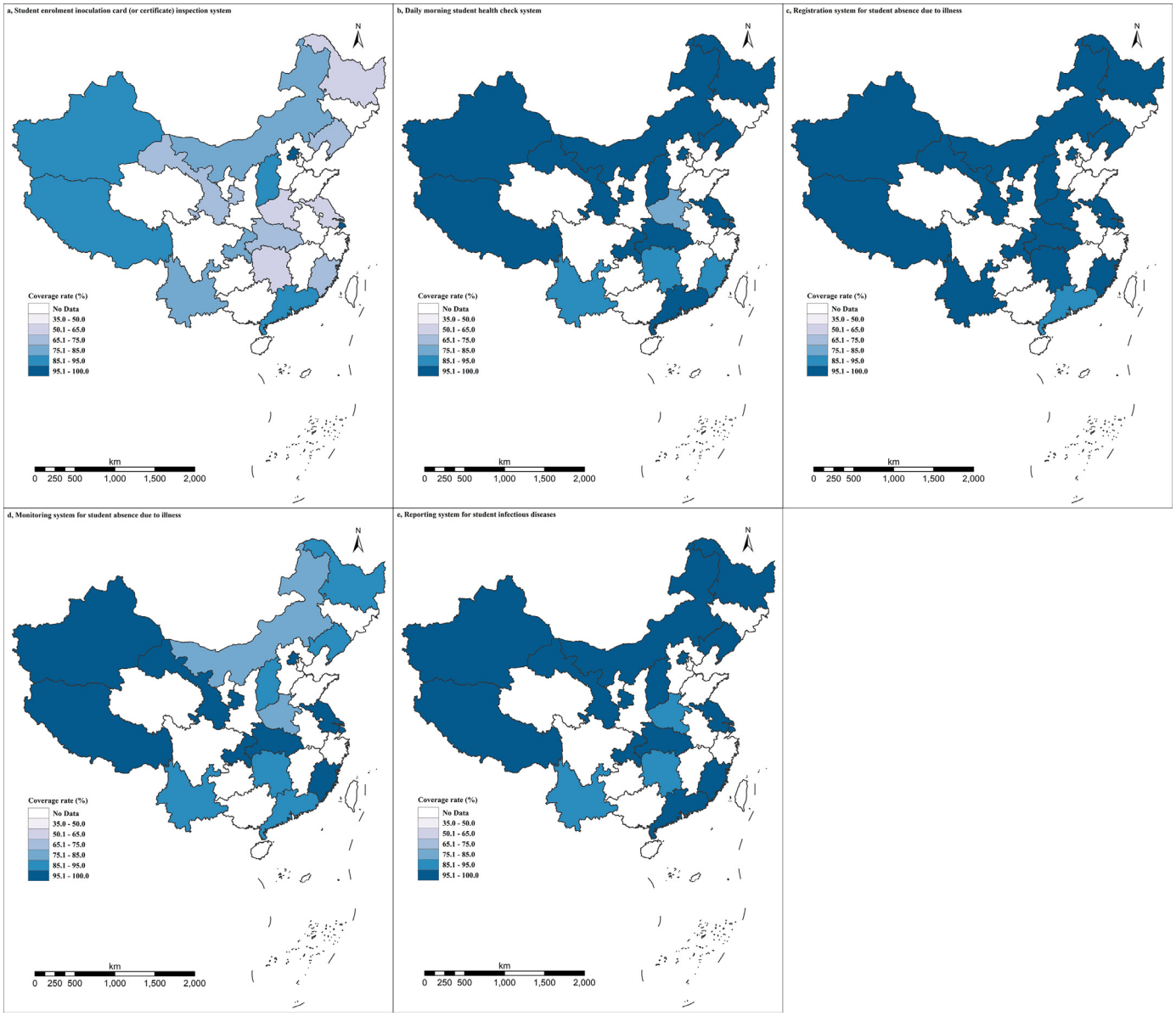

Figure 1. Coverage of school monitoring systems for infectious diseases, by province.

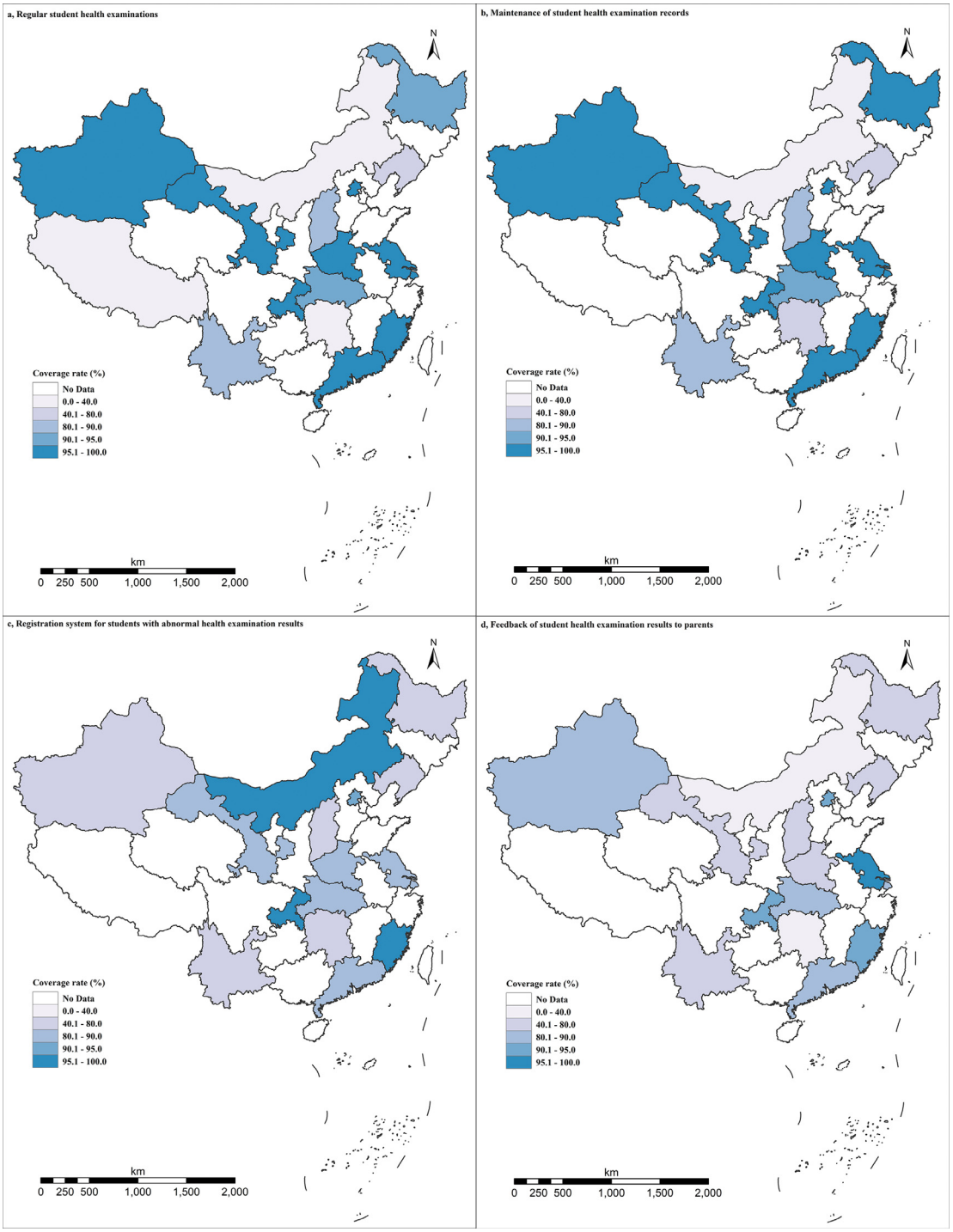

Figure 2. Coverage of school monitoring systems for non-communicable diseases, by province.

ophthalmic examination, oral examination, and so on. Annual school health examinations were more commonly undertaken in urban schools than rural schools (87·5% vs 77·7%, p < 0·05), in areas of higher rather than lower SES (85·2% vs 79·7%, p < 0·05), and in senior secondary schools than junior secondary and primary schools (89·0% vs 83·7% vs 81·4%, p < 0·05). There was a two-fold difference in the proportion of schools providing less than annual student health examinations in urban versus rural areas (6·4% vs

14·9%, p < 0·05), and in higher versus lower SES areas (6·8% vs 14·9%, p < 0·05) (Table 1, 2). The provincial distribution of coverage of a regular health examination system and maintenance of health examination records of students was similar, with coverage rates of more than 95% in three-quarters of developed provinces. However, only four provinces (Jiangsu, Beijing, Chongqing and Fujian) had coverage rates greater than 90% for the presence of a feedback system of student health examination results to parents (Figure 2).

Coverage of school monitoring systems for school physical environments

In less than 70% of schools was there evidence of implementation of the components of physical environment monitoring, except for monitoring school canteen hygiene, which was evident in 92·1% of schools. A quarter (24·9%) of schools had implemented all six environmental health monitoring components (classroom light, appropriate sizes of desks and chairs, health and safety of blackboards, classroom microclimates, drinking water quality, and school canteen hygiene). The weakest aspect of implementation was around the monitoring of classroom microclimates (temperature, relative humidity, CO_2 levels), which was evident in only 39·3% of schools. Coverage of environmental components varied greatly between urban and rural areas and by school SES. For example, the proportion of urban schools with evidence of health and safety monitoring of blackboards (checks of lighting and of blackboard colour to ensure that writing is legible) was far higher than in urban than rural schools (65·9% *vs* 44·8%, p < 0·05; PAR: 8·42% [95%CI, 6·85% to 11·01%], p < 0·05), as was the proportion of schools that monitored the classroom microclimates, which was more than twice as common in areas of higher SES than lower SES (53·3% *vs* 23·5%, p <0·05; PAR: 15·71% [95%CI, 13·69% to 17·74%], p < 0·05). All four components of monitoring for classroom physical environments showed higher coverage in senior secondary schools than in junior secondary and primary schools (Table 3, 4). The provincial coverage of the monitoring of classroom light, of the appropriate size of desks and chairs, and of the health and safety monitoring of blackboards were similar. Coverage of light monitoring was more than 60% in all developed provinces except inner Mongolia, but only two developing provinces (Heilongjiang and Shanxi) reached this level. Coverage rates of classroom microclimate monitoring were more than 60% in only three developed provinces (Beijing, Jiangsu and Shanghai). Coverage of monitoring of school canteen hygiene was over 95% in Shanghai, but was less than 50% in many developing provinces, such as Gansu (Figure 3).

Items	Total	Urban-Rural				SES areas		
		Urban	Rural	OR (95% CI)[a]	P-value[c]	Higher	Lower	OR (95% CI)[b]	P-value[c]
Monitoring of classroom light	62·8	72·9	52·5	2·40 (1·99-2·90)	<0·0001 (<0·0001)	75·9	48·1	3·51 (2·92-4·23)	<0·0001 (<0·0001)
Monitoring of appropriate sizes of desks and chairs	59·5	68·8	50·1	2·10 (1·75-2·53)	<0·0001 (<0·0001)	72·3	45·1	3·18 (2·65-3·80)	<0·0001 (<0·0001)
Health and safety monitoring of blackboards	55·4	65·9	44·8	2·32 (1·94-2·78)	<0·0001 (<0·0001)	67·2	42·2	2·85 (2·39-3·40)	<0·0001 (<0·0001)
Monitoring of classroom microclimate	39·3	47·8	30·7	2·15 (1·79-2·60)	<0·0001 (<0·0001)	53·3	23·5	3·89 (3·23-4·68)	<0·0001 (<0·0001)
Monitoring of drinking water quality	69·5	71·6	67·3	1·35 (1·12-1·63)	0·0017 (0·026)	77·4	60·5	2·45 (2·03-2·95)	<0·0001 (<0·0001)
Monitoring of school canteen hygiene[d]	92·1	92·8	91·5	1·10 (0·75-1·63)	0·63 (0·33)	93·2	90·5	1·39 (0·94-2·04)	0·095 (0·053)

Table 3: **Coverage of school monitoring systems for school physical environments in different areas (%).**

Note:

[a] Rural area as the reference group, adjusted for school types, boarding and regional SES.

[b] Lower SES area as the reference group, adjusted for school types, boarding and urban-rural areas.

[c] The raw p-values (without adjusting for any confounding variables) are shown in parentheses.

[d] Among schools with canteens.

Items	Total	Primary schools[a]		Junior secondary schools[a]			Senior secondary schools[a]		
		Rate (%)	Reference	Rate (%)	OR (95% CI)[b]	P-value[c]	Rate (%)	OR (95% CI)[b]	P-value[c]
Monitoring of classroom light	62·8	61·7	1·00	62·3	1·34 (1·07-1·67)	0·011 (0·80)	75·0	2·27 (1·50-3·50)	0·00015 (0·00096)
Monitoring of appropriate sizes of desks and chairs	59·5	59·0	1·00	58·0	1·27 (1·02-1·58)	0·030 (0·67)	70·1	2·14 (1·43-3·23)	0·00023 (0·0062)
Health and safety monitoring of blackboards	55·4	54·5	1·00	55·2	1·32 (1·07-1·64)	0·011 (0·76)	64·6	1·84 (1·25-2·74)	0·0022 (0·014)
Monitoring of classroom microclimate	39·3	37·3	1·00	41·1	1·40 (1·13-1·74)	0·0025 (0·083)	49·4	1·77 (1·20-2·61)	0·0038 (0·0027)
Monitoring of drinking water quality	69·5	67·0	1·00	72·4	1·13 (0·91-1·41)	0·27 (0·012)	78·0	1·23 (0·81-1·91)	0·34 (0·0045)
Monitoring of school canteen hygiene[d]	92·1	92·3	1·00	91·3	0·92 (0·60-1·41)	0·69 (0·48)	93·5	1·24 (0·60-2·78)	0·59 (0·61)

***Table 4:* Coverage of school monitoring systems for school physical environments in different school types (%).**

Note:
[a] Primary schools include primary schools, 9-year schools and 12-year schools; Junior secondary schools include junior secondary schools and combined secondary schools; Senior secondary schools include senior secondary schools and vocational high schools.
[b] Adjusted for urban-rural areas, boarding and regional SES.
[c] The raw p-values (without adjusting for any confounding variables) are shown in parentheses.
[d] Among schools with canteens.

Discussion

In this study of school health systems in 2318 schools in China, evidence from a Ministry of Education survey suggests that while monitoring systems for infectious diseases were widely implemented, the coverage of monitoring for non-communicable diseases was lower than for infectious diseases, and lower again for monitoring school physical environments. Generally, there was higher coverage of health monitoring in schools from urban areas rather than rural areas, in schools from higher SES areas, and in senior secondary schools, with significant provincial differences.

Since the SARS outbreak in 2003, the Chinese government has invested heavily in infectious disease control and prevention, with demonstrated improvements in disease surveillance.[25] This may explain why we found few differences in the coverage of infectious disease prevention and monitoring systems between urban and rural locations, regional SES groups, and primary and secondary schools, which is consistent with the widespread implementation of school-based monitoring systems around infectious diseases. Among the components of infectious disease monitoring in schools, the one exception to high coverage was around a system to review student enrolment inoculation cards (a certificate inspection system) which was evident in only 76·4% of schools, well lower than for other components. However, primary schools had over double the coverage than in senior secondary schools (96·4% vs 47·3%). According to China's immunization guidelines, children should be vaccinated with all national immunization programme (NIP) vaccines before the age of seven.[26] Schools are required to check the vaccination certificates of students when they enter the school and students with incomplete vaccination status are asked to rectify this and re-represent their certificates for inspection. Research based on the National Immunization Programme Information System (NIPIS) showed that the reported immunization coverage rates for 22 doses of NIP vaccines for children were all more than 98% across China in 2015.[27] Because most students have completed the immunization programme before they enter primary schools, the inoculation card inspection is no longer considered a major element of preventing infectious diseases beyond primary schools. This might change were Human Papilloma Virus vaccination to become part of the NIP. At present, some areas in China have tried to incorporate HPV vaccine into the immunization programme.[28]

Compared with school health monitoring systems for infectious diseases, coverage for non-communicable diseases was lower, with greater differences evident between urban-rural locations as well as by school SES. While the health burden in Chinese young people has rapidly shifted towards non-communicable diseases,[29] this lack of monitoring suggests a lag in the establishment and implementation of relevant nationwide

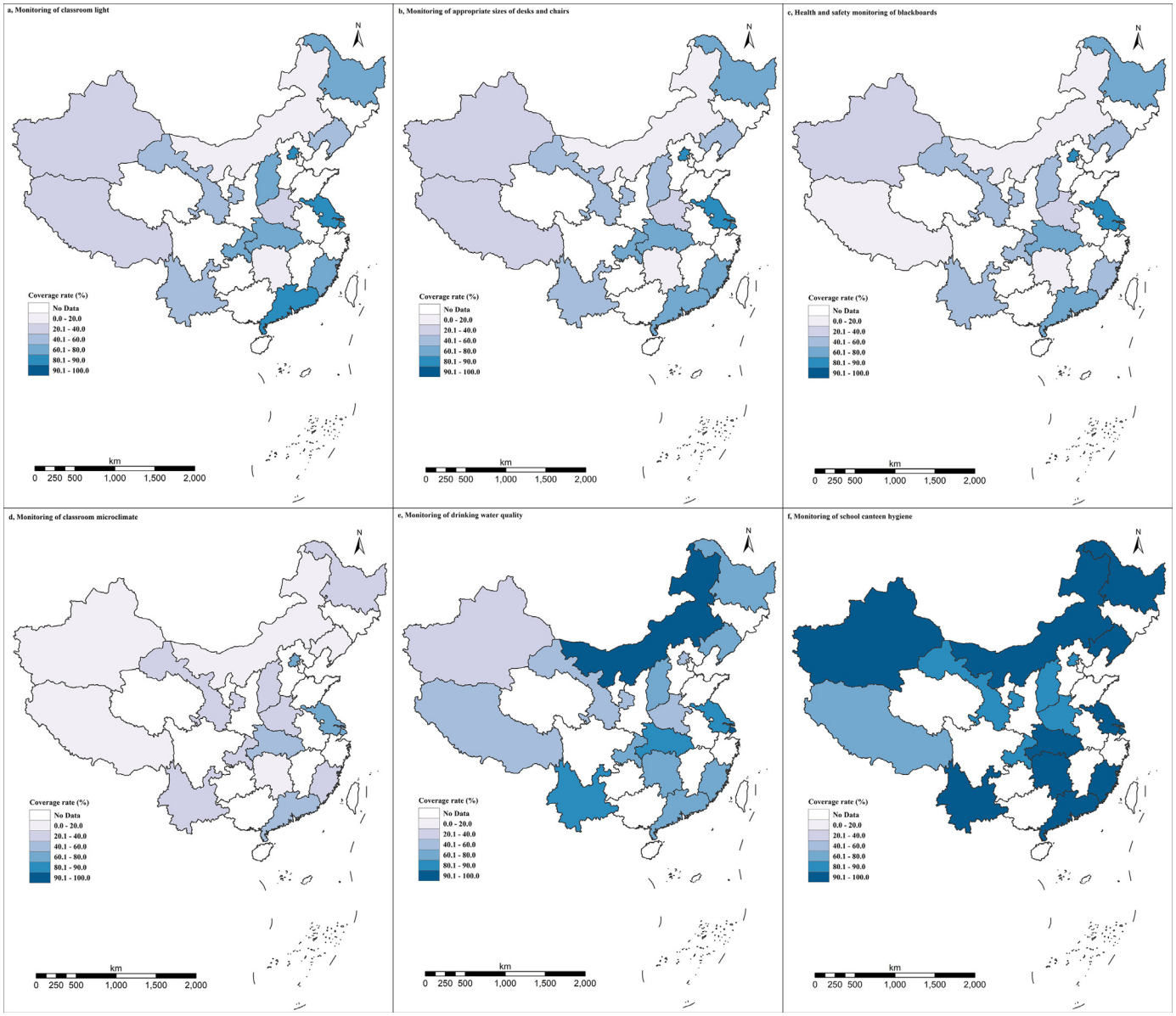

Figure 3. Coverage of school monitoring systems for school physical environments, by province.

systems and monitoring. In our survey, the monitoring for non-communicable diseases mainly focused on student health examinations, but relevant monitoring systems for non-communicable diseases in schools would ideally include evidence of school policy (e.g., that supports students being able to access medication while at school), school curriculum (e.g., around socio-emotional learning), teacher professional development (e.g., around health-promoting schools) and access to school-based health services. In China, the relatively high rate of boarding schools suggests this is particularly pertinent, as school health services will be much more significant in boarding schools given the absence of parents. Around non-communicable disease monitoring, the greatest gap was for a feedback system to parents of the results of student health examination, which suggests that more work is required to promote partnerships between schools and families around student health, consistent with health-promoting schools. Schools in China are required to conduct a regular health examination for students every year.[12] We found that more than one in ten schools did not meet this requirement; there was poorer performance among schools from rural areas and lower SES areas where the proportion not meeting the requirement was closer to one in seven. Student health examinations require professional medical personnel, standard-compliant equipment and facilities, links to referral services and government financial support.[12] It is not certain which factors are most contributing to the relatively poorer performance in some regions. This is important as while little is known about the overall benefits of these health examinations in China, any benefits would be anticipated to be greater in more disadvantaged regions due to the combination of greater health needs and less access to quality health services. We also found that annual school health examinations were more commonly undertaken in senior secondary schools than junior secondary and primary schools. Considering that many non-communicable diseases are influenced by lifestyle and daily behaviours, early detection has great significance for early intervention to effectively prevent and control the progression of non-communicable diseases.[30,31]

Within school health systems, monitoring of physical environments was less common than monitoring of infectious diseases and non-communicable diseases. There were also much more pronounced differences by region (urban-rural), SES and province. In fact, classroom environments, including the intensity of lighting, is linked to risks for myopia,[32] a highly prevalent health issue in Chinese children and adolescents. In August 2018, a comprehensive national children's myopia management plan was jointly issued by the eight central government bodies including the Ministry of Education.[33] Beyond the quality of lighting, there is also evidence that poor indoor environmental quality (e.g., poor ventilation or excess moisture) can adversely affect the health and academic performance of school-children,[34,35] which warrants further prominence in the context of the COVID-19 pandemic, as well as climate change. However, among the six domains of environmental health monitoring, the coverage of classroom microclimate monitoring was lowest (less than 40%), and the proportion in areas of lower SES was less than half than in wealthier areas. Investments are needed to reduce these regional disparities. We also found that monitoring of physical environment was better undertaken in senior secondary schools, rather than primary schools. The school physical environment supports the development of social—emotional environments that promote learning and student well-being,[10] which should also receive adequate attention from an earlier stage of schooling. Generally, the shift in health profiles in Chinese students towards non-communicable diseases, including common mental disorders, indicates that schools should include a wider focus on safety. This might include schools working to reduce the hidden spaces within physical environments in order to limit where bullying can occur and having school policies around responding to incidents of bullying. However, beyond safety, a wider focus within school environments warrants consideration. This includes approaches to promote student levels of physical activity at school, such as by having sufficient space for playgrounds and sportsgrounds, and by scheduling games and sports within the school curriculum. The only element within school physical environments that had coverage rates higher than 90% was monitoring of school canteen hygiene, which reflects the Chinese government's emphasis on food safety.[36] Disappointingly, this item did not include attention to the nutritional quality of food that is available in schools, such as access to fresh fruit or foods and drinks that are low in salt, sugar and fat. At present, the government's current attention on school food is from the perspective of health and safety, without including any standardised monitoring system or programme for the nutritional composition of school food.[37] The rapid transition in the weight and nutrition profile of China's children and young people suggests this also warrants greater attention, including through establishing standardised monitoring.[38]

A limitation of this study is that it took place in only 17 of China's 34 provinces, and in selected districts within each province, as a result of it being based on the network of schools surveyed by the monitoring stations which at that time only covered 17 provinces. However, the sample was stratified by urban and rural areas and included all school types. In addition, since more excluded schools were from lower SES areas, the regional SES differences in the coverage of school health monitoring systems may be underestimated. A further limitation is the scope of the questionnaire, as many aspects that are now considered relevant to

health-promoting schools were not monitored by this survey, such as policies on bullying, injury prevention, mental health and so on. The current monitoring systems for non-communicable diseases focus on student health examinations, without integrating these within a unified framework, such as health-promoting schools, which further limits the picture of non-communicable diseases monitoring in schools in China. In addition, many aspects of school health systems monitoring are unique to China, which limits comparison with other countries. However, a strength of this study is that it demonstrates that aspects of school health systems can indeed be taken to scale when supported by government investment in policy, implementation and monitoring systems, consistent with the recommendations within the new global standards for health-promoting schools.[10]

Conclusion

While there is evidence that schools in China have widely implemented a range of systematic approaches to preventing and controlling infectious diseases, the coverage and scope of monitoring within school health systems for non-communicable diseases and school physical environments were much lower and much less comprehensive. Overall, the coverage of school health services monitoring was higher in urban areas, in wealthier areas, and in senior secondary schools, which indicates where immediate investment is required. Ensuring a better orientation of China's school health monitoring system to the rapidly-changing health issues of its children and adolescents should be a priority.

CRediT authorship contribution statement

Xiaojin Yan: Data curation, Formal analysis, Data interpretation, Writing original draft. **Peijin Hu:** Conceptualization, Data curation, Data interpretation, Funding acquisition, Manuscript review. **Ning Ma:** Data curation, Data interpretation, Manuscript review. **Dongmei Luo:** Data curation, Data interpretation, Manuscript review. **Jingshu Zhang:** Data curation, Data interpretation, Manuscript review. **Junyi Wang:** Data curation, Data interpretation, Manuscript review. **Yanhui Dong:** Data curation, Data interpretation, Manuscript review. **Yi Xing:** Data curation, Data interpretation, Manuscript review. **Yi Song:** Conceptualization, Data curation, Data interpretation, Funding acquisition, Manuscript review. **Jun Ma:** Conceptualization, Manuscript review. **George C Patton:** Data interpretation, Manuscript review. **Susan M Sawyer:** Data interpretation, Manuscript review.

Declaration of interests

We declare that we have no conflicts of interest.

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Data sharing statement

Datasets generated and/or analysed in the present study are available from the corresponding author upon reasonable request.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.lanwpc.2021.100332.

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