Disparity in spectrum of infectious diseases between in-school and out-of-school children, adolescents, and youths in China: findings from a successive national surveillance from 2013 to 2021

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Summary

Background An accelerated epidemiological transition, economic development and urbanization have brought rapid reductions but a potential disparity in infectious diseases burdens in-school and out-of-school children, adolescents, and youths in China. This paper assesses the disparity in spectrum of infectious diseases between two groups, and described disparity's variation by age, year and province, and determined the priority diseases.

Methods A total of 7,912,274 new incident cases (6,159,021 in school and 1,753,253 out of school) aged 6–21 years across 43 notifiable infectious diseases have been collected based on China's Notifiable Infectious Disease Surveillance System from 2013 to 2021. All infectious diseases are categorized into seven categories: vaccine preventable, bacteria, gastrointestinal and enterovirus, sexually transmitted and bloodborne, vectorborne, zoonotic, and quarantinable diseases. We used the index of incidence rate ratio (IRR) of by specific disease, category, year, and age to assess the disparity between those out-of-school and in-school, and determine their separate priority diseases.

Findings From 2013 to 2021, a small disparity of notifiable infectious diseases existed with higher average yearly incidence for out-of-school children, adolescents, and youth than that in-school (327.601 v.s. 319.677 per 100,000, IRR = 1.025, 95%CI: 1.023–1.027, standardized IRR = 1.169, 95%CI: 1.155–1.183), and it gradually narrowed by surveillance years with IRR from 1.351 in 2013 to 1.015 in 2021 due to large decreased disparity in compulsory education stage group. Such disparity was mainly driven by sexually transmitted and bloodborne diseases, bacteria diseases, vectorborne diseases, quarantinable diseases and zoonotic diseases. However, vaccine preventable diseases, gastrointestinal and enterovirus diseases showed higher incidence of infectious diseases for those in-school than that out-of-school, particularly for seasonal influenza, mumps and hand-foot-and-mouth disease. Meanwhile, such disparity is obvious in most of ages and in eastern and coastal regions of China, and the narrowing trend is attributed to six categories diseases, except for sexually transmitted and bloodborne diseases with gradually widened disparity between two groups with surveillance years with IRR from 22.939 in 2013 to 23.291 in 2021 due to large disparity for those who have completed compulsory education.

Interpretation A huge achievement has been achieved in reducing the burden and disparity of infectious diseases between out-of-school and in-school children, adolescents, and youths in China, particularly for the compulsory education stage population. The priorities for the coming decades will be to extend successful strategies to a broad scope and promote education, particularly for the investment of social health resources and the improvement of personal health literacy in the non-compulsory education stage. This should involve extending the years of compulsory school, improving sex health education, strengthening monitoring, expanding immunization

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programs coverage and prioritizing the prevention and control of sexually transmitted diseases and tuberculosis among out-of-school population.

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Research in context

Evidence before this study

In the past decades, the outbreak of a variety of emerging infectious diseases, such as COVID-19 and monkeypox, has raised a new challenge for human health. China has undergone a rapid epidemiological transition with remarkable progress in the control of infectious diseases. Children and adolescents remain most susceptible to infectious diseases and many programs and national health priorities focus on these age groups, including immunization and enhanced surveillance. Yet, possibly due to significant reductions in disease burden, infectious diseases are often overlooked as causes of morbidity and mortality in China, and the assessment of some marginalized groups and its health disparity related to infectious diseases, like those drops out or adolescents who have completed compulsory education, is easily overlooked. We searched PubMed on December 29, 2022, with the terms "infectious disease" AND "trend" AND ("children and adolescents" OR "youths" OR "dropout") AND ("China") for articles published in English and Chinese. Despite some relevant studies, our search did not identify any comprehensive reports of comparison and disparity in the patterns of infectious diseases among in-school and out-of-school children, adolescents and youths in China and other countries, especially for dropouts. In this context, the upgrade of China's National Notifiable Infectious Disease Surveillance System is an opportunity to provide a national picture of notifiable infectious diseases and comprehensive evaluation of the disparity among in-school and out-of-school children, adolescents and youths.

Added value of this study

To our knowledge, this is the first study to report recent national epidemiological trends of notifiable infections and evaluate the disparity in spectrum of infectious diseases between in-school and out-of-school children, adolescents, and youths in China. In reporting cases due to the 43 notifiable infectious diseases in 6–21 year-old in-school and out-of-school children, adolescents and youths from 2013 to 2021, we were able to analyze the disparity by specific category, year, age, region, and determine the priority diseases between two groups. An disparity of the burdens of multiple infectious diseases was found that those out-of-school had higher burdens than that of in-school, particular for females and those who have completed compulsory education over 16 years, and such disparity was mainly driven by sexually transmitted and bloodborne with a largest incidence rate ratio of 23.619 between two groups, followed by bacteria, vectorborne, quarantinable and zoonotic diseases, but it was also offset by vaccine preventable diseases, and gastrointestinal and enterovirus diseases. Meanwhile, such disparity was obvious in most of ages but varied by regions that eastern and coastal regions of China faced higher burdens for those out-of-school, and it gradually narrowed by surveillance years due to six categories diseases, except for sexually transmitted and bloodborne diseases. Thus, the priority diseases were determined as several vaccine preventable diseases and gastrointestinal and enterovirus diseases for those of in-school and all four sexually transmitted and bloodborne diseases and tuberculosis for those of out-of-school from 2013 to 2021.

Implications of all the available evidence

Children, adolescents and youths in China face an unequal burden of infectious diseases, with those who have dropped out of school and completed compulsory education bearing a higher burden than their peers who remain in school, but such disparity gradually narrowed over time due to continuous achievements in infectious disease prevention and control in Chinese children and adolescents, particularly for the compulsory education stage population. Rapid shifts in infectious disease epidemiology present challenges for decision-makers to maintain gains while addressing newer threats and groups. The differing priority diseases of the two groups provide direction for the precise implementation of prevention and control measures. Effective and feasible strategies to reduce the disparity in infectious disease burdens between in-school and out-of-school children, adolescents, and youths in China could include extending the years of compulsory education, providing sex health education to earlier grades and dropouts, expanding immunization programs, increasing the investment of social health resources and the improvement of personal health literacy in the non-compulsory education stage and prioritizing the control of sexually transmitted diseases and tuberculosis among out-of-school individuals.

Introduction

Infectious diseases have long been a longstanding challenge for humanity, and the emergence of novel infectious diseases such as COVID-19 and monkeypox have posed new threats in recent years.[1,2] Factors such as global trade, climate change, population migration, and urbanization have dramatically shifted the patterns of infectious diseases. However, advancements in medical technology and health awareness have led to a steady decrease in the incidence and mortality of infectious diseases over the past few decades.[3] Infectious diseases were the primary cause of death worldwide at the turn of the 20th century, with high mortality rates among newborns and young children.[4] By 2019, infectious diseases continued to fall in the global causes of death, with sexually transmitted and respiratory infections comprising the majority.[5] Nevertheless, the transition to chronic noninfectious diseases has led to significant health and economic inequality, with developing countries struggling to make progress against infectious diseases.[6] In low- and middle-income countries (LMICs), infectious diseases remain a leading cause of death.[5] Although the incidence and mortality of infectious diseases in Chinese children and adolescents in schools have sharply decreased from 2008 to 2017, there are still some groups that urgently need attention while maintaining sustained achievements, like some drops out or adolescents who have completed compulsory education.[7,8] Children and adolescents remained a priority population for public health concerns, and a previous study described that the incidence and mortality of notifiable infectious diseases in Chinese children and adolescents in schools sharply decreased from 2008 to 2017.[8] However, the assessment of the health status related to infectious diseases among dropouts and adolescents who enter society prematurely may have been overlooked.

Although students in schools make up the majority of children and adolescents in the compulsory education stage, there is a significant proportion of non-students who are out of school, and their numbers increase with age, particularly for adolescents or youths who have completed the compulsory education stage.[9,10] Globally, 258 million children and adolescents dropped out of school in 2018, and this number has risen since the COVID-19 pandemic, particularly in LMICs.[9,11] In China, a compulsory education policy is in place for children aged 6 to 15, yet regional and economic disparities hinder access to this fundamental right for some children.[12] Despite these challenges, the dropout rate during the compulsory education phase remains relatively low in China, however, after this phase, education is no longer mandatory, and as a result, the dropout rate gradually increases with age.[13] Traditionally, school settings, including universities, are crucial for preventing and controlling infectious diseases among children, adolescents and youths, and are locations where government and health-related staff frequently conduct health education programs. This demographic is most susceptible to infectious diseases and is a priority population for infectious disease response and prevention strategies. In most counties, infectious disease prevention and control measures for children, adolescents and youths are conducted in schools, especially during the COVID-19 response procedures.[14] However, these measures and projects were few and difficult to cover and reach children, adolescents and youths who are out of school, particularly those who have dropped out or entered society at an early age, leading to a lack of sufficient assessment and evidence for the disparity in spectrum of infectious diseases between in-school and out-of-school children, adolescents, and youths.

The population of children, adolescents, and youth who are out of school or have completed compulsory education has not been adequately addressed in terms of infectious disease prevention and control. Most countries have implemented measures to prevent and control infectious diseases in schools, particularly in response to the COVID-19 pandemic.[15–18] However, there are significant differences between in-school and out-of-school populations in terms of economic status, access to health education, and living conditions that contribute to different levels of vulnerability to infectious diseases. Out-of-school children face unique challenges such as limited access to health education and preventive measures, increased contact with adults at higher risk of infectious diseases, and exposure to overcrowding sanitation.[19–21] While previous surveillance efforts have identified major infectious diseases and their priority measures among in-school populations,[4,8,22,23] it remains unclear whether these priorities apply to out-of-school populations. Therefore, this study aims to explore the disparity in spectrum of infectious diseases and determine the priority of the infectious diseases between in-school and out-of-school children, adolescents, and youths aged 6–21 years in China from 2013 to 2021 by analyzing data from 43 notifiable infectious diseases.

Methods

The surveillance system

The Chinese Government established an internet-based China Information System for Disease Control and Prevention (CISDCP) in 2003, which has been the systematic and long-term infectious diseases surveillance system, and covered the over 85% of all health facilities in China.[3,8,24] All diseases were clinically or laboratory-diagnosed according to the guidelines published by the National Health Commission of the People's Republic of China (http://www.nhc.gov.cn/). Standardized case data were uploaded to the CISDCP's database within 24 h of diagnosis by hospitals, disease prevention and control centers in various regions, community health centers, township health centers, and village health stations through the Internet-based real-time system.[8] All cases were logged into the hospital's electronic health record system by doctors who were responsible for case confirmation, or by trained personnel. The standardized infectious disease cards, which contained basic demographic data including sex, date of birth, occupation, case classification, date of symptom onset, and date of diagnosis, were filled out and submitted to the CISDCP by doctors within 24 h of diagnosing any probable, clinical, or laboratory-confirmed cases of any notifiable infectious diseases. The data uploaded by hospitals were further verified for errors, omissions, duplicates, and laboratory diagnoses by local disease control center staff. The system was equipped with a mechanism to avoid duplicate records to prevent a patient from being reported multiple times by different medical institutions. Only laboratory-confirmed and clinically diagnosed cases were included in the analysis, and suspected cases were excluded.

Data collection

Children, adolescents and youths aged 6–21 years old who had confirmed records of any of the 43 notifiable infectious diseases from 2013 to 2021 were involved in the study. The division of students in-school and peers out-of-school was determined according to the occupation recorded in the system. If the occupation record in the system was student, then the cases were categorized into students in-school, and if occupation was recorded in the system as others, such as farming, working outside, or other specific occupations, the cases would be classified as ones out-of-school. This study was conducted in strict accordance with the principles and guidelines of the Declaration of Helsinki. In this study, all patient identifiable information (name, residential address) was anonymous. The total population size was provided by the National Bureau of Statistics of China (www.stats.gov.cn), and the population size of students was estimated using data from the Ministry of Education (http://en.moe.gov.cn) based on the number of students from each year, age, and sex between 2013 and 2021. The population size of out-of-school individuals was estimated by subtracting the population size of students from the total population size. The lack of age-specific population data impedes the ability to calculate the number of dropouts within each age group. Despite this challenge, we utilize alternative methods to estimate dropout numbers for each age group. Specifically, we have employed age-specific dropout rates reported in Fig. S1 of the Main Data Bulletin of the 2015 National 1% Population Sample Survey in China, in conjunction with total population data provided by the National Bureau of Statistics.

Classification

A total of 43 notifiable infectious diseases were included in the study. Although there was no internationally unified standard for the possible classification of infectious diseases, they were divided into seven categories according to the previous categorization approach: vaccine preventable, bacteria, gastrointestinal and enterovirus, sexually transmitted and bloodborne, vectorborne, zoonotic, and quarantinable diseases.[8] The **vaccine preventable diseases** included 11 diseases: seasonal influenza, rubella, pertussis, mumps, measles, hepatitis A, B and D, neonatal tetanus, poliomyelitis and diphtheria. In the **bacteria diseases**, four infectious diseases were included: tuberculosis, scarlet fever, meningococcal meningitis, and leprosy. **Gastrointestinal and enterovirus diseases** are a cluster of infectious diseases primarily affecting the gastrointestinal system. This category encompasses diseases caused by gastrointestinal viruses and those with gastrointestinal symptoms as the principal manifestation, such as typhoid and paratyphoid, infectious diarrhea, hand, foot, and mouth disease (HFMD), dysentery, and acute hemorrhagic conjunctivitis. In the **sexually transmitted and bloodborne diseases**, four diseases were included: syphilis, gonorrhea, HIV/AIDS, and hepatitis C. The **vector borne diseases** included nine diseases: typhus, schistosomiasis, malaria, kala-azar, Japanese encephalitis, dengue, and filariasis. In **zoonotic diseases**,[9] diseases were included: brucellosis, hepatitis E, hydatid disease, rabies, anthrax, leptospirosis, H5N1, H7N9, and severe acute respiratory syndrome (SARS). The **quarantinable diseases** included hemorrhagic fever, cholera, and plague.

Statistical analysis

The yearly incidence used in the study was calculated by the number of incident cases in each surveillance year divided by the corresponding population size, then determined the mean incidence over a period of 9 years. In order to assess the disparity between those out-of-school and in-school, we used the index of incidence rate ratio (IRR) of by specific disease, category, year, and age. We also assessed the standardized incidence and IRR values by age, gender, and region to ensure the robustness of the IRR estimates. Firstly, the number of male and female students and dropouts aged 6–12, 13–15, 16–18, and 19–21 was calculated based on their respective dropout rates by age and gender which was obtained from Main Data Bulletin of the 2015 National 1% Population Sample Survey in China, and used as the standard population data. The age of 6–15 years was defined as compulsory education stage and the range of 16–21 years were defined as non-compulsory education stage. Next, the proportional weight of the standard population data was applied to the incidence rate of infectious diseases for each year, province, gender, and age group, in order to calculate the standardized incidence rate of infectious diseases in each province. Then, the annual incidence rate was calculated and averaged to obtain the standardized annual incidence rate. Finally, the standardized IRR values were calculated based on the standardized annual incidence rate. The 95% Confidence Interval (95%CI) was estimated by the following formula: $95\%CI = \exp\left(\log(IRR) \pm 1.96 \times \sqrt{1/e1 + 1/e2}\right)$, where $e1$, $e2$ is the number of incident cases among in-school and out-of-school. For the comparability of values, we also logged the values to convert the IRR values into a standard range of −5 to 5, which was convenient for assessing the disparity between two groups for the difference comparison of diseases. Pie chart with thermal chart was used to evaluate the epidemiological distribution and disparity in incidence of infectious by year and category between two groups of in-school and out-of-school. Joinpoint regression models were applied to access the long-term trends in incidence for each specific disease using the index of annual percentage changes (APC). To determine if APC was substantially different from zero, we employed the Z test. According to the APC, the long-term trends of each disease were categorized into increasing trends, decreasing trends, and stable trends. The increasing and decreasing trends were identified by the slope of APC and its significance ($p < 0.05$). And the stable trends referred to non-significant APC ($p \geq 0.05$), which indicated that the incidence was maintained at a perennially stable level or that the incidence was perennially unreported or only reported sporadically. The thermodynamic diagram was used to assess the disparity and patterns of incidence of infectious diseases between two groups by age using the standardized converted incidence and log converted IRR. Maps in different colors were used to evaluate the regional distribution and disparity of total and specific categorized infectious disease in incidence between two groups. To identify the different priority diseases for two groups, we regarded those diseases with higher incidence and higher than those of the other group in their respective groups as the priority diseases, and then we conducted such approaches in each province to determine the priority diseases in different provinces. In order to examine the variations in the spectrum of infectious diseases across different genders and age cohorts, we performed a calculation of the IRR values by gender and age. Statistical analyses were performed using the R program (version 4.1.1, R Development Core Team 2021). Joinpoint (version 4.3.1) was applied to perform the Joinpoint regression.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The authors from Peking University and China CDC had full access to the data in the study.

Results

Overall disparity of notifiable infectious diseases between in-school and out-of-school

As shown in Table 1, from 2013 to 2021, a total of 7,912,274 cases of 43 infectious diseases were reported with 6,159,021 in school (Compulsory and non-compulsory education stage: 78.24% v.s. 21.76%) and 1,753,253 out of school (Compulsory and non-compulsory education stage: 15.51% v.s. 84.49%), and a small disparity of notifiable infectious diseases existed with higher average yearly incidence for out-of-school children, adolescents, and youth than that in-school (327.601 v.s. 319.677 per 100,000, crude IRR = 1.025, 95%CI: 1.023–1.027; standardized IRR = 1.169, 95%CI: 1.155–1.183). Such disparity changed due to different diseases categories, and higher incidence of infectious diseases for those out-of-school than that in-school was mainly driven by sexually transmitted and bloodborne diseases (90.852 v.s. 3.847 per 100,000, standardized IRR = 26.725, 95%CI: 28.647–24.926), bacteria diseases (73.273 v.s. 29.285 per 100,000, standardized IRR = 3.087, 95%CI: 3.070–3.107), vectorborne diseases (1.183 v.s. 0.568 per 100,000, standardized IRR = 2.448, 95%CI: 2.402–2.720), quarantinable diseases (0.353 v.s. 0.182 per 100,000, standardized IRR = 2.255, 95%CI: 1.824–3.009) and zoonotic diseases (2.320 v.s. 0.666 per 100,000, standardized IRR = 4.063, 95%CI: 4.019–4.133). However, vaccine preventable diseases 97.386 v.s. 194.959 per 100,000, standardized IRR = 0.561, 95%CI: 0.546–0.577), gastrointestinal and enterovirus diseases (61.766 v.s. 88.595 per 100,000, standardized IRR = 0.903, 95%CI: 0.877–0.930) showed higher incidence of infectious diseases for those in-school than that out-of-school.

Disparity by year and category between in-school and out-of-school

As shown in Fig. 1, Fig. S2 and Table S1, the epidemiologic distribution of infectious diseases by year between in-school and out-of-school children, adolescents, and youth basically showed the similar patterns that the high-class incidence rate diseases were almost concentrated in vaccine preventable diseases represented by seasonal influenza, mumps, and hepatitis B, bacteria diseases represented by tuberculosis and scarlet fever, all gastrointestinal and enterovirus diseases, and almost all sexually transmitted and bloodborne diseases. Except for a big reversal in 2019, the burden of infectious diseases of those out-of-school was always higher than that of in-school during the surveillance years, but such disparity gradually narrowed by years with IRR from 1.351 in 2013 (incidence: 290.566 v.s. 215.062 per

	In-school			Out-of-school			RR (out-of-school v.s. in-school)	Standardized IRR (out-of-school v.s. in-school)
	Cases (n)[a]	Yearly incidence (per 100,000)[b]	Standardized incidence	Cases (n)[a]	Yearly incidence (per 100,000)[b]	Standardized incidence		
Total	**6,159,021**	**319.677**	**342.938**	**1,753,253**	**327.601**	**400.976**	**1.025 (1.023–1.027)**	**1.169 (1.155–1.183)**
Vaccine preventable	**3,801,159**	**194.959**	**215.717**	**523,096**	**97.386**	**121.024**	**0.500 (0.499–0.501)**	**0.561 (0.546–0.577)**
SI	2,505,850	126.700	142.615	164,239	33.836	43.921	0.267 (0.266–0.268)	0.308 (0.295–0.322)
Rubella	44,035	2.301	2.422	6336	1.192	1.501	0.518 (0.505–0.532)	0.619 (0.521–0.804)
Pertussis	6902	0.35	0.369	742	0.150	0.205	0.428 (0.397–0.462)	0.556 (0.338–1.343)
Mumps	1,119,487	58.988	63.804	64,154	11.356	16.775	0.193 (0.191–0.195)	0.263 (0.240–0.289)
Measles	8121	0.439	0.434	4628	0.763	0.960	1.740 (1.678–1.804)	2.210 (2.089–2.598)
Hepatitis D	16	0.002	<0.001	34	0.010	0.008	5.345 (2.950–9.683)	8.939 (11.276–7.512)
Hepatitis B	107,540	5.684	5.574	277,075	49.069	56.360	8.633 (8.572–8.694)	10.111 (10.505–9.735)
Hepatitis A	9208	0.495	0.497	5888	1.010	1.295	2.042 (1.976–2.110)	2.605 (2.399–2.942)
NT	–	–	–	–		–	–	–
Poliomyelitis	–	–	–	–	–	–	–	–
Diphtheria	–	–	–	–	–	–	–	–
Bacteria	**558,673**	**29.285**	**28.328**	**408,677**	**73.273**	**87.457**	**2.502 (2.492–2.512)**	**3.087 (3.070–3.107)**
TB	335,485	17.521	16.382	395,290	70.834	83.747	4.043 (4.024–4.062)	5.112 (5.135–5.090)
SF	222,648	11.735	11.915	13,135	2.394	3.652	0.204 (0.200–0.208)	0.307 (0.252–0.378)
MM	406	0.022	0.024	72	0.012	0.017	0.564 (0.439–0.725)	0.711 (0.557–3.695)
Leprosy	134	0.007	0.007	180	0.033	0.041	4.722 (3.776–5.905)	5.565 (6.969–5.091)
Gastrointestinal and enterovirus	**1,698,038**	**88.595**	**93.551**	**331,383**	**61.766**	**84.462**	**0.697 (0.694–0.700)**	**0.903 (0.877–0.930)**
T/P	12,873	0.681	0.690	4544	0.805	0.999	1.181 (1.142–1.222)	1.447 (1.260–1.842)
ID	685,209	35.402	37.827	185,677	35.748	44.640	1.010 (1.005–1.015)	1.180 (1.143–1.220)
HFMD	862,116	45.211	47.586	106,030	19.03	31.072	0.421 (0.418–0.424)	0.653 (0.620–0.690)
Dysentery	93,853	4.98	4.964	25,100	4.379	5.559	0.879 (0.867–0.891)	1.120 (1.014–1.245)
AHC	43,987	2.319	2.483	10,032	1.805	2.193	0.778 (0.761–0.795)	0.883 (0.760–1.069)
Sexually transmitted and bloodborne	**74,379**	**3.847**	**3.866**	**468,762**	**90.852**	**103.329**	**23.619 (23.437–23.802)**	**26.725 (28.647–24.926)**
Syphilis	24,368	1.251	1.227	245,687	47.729	51.333	38.163 (37.664–38.669)	41.838 (47.966–36.394)
Gonorrhea	18,914	0.969	1.028	154,898	30.651	37.264	31.623 (31.149–32.104)	36.248 (41.556–31.371)
HIV/AIDS	24,276	1.266	1.26	49,474	9.253	11.049	7.309 (7.198–7.422)	8.769 (9.328–8.252)
Hepatitis C	6821	0.361	0.351	18,703	3.220	3.682	8.927 (8.683–9.178)	10.480 (12.493–8.889)
Vectorborne	**10,604**	**0.568**	**0.584**	**6692**	**1.183**	**1.430**	**2.082 (2.019–2.147)**	**2.448 (2.402–2.720)**
Typhus	1511	0.079	0.084	487	0.086	0.112	1.083 (0.978–1.199)	1.339 (0.963–2.969)
SM	309	0.019	0.017	493	0.103	0.098	5.426 (4.707–6.255)	5.664 (6.197–4.656)
Malaria	170	0.009	0.009	557	0.094	0.119	10.45 (8.801–12.408)	13.327 (15.306–6.120)
Kala-azar	115	0.006	0.006	35	0.006	0.008	0.992 (0.679–1.448)	1.256 (0.757–4.677)
JE	2197	0.117	0.125	492	0.084	0.125	0.713 (0.647–0.786)	1.002 (0.639–2.372)
Dengue	6302	0.337	0.343	4628	0.810	0.968	2.401 (2.312–2.494)	2.823 (2.774–3.227)
Filariasis	–	–		–	–			
Zoonotic	**12,690**	**0.666**	**0.699**	**12,681**	**2.320**	**2.841**	**3.484 (3.399–3.571)**	**4.063 (4.019–4.133)**
Rabies	409	0.022	0.024	115	0.021	0.028	0.964 (0.784–1.186)	1.154 (0.633–3.477)
Leptospirosis	72	0.004	0.004	83	0.014	0.018	3.767 (2.747–5.165)	4.458 (6.574–5.011)
Hepatitis E	1470	0.077	0.076	2636	0.484	0.559	6.243 (5.857–6.654)	7.357 (9.494–6.053)
HD	1922	0.1	0.103	1842	0.336	0.424	3.368 (3.159–3.590)	4.128 (4.080–4.504)
H7N9	12	0.002	0.001	5	0.002	0.001	1.267 (0.446–3.596)	1.917 (6.480–4.882)
Brucellosis	8746	0.458	0.489	7884	1.441	1.784	3.147 (3.053–3.244)	3.650 (3.634–3.790)
Anthrax	59	0.003	0.003	116	0.022	0.027	7.014 (5.127–9.596)	8.338 (18.159–5.244)
H5N1	–	–	–	–	–	–	–	–
SARS	–	–	–	–	–	–	–	–
Quarantinable	**3478**	**0.182**	**0.192**	**1962**	**0.353**	**0.433**	**1.944 (1.839–2.055)**	**2.255 (1.824–3.009)**
HF	3472	0.181	0.192	1956	0.351	0.433	1.937 (1.833–2.047)	2.251 (1.824–3.007)

(Table 1 continues on next page)

	In-school			Out-of-school			RR (out-of-school v.s. in-school)	Standardized IRR (out-of-school v.s. in-school)
	Cases (n)[a]	Yearly incidence (per 100,000)[b]	Standardized incidence	Cases (n)[a]	Yearly incidence (per 100,000)[b]	Standardized incidence		
(Continued from previous page)								
Cholera	6	<0.001	<0.001	6	0.002	0.001	4.514 (1.456–13.996)	4.829 (9.527–4.227)
Plague	–	–	–	–	–	–	–	–

Notes: –, no cases. SI, Seasonal influenza; NT, Neonatal tetanus; TB, Tuberculosis; SF, Scarlet fever; MM, Meningococcal meningitis; T/P, Typhoid and paratyphoid; HFMD, Hand, foot, and mouth disease; AHC, Acute hemorrhagic conjunctivitis; ID, Infectious diarrhea; AIDS, Acquired Immune Deficiency Syndrome; SM, Schistosomiasis; JE, Japanese encephalitis; HD, Hydatid disease; SARS, severe acute respiratory syndrome; HF, Hemorrhagic fever; IRR, incidence rate ratio. [a]Total numbers from 2013 to 2021. [b]Average incidence from 2013 to 2021.

Table 1: **The overall disparity in incidence of total 44 notifiable infectious diseases by category and specific diseases between in-school and out-of-school children, adolescents, and youth.**

100,000) to 1.015 in 2021 (incidence: 319.329 v.s. 314.475 per 100,000).

Among the **vaccine preventable diseases**, the high increase of seasonal influenza and mumps among those in-school led to a sharp reversal in 2019 for the disparity of two groups, which ultimately led to the fact that the average burden of infectious diseases over 9 years of those in-school was higher than that of out-of-school (97.386 v.s. 194.959 per 100,000, IRR = 0.500, 95%CI: 0.499–0.501), with the IRR in 2021 being 0.346. The

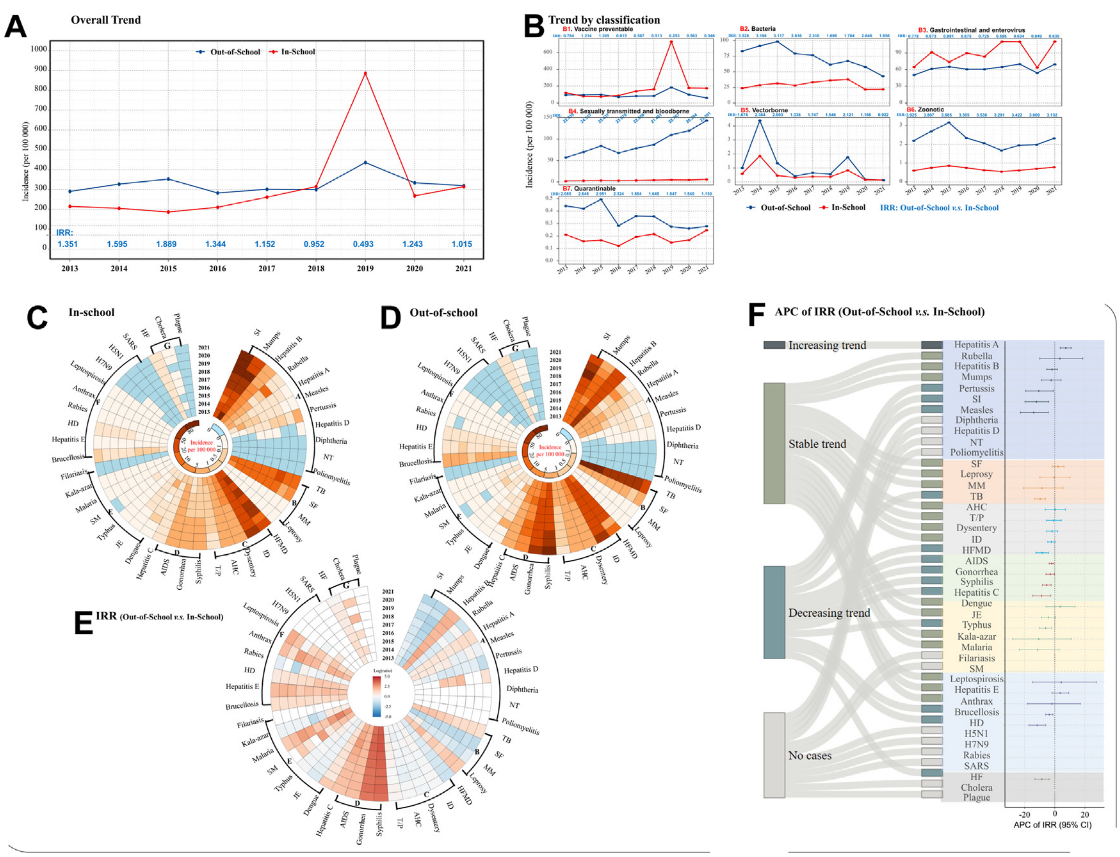

Fig. 1: **Trends in incidence, disparity of incidence rate ratio (IRR) and annual percentage change (APC) of notifiable infectious diseases between in-school and out-of-school children, adolescents, and youth by diseases category, specific disease, and disease change pattern from 2013 to 2021**. Note: Seven subfigures showed the secular trends of disparity in incidence for total infectious disease (subfigure A), each category (subfigure B), each infectious disease by category for those of in-school (subfigure C) and out-of-school (subfigure D), and their disparity (subfigure E) for those of out-of-school towards in-school using the index of incidence rate ratio (IRR), and the disparity of disease incidence change patterns (subfigure F). Abbreviations referred to the notes in Table 1.

overall disparity with higher burdens of infectious diseases for those in-school than that out-of-school across years was mainly driven by seasonal influenza (IRR = 0.267, 95%CI: 0.266–0.268), rubella (IRR = 0.518, 95%CI: 0.505–0.532), pertussis (IRR = 0.428, 95%CI: 0.397–0.462) and mumps (IRR = 0.193, 95%CI: 0.191–0.195), although measles (IRR = 1.740, 95%CI: 1.678–1.804), hepatitis A, B and D (IRR = 2.042 with 95%CI: 2.950–9.683, 8.633 with 95% CI: 8.572–8.694, and 5.345 with 95%CI: 1.976–2.110) showed opposite disparity following by higher burden in those out-of-school that in-school (Table S2).

Bacteria diseases always showed higher incidence in those out-of-school than in-school during the surveillance years (73.273 v.s. 29.285 per 100,000, IRR = 2.502), but such disparity continued to shrink by years with IRR from 3.528 in 2013 (incidence: 83.393 v.s. 23.635 per 100,000) to 1.956 in 2021 (incidence: 43.083 v.s. 22.026). However, such narrowing disparity between two groups was mainly driven by scarlet fever (IRR = 0.204) and meningococcal meningitis (IRR = 0.564) across years, although an always higher incidence was found for tuberculosis (IRR = 4.043) and leprosy (IRR = 4.722) in those out-of-school than in-school from 2013 to 2021.

Gastrointestinal and enterovirus diseases almost kept a consistent disparity with higher incidence for those in-school than out-of-school across years with IRR of 0.778 in 2013 and 0.630 in 2021, and average yearly IRR of 0.697 (61.766 v.s. 88.595 per 100,000) during these nine years. And such stable disparity was mainly driven by HFMD with a yearly decrease and average less than 1 of IRR (19.030 v.s. 45.211 per 100,000, IRR = 0.421).

Sexually transmitted and bloodborne diseases showed notable and gradually widening disparity across years with consistently higher incidence for those out-of-school than that in-school. The total incidence of sexually transmitted and bloodborne diseases was 56.835 and 2.478 per 100,000 for those out-of-school and in-school with an IRR of 22.939 in 2013, but such disparity gradually widened to 23.291 with incidence of 143.562 and 6.164 per 100,000 for two groups in 2021. In addition, such disparity is caused by all subtype's diseases including syphilis (IRR = 38.163), gonorrhea (IRR = 31.623), hepatitis C (IRR = 8.927) and HIV/AIDS (IRR = 7.309).

Vectorborne diseases showed a gradually narrowing disparity with IRR of 1.674 (1.003v.s. 0.599 per 100,000) in 2013 to 0.922 (0.122 v.s. 0.133 per 100,000) in 2021 between two groups, though those out-of-school always had a higher incidence than that in-school with an average yearly IRR of 2.082 (1.183 v.s. 0.568 per 100,000). Such large disparity was mainly driven by malaria (IRR = 10.450), schistosomiasis (IRR = 5.426) and dengue (IRR = 2.401), but such narrowing disparity was mainly driven by typhus (IRR = 1.083, but consistently decreased with years), Kala-azar (IRR = 0.992) and Japanese encephalitis (IRR = 0.713).

Zoonotic diseases almost kept constant disparity with higher incidence in out-of-school than in-school and an IRR of 3.925 from 2014 (2.241 v.s. 0.571 per 100,000) to 3.132 in 2021 (2.372 v.s. 0.757 per 100,000). Except for rabies, almost all other subtype's diseases drove such constant disparity including leptospirosis (IRR = 3.767), hepatitis E (IRR = 6.243), hydatid disease (IRR = 3.368), H7N9 (IRR = 1.267), brucellosis (IRR = 3.147) and anthrax (IRR = 7.014).

Quarantinable diseases showed a higher incidence in out-of-school than in-school (0.353 v.s. 0.182 per 100,000, IRR = 1.944) but a narrowing disparity from the IRR of 2.085 in 2013 to 1.130 in 2021 between two groups, which was mainly driven by the hemorrhagic fever with a higher but yearly decreased incidence for those out-of-school than that in-school.

Disparity by gender and age between in-school and out-of-school

Notably, there were no significant gender differences observed in other infectious disease classifications except for the sexually transmitted and bloodborne diseases. Although the incidence of sexually transmitted and bloodborne diseases except for hepatitis C in both in-school and out-of-school males (5.423 and 93.346 per 100,000) was higher than that in females (2.115 and 87.939 per 100,000), females had larger disparity between in and out of school groups with IRR of 41.583 (39.796–43.450) than males IRR of 17.212 (16.742–17.695). Among these diseases, the incidence of syphilis and gonorrhea was largely higher than HIV/AIDS and hepatitis C, and syphilis in females and gonorrhea in males even had the largest disparity between in and out of school groups with IRR of 54.843 and 31.938, respectively (Tables S3 and S4).

Fig. 2 showed the disparity of incidence of total infectious diseases and specific disease by age from 6 to 21 years between in-school and out-of-school children, adolescents, and youths. The incidence of total average yearly infectious diseases in those in-school stably decreased from 1053.890 in age of 6–103.616 per 100,000 in age of 21, but the incidence in those out-of-school had a jumping growth from age of 6–7, but then it sharply decreased from 1138.778 in age of 7–132.528 in age of 13, then slightly increased to 353.541 per 100,000 in age of 21. Thus, except for the age of 6, 12 and 13, the disparity in the incidence of total infectious diseases in each other age years during the 9 years was higher in those out-of-school than that in-school. The thermodynamic diagram between two groups showed a similarly pattern in incidence of specific infectious diseases with age, but the disparity with age between two groups showed that almost most specific diseases had a higher incidence in each age for those out-of-school than in-school, only seasonal influenza, mumps, rubella, infectious diarrhea, acute hemorrhagic conjunctivitis, dysentery, and hemorrhagic

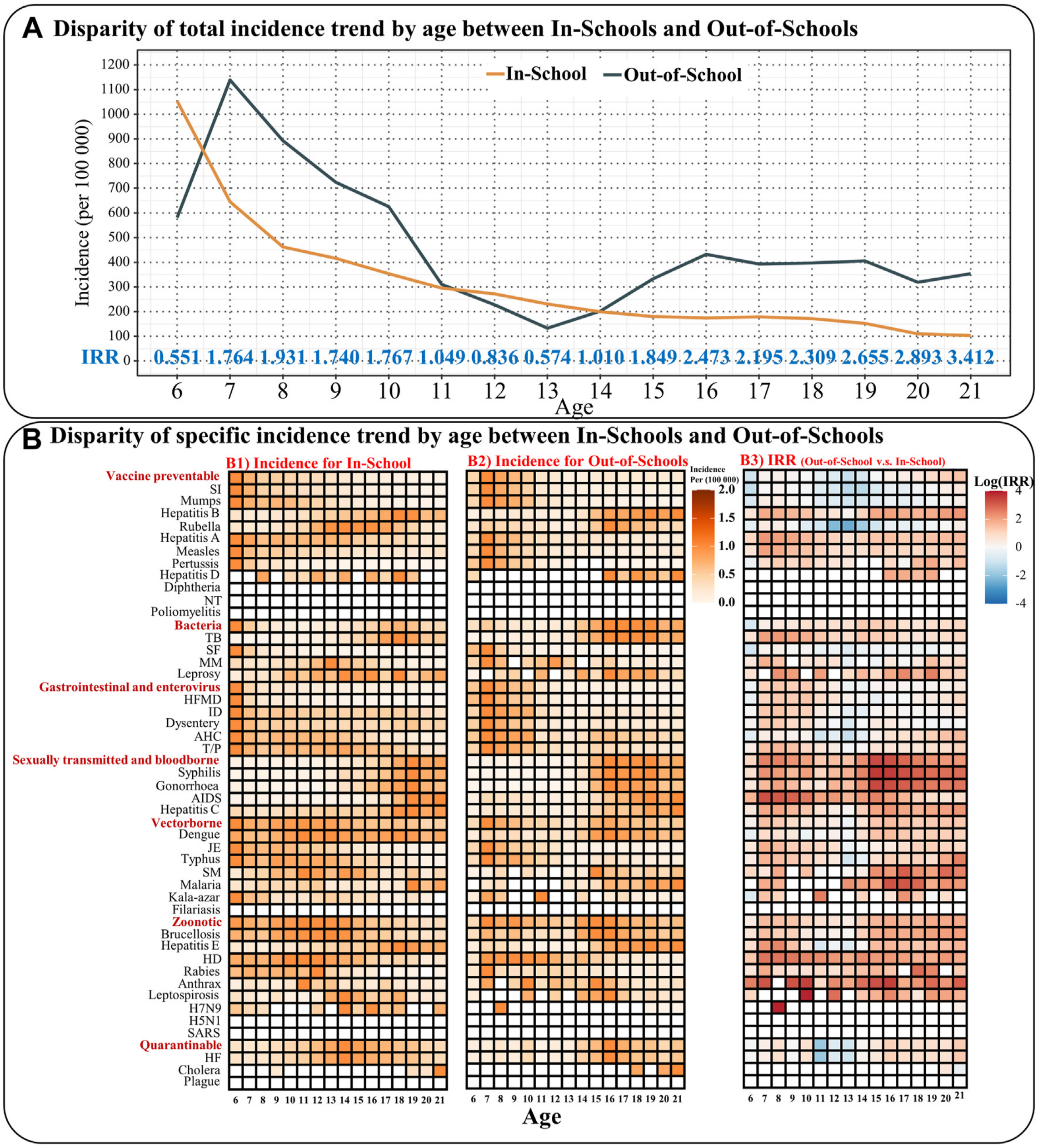

Fig. 2: **Disparity of incidence of total infectious diseases (Subfigure A) and specific disease (Subfigure B) by age from 6 to 21 years between in-school and out-of-school children, adolescents, and youth**. Notes: Abbreviations referred to the notes in Table 1.

fever showed an opposite log converted IRR less than 0 with higher incidence in those in-school than out-of-school in the middle age between 11 and 14. The disparity between two groups also varies by disease category with vaccine preventable and bacteria diseases having smallest disparity in primary school stage population, gastrointestinal and enterovirus having smallest disparity in college stage population, sexually transmitted and bloodborne, vectorborne and zoonotic diseases having largest disparity in middle–high and college stage population. In addition, the narrowed trend of disparity between two groups were mainly attributed to the large decreased disparity in compulsory education stage group aged 6–15 years.

Disparity by region between in-school and out-of-school

Fig. 3 showed the regional distribution and disparity of total and specific categorized infectious disease in incidence between in-school and out-of-school children, adolescents, and youth. In general, the regional distribution of incidence of infectious diseases between the two groups was different, but also has similar characteristics. Most provinces with relatively higher incidence for those out-of-school were concentrated in regions of coastal areas, such as Liaoning, Fujian and Guangdong, but higher incidence for those in-school in regions of central and west China, such as Hubei, Hunan, Tibet and Qinghai. Such differential distribution in incidence by regions lead to a regional variability in disparity between two groups that infectious diseases' burdens in out-of-school children, adolescents, and youth were most obvious in regions of coastal areas, but those in-school were most obvious in regions of central and west China.

The regional distribution in incidence between two groups for **vaccine preventable diseases** and **gastrointestinal and enterovirus diseases** presented an almost similar situation to total infectious diseases, but the incidence in those in-school in most provinces was higher than that out-of-school, which lead to an almost all provinces had a stable disparity between two groups with low log converted IRR less than 0, except for Liaoning, Fujian, and Hebei. **Bacteria**, **vestorborne**, **zoonotic**, **quarantinable diseases** simultaneously presented a higher incidence of infectious diseases for those in-school in west of China, but a higher incidence for those out-of-school in east of China, especially in coastal areas, which lead to a similar regional disparity that these four categories diseases' burdens for those out-of-school were most obvious in eastern and coastal regions of China, but those in-school were most obvious in regions of west China. Notably, the incidence of **sexually transmitted and bloodborne diseases** for those out-of-school were relatively higher in east and coastal areas, particularly in Zhejiang, Fujian, Shanghai and Liaoning, which was almost simultaneously higher than the incidence of in-school in each province that presented a stable reginal epidemic distribution in incidence by province. Thus, the regional disparity between two groups for **sexually transmitted and bloodborne diseases** was completely different from other categories' diseases that diseases burdens of such category in all provinces were most obvious for those of out-of-school, particularly in eastern and coastal regions of China.

Disparity of priority infectious diseases between in-school and out-of-school

Fig. 4 and Fig. S3 showed the disparity of priority infectious diseases between in-school and out-of-school children, adolescents, and youth by year and province, and the priority diseases were determined by the higher incidence of all diseases and the higher incidence of the two groups than that of the other group. During the 9 surveillance years, the priority diseases did not change

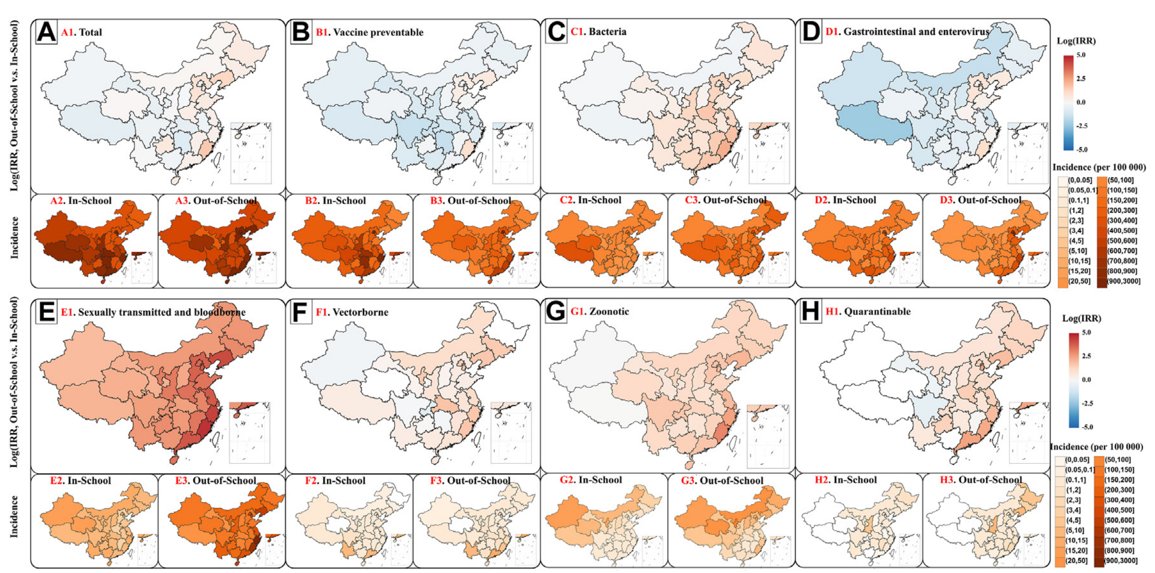

Fig. 3: **Regional distribution (Subfigure A2-H2 for in-school population; A3-H3 for out-of-school population) and regional disparity (Subfigure A1-H1) of total and specific infectious disease in incidence and incidence rate ratio (IRR) between in-school and out-of-school children, adolescents, and youth**. Notes: Subfigure A1 to H1 showed the regional disparity of total and specific infectious disease using the index of incidence rate ratio (IRR) for out-of-school children, adolescents, and youth aged 6–21 years towards those of in-school. Regional distribution of total and specific infectious disease in incidence was showed for those in-school (Subfigure A2-H2) and out-of-school (Subfigure A3-H3).

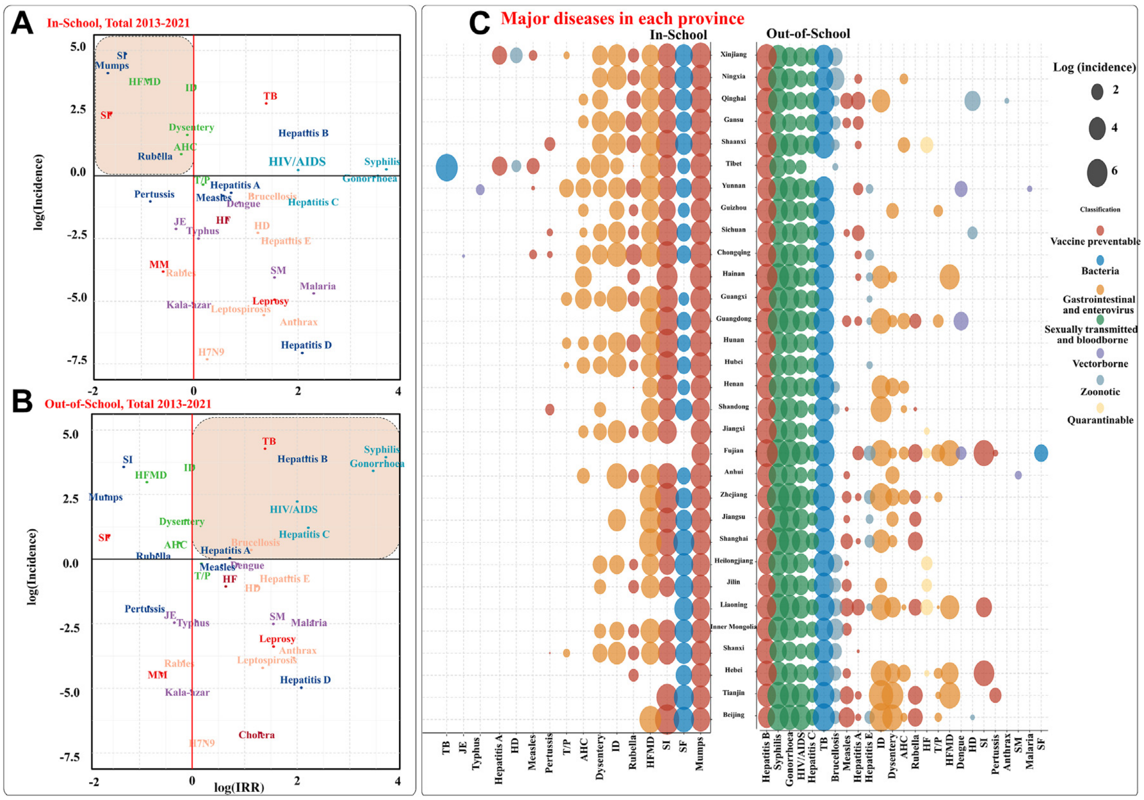

Fig. 4: **Disparity of distribution of incidence of infectious diseases and identification of priority infectious diseases between in-school and out-of-school children, adolescents, and youth by province.** Notes: Disparity of distribution of incidence of all infectious diseases was showed for total levels from 2013 to 2021 (subfigure A and B), and disparity of priority infectious diseases in each province was showed between two groups in subfigure C.

significantly with the years, but it is worth noting that several vaccine preventable diseases and gastrointestinal and enterovirus diseases kept the priority diseases for those of in-school, such as seasonal influenza, mumps, HFMD, dysentery, acute hemorrhagic conjunctivitis, and rubella. Among those of out-of-school, 9 infectious diseases were identified as priorities during the 9 years: tuberculosis, hepatitis A, B and C, infectious diarrhea, syphilis, gonorrhea, HIV/AIDS, and brucellosis, and all four sexually transmitted and bloodborne diseases and tuberculosis always kept the priority diseases for those of out-of-school from 2013 to 2021. Such different priority infectious diseases between two groups almost kept similar in different provinces.

Discussion

Principal findings

This study represents the first investigation into the disparity in the spectrums of 43 notifiable infectious diseases between in-school and out-of-school children, adolescents, and youths aged 6–21 years old in China. Our results indicate the burden of infectious diseases among out-of-school population was higher than those who remained in school, with sexually transmitted and bloodborne, bacteria, vectorborne, quarantinable, and zoonotic diseases contributing most to this disparity, but such disparity gradually narrowed over time due to continuous achievements and measures in infectious disease prevention and control in Chinese children, adolescents, and youths, particularly for the compulsory education stage population. Vaccine preventable diseases and gastrointestinal and enterovirus diseases offset this difference. Notably, we found that such disparity was most pronounced in most age groups and in eastern and coastal regions of China, and narrowed over time for six categories diseases, except for sexually transmitted and bloodborne diseases, which showed an increasing disparity. Based on our findings, the priority diseases for in-school students should focus on several vaccine preventable diseases and gastrointestinal and enterovirus diseases, while for out-of-school those, priority should be given to four sexually transmitted and bloodborne diseases and tuberculosis from 2013 to 2021. These findings provide important insights into the disparity of infectious diseases between in-school and out-of-school populations and offer a roadmap for future public health interventions to address this disparity.

China has made significant strides in infectious disease control, with incidence rates of most key infectious diseases with significant harm decreasing among in-school children and adolescents, and youths, and this is a testament to the effectiveness of China's prevention and control measures, which have been implemented through various programs and initiatives in recent years.[8] most diseases, the incidence of infectious diseases was higher among those out of school than in-school, particularly for sexually transmitted diseases (STDs). However, comparisons with other countries and regions are limited due to a lack of research on the distinctions between two groups. Global infectious disease burdens among children, adolescents, and youths have decreased in recent decades,[25–28] but burdens are still disproportionately high in LMICs.[29–33] The proportion of children, adolescents and youths between out-of-school and in-school varies by country and area, with lower proportions in high-income countries and higher proportions in LMICs.[10] Our study reveals a higher incidence of most infectious diseases among those out-of-school, suggesting that LMICs might have a higher proportion of non-students out-of-school and a heavier burden of infectious diseases. Interestingly, regional differences within China show that economically developed regions in the east, particularly coastal areas, have a higher burden of infectious diseases among out-of-school children, adolescents and youths, particularly for those who have completed compulsory education, while economically underdeveloped regions in the west have a higher burden of infectious diseases among those in-school. Although the proportion of those out-of-school in the west might be higher, more out-of-school youths may migrate to the east to work, and the out-of-school population in the east is relatively low, leading to more obvious and higher risks of infectious diseases in the east than west. The findings emphasize the importance of ensuring vaccination coverage, regular health monitoring, morning and afternoon examinations, and emergency response capabilities for school students in some central and western provinces of China. On the other hand, the eastern coastal provinces, which are major labor-intensive regions, need to prioritize timely and universal health education to promote the implementation of infectious disease prevention and control measures for young migrant workers who are not attending school.

While traditional infectious disease prevention and control projects focused on school-aged children and adolescents, our study highlights the validity of this approach. However, our findings also reveal a potential gap in current prevention efforts, as out-of-school children, and adolescents, particularly for those who have completed compulsory education and were able to enter society, remain vulnerable and may require targeted prevention strategies to meet their unique needs. Thus, we suggest an adaptive strategy in China that incorporates the characteristics out-of-school children, adolescents, and youths, such as age-specific community health education and life skills education, in community-based interventions, as they need to strengthen their awareness of being the first responsible person for their health when they leave school settings. Moreover, expanding the coverage and scope of immunization programs and surveillance systems could benefit more out-of-school peers, reducing health disparity between two groups.

The incidence of infectious diseases among school population is dominated by vaccine preventable diseases, gastrointestinal and enterovirus diseases, with a high incidence in younger age groups. The high concentration of students in schools provides an opportunity for seasonal influenza, which typically occurs indoor.[34] Classrooms with a high concentration of students are the best places for seasonal influenza transmission. The possibility for transmission of gastrointestinal and enterovirus infections among students in schools increases due to collective eating behaviors such as HFMD, and dysentery. Future health education on dietary hygiene and daily hygiene needs to be strengthened for younger age groups, as these diseases have a high incidence among students in schools.[35,36] Most vaccine preventable diseases present a gradually narrowing disparity between the two groups, even including tuberculosis, which is included in bacterial diseases, reflecting China's important achievements in the national immunization plan during the past decade. However, the heavier burden of vaccine preventable diseases in population in schools than those out of schools was primarily driven by seasonal influenza and mumps. The concentration of students in schools may contribute to the increased incidence of these two highly contagious diseases among this population, and immunization policies may also have some impact on the large disparity for these two diseases between two groups. And Continuous upgrading and improvement of monitoring systems, coupled with the strengthening of infectious disease management systems, enable the timely and effective detection of a greater number of cases in school environments as opposed to community settings. Seasonal influenza vaccine is a self-funded vaccine that is not within the scope of national immunization planning policies, resulting in low coverage rates.[37] Conversely, out-of-school children face a heightened risk of hepatitis B and other diseases due to familial clustering, creating a more complex environment.[38] However, the student population in schools have the advantage of being able to detect hepatitis B patients or carriers during regular health check-ups, while out-of-school population may not have the same level of access to healthcare. Therefore, proactive measures such as increasing influenza vaccine coverage and strengthening health management in schools are crucial to prevent vaccine preventable diseases among students. Expanding vaccination was also required, especially during the COVID-19 pandemic, as the immature immune system of young children is more susceptible to assault by viruses.[39]

However, sexually transmitted and bloodborne diseases, of course mainly STDs, are the priority infectious diseases of those out-of-school, and its incidence remains high among students in schools.[22,40] Previous study reported that the incidence of HIV/AIDS among those in-school increased by five times from 2008 to 2015.[8] The dominating age for priority STDs among those in-school is the high age groups, with out-of-school girls disproportionately at risk. Sexual transmission, especially MSM, is the main route of transmission of STDs.[8,41] More importantly, we found for the first time that the disparity of gonorrhea and syphilis between two groups was higher than that of HIV/AIDS, which also meant that STDs in out-of-school groups, particularly for those who have completed compulsory education, faced a major challenge of co-occurrence of multiple diseases. As in 2022, many countries have issued warnings, indicating that STDs would have the potential of "out-of-control" with the including 26% syphilis spike sparking US alarm.[42] A similar national surveillance in US reported that the rates of chlamydia, gonorrhea, and syphilis across the country have been climbing since 2013, particularly during first year of the COVID-19 and the majority of cases were occurring in adolescents and young people.[43,44] Similar events were also reported in Japan that 2022 was shaping up as Japan's worst on record for syphilis infections, with total reported cases for 2022 exceeding 10,000 in October.[45] Thus, effective and doable preventive measures include learning enough about sexual safety before engaging in unsafe sex and rapid detecting STDs afterward, and adequate health education to eliminate sense of stigma,[46] which meant that sex education needed to be brought forward before first sex behavior. In addition, the prevalence of STDs is a major concern for those out-of-school, who engage in sexual behavior earlier and more frequently than their in-school peers. However, lack of convenient and sufficient access to sexual health education increases the risk of these diseases for those out-of-school.[47] Compounding the issue is the limited access to sexual health education, as these individuals are no longer attending schools where such education is typically provided.[48,49] To address this, extending the years of compulsory education and allowing more school-age youngsters to attend schools may be an effective and achievable strategy with broad health benefits.[50–52] Minors and those who have just completed compulsory education and entered society should also be included in community-based health education interventions and counseling to address the public health blind spot of those out-of-school.

Among those out-of-school, tuberculosis was identified as the infectious disease with the highest incidence, which was also among the top five for those in-school. The increased incidence of tuberculosis might be directly connected to active behavior, crowded environments, intensive testing, and technological advancements.[53–56] However, prior to identifying the tuberculosis burden in children and adolescents, the out-of-school population was largely unrecognized,[57] which highlighted the need for targeted interventions. While China's tuberculosis care and preventive measures have succeeded in reducing the overall burden of tuberculosis among children and adolescents,[8] additional attention and innovative strategies are necessary to address the disparities in incidence between those in and out of school. Additionally, tuberculosis is closely linked to STDs, which accounted for 1.5 million people worldwide in 2020, including 241,000 HIV-positive individuals.[57] The coexistence of HIV and tuberculosis was lethal and mutually reinforcing.[58] The simultaneous occurrence of high incidence of STDs and tuberculosis among those out-of-school is concerning, as it may increase the risk of death and exacerbate the health disparity between two groups. In the tuberculosis response, children and adolescents have been prioritized,[59] thus, previously neglected out-of-school children, adolescents and youths should also be the key population, particularly in LMICs where the proportion of non-students is higher.[60]

Implications

Several implications should be noted in our study. Firstly, as human activities continue to strengthen and globalization accelerates, the risk of global pandemics of infectious diseases is increasing.[61,62] COVID-19 has raised public health awareness of infectious diseases, but regular emphasis on infectious disease surveillance and prevention is necessary. Children and adolescents are the most susceptible age groups, and this study highlights the need to distinguish the disparity of infectious diseases burdens between in-school and out-of-school children, adolescents, and youths. On the basis of maintaining existing advantages and achievements, extended coverage and expanded immunization programs are necessary for both groups, especially after COVID-19 pandemic. Sex health education should also be advanced to address the low accessibility of sexual health knowledge for those out-of-school. Secondly, determining the priority infectious diseases between in-school and out-of-school children, adolescents, and youths is critical for public health. Priorities for public health and conventional infectious diseases could be determined in a variety of methods, particularly when medical resource available was limited.[10,63] The priority infectious diseases of non-students and students diverge significantly, with a greater number of priorities among those out-of-school. The disparity in priorities may be due to differences in aggregation and behavioral characteristics, and the inaccessibility of infectious diseases health promotion policies for those out-of-school. Thirdly, prioritizing the response to STDs and tuberculosis among those out-of-school and ensuring access to prompt community testing is crucial to decrease the incidence of these diseases in all children, adolescents and youths. Our study highlights the high priority of non-students in the STDs and tuberculosis control notably emphasized, particularly in LMICs, providing international evidence for LMICs to develop strategies to tackle these diseases. The implications of the research findings are aligned with China's current national health strategy and priorities. The Healthy China 2030 Plan has outlined specific goals and detailed tasks for improving the health of the entire population. The study's results provide precise information for targeted prevention and control measures, as well as priority concerns and interventions, that can be implemented to further advance this major national strategy.

Strengths and limitations

The current study has several notable strengths and limitations. On the positive side, it recognizes, for the first time, the disparity in the incidence of infectious disease between in-school and out-of-school children, adolescents, and youths, and identifies the priority infectious diseases for both groups. The study draws on data from the comprehensive and accurate CISDCP surveillance system for infectious diseases, which covers all notifiable infectious diseases across all age groups. However, the study may underestimate the incidence of infectious diseases, particularly among out-of-school individuals, due to the passive detection nature of the surveillance system and the lack of regular supervision for those not attending school. Furthermore, economically deprived areas with poorer coverage of the surveillance system may have had their incidence underestimated. Nevertheless, the high coverage of the system across the country, with over 85% coverage and 95% coverage for county-level and higher facilities, respectively, increases the reliability of the research data.[8]

Conclusion

China has made significant achievements in preventing and controlling infectious diseases in reducing the disparity among in and out school children, adolescents, and youths. However, the burden of infectious diseases remains higher among the out-of-school population compared to their peers in-school. The disparity is mainly driven by sexually transmitted and bloodborne, bacteria, vectorborne, quarantinable and zoonotic diseases, while it is offset by vaccine preventable diseases, and gastrointestinal and enterovirus diseases. Although there has been a gradual reduction in the overall disparities in infectious diseases over the surveillance years, particularly for the compulsory education stage population, sexually transmitted and bloodborne diseases appear to widen the gap and remain a top priority among out-of-school populations, along with tuberculosis. The incidence of sexually transmitted infections is disproportionately high among female out-of-school populations and those completing compulsory education. Although in-school populations were dominated by gastrointestinal and enterovirus diseases, sexually transmitted and blood-borne diseases cannot be ignored. Efforts to combat tuberculosis and STDs should be emphasized among the out-of-school population, particularly in LMICs with a high proportion of non-students. Although there has been a gradual reduction in overall disparities in infectious diseases over the surveillance years, more efforts are needed to narrow the gap further between in-school and out-of-school children, adolescents, and youths in China, such as extending the years of compulsory school, providing sex health education to earlier grades and dropouts, expanding immunization program coverage, increasing the investment of social health resources and the improvement of personal health literacy in the non-compulsory education stage, and raising the priority of the control of STDs and tuberculosis among those out-of-school. This study provides a foundation for further implementing the Healthy China 2030 Plan strategy and adds evidence for educational development and measures to promote population health in LMICs worldwide.

Contributors

LC and LW conceptualized and designed the study, completed the statistical analyses, drafted the initial manuscript, and reviewed and revised the manuscript; YD and JM contributed to the conceptualization and design of the study, supervised the data collection, the statistical analyses and initial drafting of the manuscript, and reviewed and revised the manuscript; YX and YS critically reviewed and revised the manuscript from preliminary draft to submission; JX, BS, MG and XR assisted with the data interpretation, and reviewed and revised the manuscript; Dr. YZ, JL, TM, MC, QM, JJ, MC, TG and WY reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. We confirm that LC, LW, YD and JM have had access to the data and have verified its accuracy. LC, LW, YD and JM were responsible for accessing and verifying the data, while YD and JM were responsible for the decision to submit the manuscript.

Data sharing statement

All of the data (de-identified) collected in the surveillance system can be shared with investigators whose proposed use of the data has been approved by an independent review committee identified for this purpose by contacting the corresponding author. The study protocol and statistical analysis plan must be approved by the committee. Proposals should be directed to majunt@bjmu.edu.cn and dongyanhui@bjmu.edu.cn.

Editor note

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Declaration of interests

We declare no competing interests.

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Appendix A. Supplementary data
Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100811.

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