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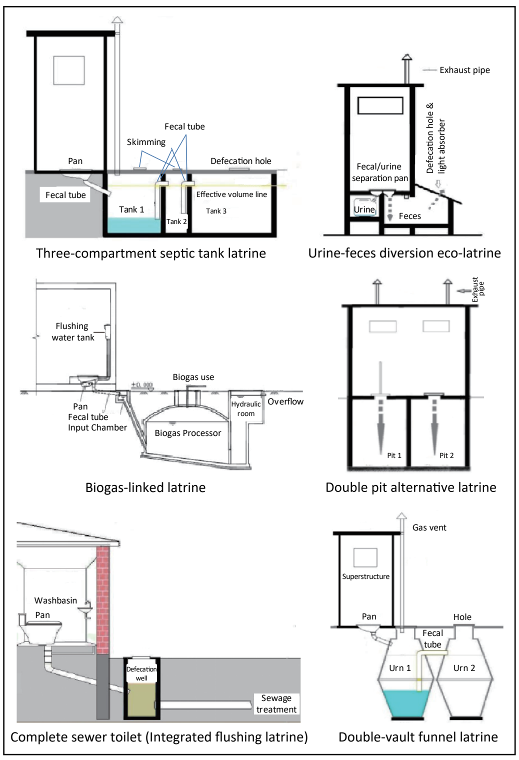

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Cover Image: Schematic diagram of six types of sanitary toilets.

Preplanned Studies

Improving Sanitary Latrines in Rural Areas Correlated to Decreasing the Related Disease Burden — China, 2006−2017

Lin Lin[1]; Wei Yao[2,#]; Hongxing Li[2]; Dongshan Liu[1]; Rong Zhang[2,#]

Summary

What is already known on this topic?

A Latrine Revolution was conducted to promote the coverage of sanitary latrines, and this coverage has shown to increase significantly from 2006 to 2017. Sanitary latrines are an important strategy for reducing disease burdens associated with poor sanitation infrastructure.

What is added by this report?

Mortality of diarrheal diseases attributable to unsafe sanitation decreased from 7,748.05 in 2006 to 2,405.46 in 2017 and was correlated with increased use of sanitary latrines.

What are the implications for public health practice?

The coverage of sanitary latrines in rural areas of China should be further improved through the adjustment of policies and plans and by combining health education and hygiene promotion.

The improvement of obsolete latrine pits in rural areas of China was proposed as early as 1960s, and campaigns were discussed in 2015 to prioritize the the improvements of latrines across the country (*1*). By 2015, the Chinese government announced that farmers and other rural residents needed access to sanitary latrines and subsequently launched the Latrine Revolution in rural areas (*2*). Following these comments, China has been promoting the Latrine Revolution meant to continuously improve sanitary latrines that have played important roles in improving rural living conditions, decreasing the rates of fecal-oral transmitted diseases, and further progressing the civilizing of society goals. There were six different sanitary latrine types promoted in rural household to improve the disposal of feces. The coverage of sanitary latrines in rural communities rose from 55.0% in 2006 to 81.8% in 2017 and were accompanied by sharp drops in the rates of diarrheal diseases and soil-transmitted helminths (STH). A correlation analysis was conducted using data on the improving coverage of sanitary latrines and indicators of STH and diarrheal diseases caused by unsafe sanitation in China during 2006 and 2017. The human capital approach was also applied to calculate the reduction of indirect economic burden (IEB) associated with unsafe sanitation during 2006 and 2017. Both the prevalence of STH infections (R^2 = 0.94) and mortality of diarrheal diseases (R^2=0.95) due to unsafe or poor sanitation had negative correlations to increased coverage of sanitary latrines. Furthermore, in 2017, an estimated 7.60 billion CNY (1.12 billion USD in 2017) was saved in 2017 compared to 2006. This suggested that the increased coverage of these sanitary latrines significantly contributed to reducing intestinal infectious diseases and other related disease burdens, so continuing the Latrine Revolution should be a top priority and combined with health education and promotion to target affected populations.

In developing countries, controlling diseases related to sanitation facilities are vital to maintaining public health especially as fecal-oral disease burdens remain significant. In low- and middle-income countries in Southeast Asia, the lack of sanitation accounted for approximately 29% of the burden of diarrheal diseases (*3*). In 1993 in China, sanitary latrine coverage in rural China was only 7.5% and fecal-oral transmission of diseases accounted for more than 70% of infectious disease incidence as there were 490 million people infected with *Ascaris*, 200 million with hookworm, more than 1.13 million with schistosomiasis (*4*). Sanitation interventions and improvements are directly related to the protection of public health (*5*). This study aims at describing the health impacts from the Latrine Revolution on intestinal infectious diseases, especially diarrheal diseases, during 2006 and 2017.

Coverage of sanitary latrines in rural areas was extracted from the China Health Statistical Yearbook (*6*). The prevalence of STH infection was extracted from the National Surveillance System for Key Infectious Diseases and Vectors (*7*). Mortality and burden of diarrheal diseases attributed to unsafe sanitation were extracted from the Global Burden of

Disease Study 2017 (GBD 2017) (*8*). Indicators of disease burden include disability-adjusted life years (DALYs), years of life lost (YLLs), and years lived with disability (YLD). The human capital approach (*9*) was applied to measure IEB, and gross domestic product (GDP) per capita was collected from the China Health Planning Statistical Yearbook 2018 (*6*).Correlation analysis was adopted to examine the correlation of the coverage of sanitary latrines and indicators of diarrheal diseases due to unsafe sanitation and STH. Human capital approach was applied to measure indirect economic burden (IEB) using the following formula.

$$\text{IEB} = \sum_{i=1}^{n} DALY_i \times W_i \times GDP\ per\ capita \qquad (1)$$

In formula (1), IEB was the sum of products of age-specified $DALY_i$, W_i, and GDP per capita. $DALY_i$ is DALY in age group i . W_i is weights of productivity in age group i. GDP per capita in 2017 was used in IEB in 2006 and 2017.

During the period between 2006 and 2017, the coverage of sanitary latrines in rural areas of China increased from 55.0% to 81.8%, while deaths from diarrheal diseases attributable to unsafe sanitation decreased from 0.58/100,000 population to 0.17/100,000, and prevalence of STH infection from 20.88/100,000 reduced to 1.78/100,000 (Table 1). The result showed that the coverage of sanitary latrines in rural China was negatively correlated with both the mortality of diarrheal diseases attributable to unsafe sanitation (R^2=0.94) and the prevalence of STH (R^2=0.95). Moreover, both the infection rate of STH and the mortality rate of diarrheal diseases have decreased significantly alongside increasing coverage of sanitary latrines in rural China during the period from 2006 to 2017.

The number of deaths from diarrheal diseases attributable to unsafe sanitation decreased by 68.95% from an estimated 7,748.05 in 2006 to 2,405.46 in 2017. In the year 2017, DALYs (845,966.23 *vs.* 346,274.02, −59.07%), YLLs (531,449.12 *vs.* 115,418.89, −78.28%), and YLDs (314,517.12 *vs.* 230,855.13, −26.60%) of diarrheal diseases attributable to unsafe sanitation significantly decreased compared with those in 2006. Decreases in DALYs and YLLs were mainly found in children under 5 years old, and decreases in YLDs were mainly found in individuals over 5 years old (Table 2).

In addition, the human capital approach suggested that the weighted DALYs in 2017 decreased by 127,376.11 person-years compared with 2006, which was equivalent to a reduction of 7.60 billion CNY (1.12 billion USD in 2017) in IEB (Table 3).

TABLE 1. Coverage of sanitary latrines in Rural Areas, mortality of diarrheal diseases attributable to unsafe sanitation, and prevalence of soil-transmitted helminths (STH) infection — China, 2006−2017.

Year	Coverage of sanitary latrines (%)*	Mortality of diarrheal diseases attributable to unsafe sanitation (per 100,000)†	Prevalence of STH infection (per 100,000)§
2006	55.0	0.58	20.88
2007	57.0	0.48	18.93
2008	59.7	0.41	16.59
2009	63.2	0.36	13.30
2010	67.4	0.31	11.25
2011	69.2	0.27	9.67
2012	71.7	0.24	6.90
2013	74.1	0.22	3.12
2014	76.1	0.20	4.49
2015	78.4	0.19	4.95
2016	80.4	0.18	–¶
2017	81.8	0.17	1.78

* Data Source: China Health and Family Plan Statistical Yearbook (*5*).
† Data Source: Global Burden of Disease Study 2017 (GBD 2017) Results (*7*).
§ Data Source: National Surveillance System of Key Infectious Diseases and Vectors (*6*).
¶ Not available.

DISCUSSION

The findings showed that there were decreases in the mortality rate and burden of diarrheal diseases in relation to the use of unsafe sanitation facilities (mainly rural household latrines) in China during the period between 2006 and 2017. However, among children aged 1–4 years old, the YLD rate was 4.03% higher in 2017 than in 2006. It is indicated that it is worthy to promote the latrine revolution continuously due to its many health benefits as well as rich the economic benefits to China.

Previous studies in China (*10*–*11*) found that improving latrines as an intervention in rural areas was associated with lower incidence of diarrheal diseases with a relative risk of diarrheal diseases in relation to latrine improvement being 0.49; this study obtained consistent results.

Along with the development of social economy in China, the Latrine Revolution in rural areas played an important role in promoting public health, especially children's health. The under-five mortality rate of

TABLE 2. Burden of diarrheal diseases attributable to unsafe sanitation — China, 2006−2017 *.

Item	2006	2017	Change	
Mortality	7,748.05	2,405.46	−5,342.59	−68.95%
Mortality rate, per 100,000				
Under 5 years	7.36	1.13	−6.23	−84.65%
<1 year	30.78	4.20	−26.58	−86.35%
1 to 4 years	1.59	0.22	−1.37	−86.16%
DALYs (person years)	845,966.23	346,274.02	−499,692.21	−59.07%
Age-Standardized DALY rate, per 100,000	100.99	31.38	−69.61	−68.93%
DALY rate, per 100,000				
Under 5 years	731.65	185.00	−546.65	−74.71%
<1 year	2,869.32	501.27	−2,368.05	−82.53%
1 to 4 years	205.55	91.01	−114.54	−55.72%
YLLs (person years)	531,449.12	115,418.89	−416,030.23	−78.28%
Age-Standardized YLL rate, per 100,000	72.49	11.58	−60.91	−84.03%
YLL rate, per 100,000				
Under 5 years	640.76	98.68	−542.08	−84.60%
<1 year	2,691.17	367.48	−2,323.69	−86.34%
1 to 4 years	136.13	18.79	−117.34	−86.20%
YLDs (person years)	314,517.12	230,855.13	−83,661.99	−26.60%
Age-Standardized YLD rate, per 100,000	28.50	19.79	−8.71	−30.56%
YLD rate, per 100,000				
Under 5 years	90.89	86.33	−4.56	−5.02%
<1 year	178.15	133.79	−44.36	−24.90%
1 to 4 years	69.42	72.22	2.80	4.03%

* Data source: Global Burden of Disease Study 2017 (GBD 2017) results.
Abbreviations: DALYs=disability-adjusted life years, YLLs=years of life lost, YLD=years lived with disability.

TABLE 3. The age-specified indirect economic burden of diarrheal diseases attributable to unsafe sanitation — China, 2006−2017.

Age group(years)	W_i	2006		2017	
		$DALY_i$* (person years)	IEB† (100,000 CNY)	$DALY_i$* (person years)	IEB† (100,000 CNY)
≥ 0	0.15	88,682.45	52,907.95	27,096.68	16,165.88
≥ 15	0.75	91,918.96	54,838.85	36,219.17	21,608.36
≥ 45	0.8	41,354.20	24,671.92	31,498.47	18,791.99
≥ 60	0.1	8,049.85	4,802.54	7,815.03	4,662.45
Total		230,005.47	137,221.26	102,629.36	61,228.67

Note: W_i means the weights of productivity in age group.
* $DALY_i$ was collected from Global Burden of Disease Study 2017 (GBD 2017) results (*7*).
† GDP per capita in 2017 was used in IEB both 2006 and 2017, in order to avoid the impact of economic development.
Abbreviations: DALY=disability-adjusted life year, IEB=indirect economic burden.

diarrheal diseases attributable to unsafe sanitation in China during 2006 and 2017 dropped by 84.65%; during the same period, the overall under-five mortality rate in China declined by 56.08% (*12*). Diarrheal diseases have been known to cause malnutrition and affect the growth and development of children. Although the overall burden of diarrheal diseases has declined, the YLD rate in children aged 1–4 years in 2017 was higher than that in 2006. Therefore, it is necessary to take and develop comprehensive sanitation improvement policies and plans and combine them with health education, hygiene promotion, and improving socioeconomic conditions and living environments to achieve further success. Previous studies found that increasing coverage of sanitary latrines in rural areas was accompanied by enhanced health awareness of local residents, and the elimination of fecal pollution was accompanied by decreases in incidence of related intestinal infectious diseases that improved overall health and family life quality and promoted the development of the countryside to eliminate poverty. Meanwhile, the safe treatment of human excreta is an important environmental protection measure as it provides good organic fertilizer resources for farmland and is of great benefit to the development of agricultural ecology. This is a sound policy basis to benefit individual, societal, and environmental health.

Furthermore, several interventions related to sanitation and hygiene should be more targeted to children and their caregivers in rural areas in order to develop their health habits, and the financial support for such interventions should be further strengthened at the policy level by the government. In addition, universal access to sanitary latrines is gradually being introduced, which will produce significant effects for public health and environmental and economic benefits.

This study was subject to at least several limitations. First, the national prevalence of STH infection and national mortality of diarrheal diseases were used in this study as data focusing on rural areas was not available. This may have resulted in an overestimation of the reduction of the burden of diarrheal diseases related to the Latrine Revolution and underestimating the correlation between sanitary latrine coverage and indicators of STH and diarrheal diseases. Second, costs of patient healthcare were not included in the IEB due to data unavailability. The contribution of economic growth to GDP per capita also played an important role in the reduction of IEB. Third, the data sources used in this study were collected beginning in 2006 and GBD 2017 was the most updated version to be used in this study. This range limited the years in which the impact of the Latrine Revolution, having begun in 2015, could be examined, but the effects of gradual improvements are noticeable.

The findings of this study provided evidence for further developing the rural Latrine Revolution and plans for health education and hygiene promotion, which represent good practice and play a key role in advancing further rural social and economic development.

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Preplanned Studies

Prevalence of Falls Among the Rural Elderly — Three PLADs of Western China, 2017–2018

Tong Xu[1]; Hui Han[1,#]

Summary

What is already known about this topic?

As population aging becomes serious in China, the elderly health problems stand out prominently. Prevention of falls of the elderly has become an important subject in China's public health.

What is added by this report?

The prevalence of falls among rural elderly in western China was 9.6%. The highest prevalence was registered among the groups of female, aged 70 and over, or Salar ethnicities, or with visual deficiency and chronic diseases, of which 33.0% fell subjectively due to their poor body balance, and 65.8% fell objectively due to slippery floor or ground obstacles.

What are the implications for public health practice?

Considering the health status of the elderly in the western China and the prevalent fall-related risk factors, health education in respect of falls prevention should be performed. Moreover, the home environment of the elderly should be checked for potential safety hazards and improved if necessary, and medical and health resources should be rationally allocated to target population in order to avoid any reoccurrence of falls injury and thus relieving the burdens upon individuals, families and the society.

According to the Sixth National Population Census of China, people aged 65 years and older accounted for 8.9% of the total population in 2010, which suggested that China had transitioned into an aging society (*1*). As the elderly population increases, their health problems are becoming increasingly concerning, and unintentional injuries, such as falls, being one of the most important issues affecting their health (*2*). Physiological factors including sensory and muscular degeneration, diseases, and environmental factors may all contribute to a higher prevalence of falls in the elderly (*3*). This study investigated the prevalence of falls among the 4,582 rural elderly aged 60 years and older in 3 provincial-level administrative divisions (PLADs) of western China — including Chongqing Municipality, Yunnan Province, and Qinghai Province. This study was part of the National Health Commission's (NHC) survey "Community Participation to Promote Rural Elderly Health — Phase II" project that was completed from November 2018 to January 2019. The participants were selected using a multistage random cluster sampling method from 36 administrative villages in 6 project counties of Yunnan, Qinghai, and Chongqing: 2–3 townships of each county were randomly selected followed by 2 villages of each township; elderly villagers aged 60 years and over in the selected villages were interviewed if they were able to understand and answer the questions on their own and had a local residence history of no less than 6 months.

The face-to-face questionnaire interviews were conducted to collect information on participants' demographic characteristics, health-related conditions, and prevalence of falls (occurrence and number of falls in the past year, the causes of the falls, and consequences of falls). A fall was defined as "an incident in which a patient suddenly and involuntarily came to rest upon the ground or surface lower than their original station" (*4*). There were two types of falls: 1) falls from one surface to another surface; and 2) falls on the same surface excluding those caused by paralysis, epilepsy, or external violence (*5*). This study investigated falls within a year before the survey time.

Chi-square analysis was performed to determine the differences in the prevalence of falls across groups. Significance was defined as $p<0.05$, and SPSS statistical software (version 22.0, SPSS Inc, Chicago, IL, USA) was used to conduct all analyses.

Among the 4,582 persons interviewed, 2,313 were male (50.5%), and 2,269 were female (49.5%). The average age was 71.5±7.2 years old (Table 1). A total of 439 persons experienced falls with 75.6% experiencing 1 fall and 24.4% experiencing 2 or more falls. The average prevalence of falls was 9.6%, with 8.5% for males and 10.7% for females (χ^2=6.609, p=0.01).

TABLE 1. Demographic characteristics and prevalence of falls among rural elderly — three provincial-level administrative divisions of western China, 2017–2018.

Item	Number	Percentage (%)	Number of falls	Prevalence (%)	χ^2	*p*
Gender					6.609	0.010
Male	2,313	50.5	196	8.5		
Female	2,269	49.5	243	10.7		
Age					21.200	<0.001
≥ 60 years	2,522	55.0	196	7.8		
≥ 70 years	1,451	31.7	171	11.8		
≥ 80 years	609	13.3	72	11.8		
Ethnicity					11.375	0.003
Han	1,827	39.9	194	10.6		
Salar	78	1.7	14	17.9		
Other	2,677	58.4	231	8.6		
Educational level					15.606	<0.001
Below primary school	3,032	66.2	324	10.7		
Primary school	1,164	25.4	95	8.2		
Junior high school and above	386	8.4	20	5.2		
Vision problems					14.873	<0.001
Yes	3,351	73.1	152	12.3		
No	1,231	26.9	287	8.6		
Chronic disease					10.997	0.001
Yes	2,910	63.5	192	11.5		
No	1,672	36.5	247	8.5		
Total	4,582	100.0	439	9.6		

The prevalence of falls was the highest (11.8%) in the group aged ≥70 years (χ^2=21.2, p<0.001).

The consequences of falls were serious and typically represented by injuries of different levels (52.8%), which included severe pain or soft tissue injury (40.5%) and fractures (12.3%). The multiple-choice questionnaire analysis showed that poor body balance (33.0%), skelasthenia (24.4%) and instant physical discomfort (24.1%) were the main personal reasons of falls. Slipper floors/obstacles (65.8%) and insufficient/blinding light (11.6%) were the main environment causes of falls (Table 2).

TABLE 2. The causes of falls among rural elderly in three provincial-level administrative divisions of western China, 2017–2018.

Cause of fall	Number	Proportion (%)
Personal cause		
Poor body balance	145	33.0
Skelasthenia	107	24.4
Instant physical discomfort	106	24.1
Inattentive	65	14.8
Poor eyesight	52	11.8
Other	14	3.2
Environmental cause		
Floor slippery/obstacle	289	65.8
Insufficient or blinding light	51	11.6
The stairs being too high	21	4.8
Other	13	2.9
Furniture height not suitable	12	2.7
The bathroom lacks handrails	5	1.1

DISCUSSION

This study showed that the prevalence of falls among this sample of the rural elderly in the western China was 9.6%. The prevalence of falls was higher among females than males, and the prevalence of falls was higher among the group aged ≥70 years than the group aged <70 years.

The prevalence of falls appeared to vary among areas, regions, and countries (*6–7*). In China, a study in Qingpu District of Shanghai found that the prevalence of falls among the community elderly was 7.9% (*8*), while another in Shijiazhuang City of Hebei Province found that the prevalence was 11.2% (*9*). Globally, studies in Japan suggested that an estimated 20% of older adults fall each year, while a study in the Latin/Caribbean region found that the proportion of elderly adults who fell each year ranging from 21.6% in Barbados to 34% in Chile (*10*). One possible reason for this inconsistency is that many studies fail to specify a clear definition of falls and result in ambiguity. Therefore, the operational definition of a fall with explicit inclusion and exclusion criteria is critical.

This study had several conclusions about falls amongst the study population. First, 70 years appeared to be a node indicating a changing trend in prevalence, and the prevalence of falls was higher for females than male in all age groups. Second, the prevalence of falls was high among the elderly with visual deficiencies and chronic diseases as elderly with visual deficiencies likely could not accurately detect risk factors in their environment, which made them more susceptible to falls that were avoidable. The elderly with chronic diseases were more vulnerable to illnesses and other physical problems than otherwise healthy elderly individuals, which likely made them more likely to fall.

Various personal and environmental causes may lead to falls among elderly people. Personal causes included poor body balance, sickness, vision loss, chronic diseases, or other health problems. Environmental main causes included slippery floors or ground obstacles and inadequate lighting. Such causes can be avoided through increasing exercise interventions, observing poor physical conditions, and improving home/living environments. Key health education information should be developed and distributed to help elderly people know what preventive actions can be taken when they feel uncomfortable physically, how to prevent osteoporosis, and how to check/improve their home environment. In addition, appropriate interventions such as physical exercises should be intensified to maintain or improve the physical condition of elderly people.

Being an ethnic minority was also found to be an important fall-related risk factor. Our study indicated that the prevalence of falls was higher among the elderly of Salar. A pairwise comparison of fall rates of various ethnic groups found that the difference between the Salars and other ethnic groups was statistically significant. The analysis suggested that this may be due to poorer living environments of the Salars, as this group typically lived in plateaus and mountainous areas where factors such as slippery floor or obstacles may lead to falls. Attention should therefore be paid to this vulnerable population in terms of improving living environments and providing educational materials and intervention activities in the appropriate language.

This study was subjected to some limitations. First, this was a retrospective study, which when coupled with elderly patients having likely reduced memory capacities and other health problems, may have made recall bias inevitable. Prospective study designs are more widely used, which may contribute to the prevalence of falls being lower in this study than others. Second, this study did not collect information on deaths due to falls. Some participants also denied or failed to report certain falls that did not cause body injuries. The prevalence of falls might therefore be underestimated.

This study investigated the prevalence of falls amongst the rural elderly population in three PLADs of western China. These results could help inform targeted interventions that can prioritize high-risk groups and help design educational materials.

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Outbreak Reports

A Tuberculosis Outbreak at a School — Xinjiang Uygur Autonomous Region, China, 2019

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Summary

What is already known about this topic?

Worldwide, tuberculosis (TB) continues to be the most important cause of death from a single infectious agent, and China has a high TB burden. Although the reported incidence of TB in students is lower than that in general population, TB outbreaks in schools have continuously been reported in the past years, suggesting that schools are a high-risk setting for TB transmission.

What is added by this report?

In total, 31 TB patients were founded in students. Epidemiological linkage among all TB cases could not be determined due to absence of genome sequencing. However, based on the analysis of screening results, the index case was probably the source of transmission.

What are the implications for public health practice?

The preventative measurements should be implemented in schools. Adding TB examinations into entrance examinations and strengthening health education could find TB cases early, and improving ventilation could decrease the risk of TB transmission in schools.

On March 8, 2019, Aletai City People's Hospital in Xinjiang Uygur Autonomous Region confirmed and reported 1 student with pulmonary tuberculosis (TB). The Aletai-County CDC verified this TB case and carried out epidemiological investigation and close contact screening immediately according to the National Standard of Tuberculosis Prevention and Control in Schools (2017) (*1*). In total, 31 TB patients were identified and reported in this investigation.

INVESTIGATION AND RESULTS

This outbreak occurred at a vocational school with 26 classes in 3 grades with a total of 1,125 students (790 resident students) and 146 staff members. A school doctor was responsible for disease control work and health emergencies. There were 392 male students (34.8%) and 733 female students (65.2%). Each dormitory room has 6 residents and the windows of the rooms were often kept closed, which may have resulted in poor ventilation. Each class has its own fixed classroom.

The index patient was a 21-year-old female student in Grade 3. The interview with this student revealed that she visited the local hospital in her place of origin on March 3, 2019 complaining of chest tightness and shortness of breath and was treated as a suspected TB case according to the Standard of Diagnosis for Pulmonary Tuberculosis (WS 288–2017) (*2*). Subsequently, she was transferred to the Aletai County designated TB hospital and hospitalized for further examination. On March 8, she was confirmed to have TB and was reported to the National Notifiable Disease Report System (NNDRS).

According to National Standard of Tuberculosis Prevention and Control in School (2017), Aletai-county CDC launched close contact screening immediately. All students and teachers sharing the same classroom and dormitory with the index case received suspected TB symptom screening, tuberculin skin test (TST), and chest X-rays (CXR). Sputum examination followed for those with TB symptoms or strongly positive purified protein derivative (PPD) reactions (defined as an average diameter exceeding 15 mm) or abnormal CXR to identify new cases. In total, 38 students and 8 teachers were screened from March 10 to April 9. Out of these close contacts, 16 out of 38 students (42.1%) and 2 out of 8 teachers (25%) had strong positive PPD reaction, and 5 TB cases were identified among students, including 3 bacteriologically positive TB patients. During this time period, 2 students visited the local hospital proactively and were diagnosed as bacteriologically positive TB and active TB respectively. Their close contacts were given screening by using the same screening procedure, and 2 clinically-diagnosed TB cases were founded.

Because new TB cases were identified, Aletai-

County CDC expanded screening to all students and teachers in the same floor of both the teaching building and the dormitory. Out of a total of 198 students and 63 teachers, 48 students (24.2%) and 8 teachers (12.7%) had strong positive PPD reaction, and 14 new TB cases were founded in students, including 4 bacteriologically positive TB patients. A third screening at a larger-scale was subsequently carried out, and all unscreened students, teachers, and other staff were screened. Strong positive PPD reactions were founded in 68 out of 838 students (8.1%) and 9 out of 37 teachers (24.3%), and 7 clinically-diagnosed TB cases were found among students.

Other strict control measurements were conducted in this school. All TB patients were treated in hospitals and given home-based treatment after discharge. Among persons having strong positive PPD reaction, 8 received preventative therapy (*3*), and others received periodic CXR at regular intervals of 3, 6, and 12 months after screening. In addition, daily symptom screening for each student and isolation of those with suspected TB symptoms were strengthened, and ventilation was improved in this school.

Absence of sputum culture resulted in a failure to conduct genome sequencing. The results of screening revealed that there were higher rates of strongly positive PPD reactions and TB incidence among students in the same floor of both the teaching building and dormitory with the index case, and these rates reached 42.1% and 15.4%, respectively, in the index patient's class. Because these students shared the same space, they had increased chances to come in direct contact with the index case, and the epidemiological linkage could therefore be established based on this analysis. According to the time of TB symptom appearance, the index case probably acted as the source of transmission among students in the same floor of both the teaching building and the dormitory. The epidemiological linkage of these patients with others could not be determined.

DISCUSSION

The epidemiological investigation yielded several contributing factors for this outbreak. First, preventative measures were not implemented in this school. Although TB examination for student entrance physical examination were required since 2010 (*4*), all students entering this school before 2018 did not receive examination. Students who had previously been infected with TB might have entered this school and acted as the source of transmission for this outbreak.

Second, health education for students was insufficient in this school. During the first round of screening, a student with TB-like symptoms was diagnosed. This patient was likely to have onset of symptoms as early as January 2019 but did not visit a hospital until March 16 because of worsening condition. Delayed diagnosis and treatment increased the risk of transmission in this school, especially among classmates.

Finally, environmental hygiene was not sufficient in this school. Ventilation is an important measure for TB infection control, and the classrooms and dormitories had poor ventilation. Cases of pulmonary TB in classrooms and dormitories are likely to transmit infectious aerosols in rooms with poor ventilation, and students coming into contact are at high risk of infection.

This investigation showed the implementation of preventative measures were important for TB control in schools. Under the guidance of local CDCs, entrance examinations, health education, and improved environmental conditions in schools could establish a firm foundation for TB control and prevention.

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Notes from the Field

A Case of COVID-19 — Tianjin Municipality, China, November 7, 2020

COVID-19 Field Response Group[1]; Laboratory Testing Group[1]; Yang Song[2]; Xiang Zhao[2]; Xiaoyan Li[1,#]; Wenbo Xu[2,#]

On November 7, 2020, Tianjin Municipality received notification from Dezhou City, Shandong Province that specimens of the outer packaging of imported frozen pork products shipped from Germany via Tianjin Port were positive for coronavirus disease 2019 (COVID-19) viral nucleic acid. Tianjin Municipal Government then conducted an investigation for people working at the Tianjin Hailian Frozen Food Co., Ltd. On November 8, a 38-year-old cold chain dockworker from the company was found positive via nucleic acid test. The patient had participated in the transport of the infected batch of frozen products on November 4. The patient was transferred to a designated hospital for medical isolation and was classified as a standard clinical case of COVID-19. As of November 11, 8 close contacts of the patient and 13 employees of the company were tested 2 times with nucleic acid and antibody tests and all returned negative results. In addition, 30 samples of items suspected of contamination and other environmental samples at the company were collected, of which 1 sample of the door handle of the cold storage room was found to be positive. Nucleic acid tests for 156 people in the patient's residential building were all negative, and the scope of testing was further expanded. Nucleic acid tests were performed on 2,186 people from 765 households in 25 buildings in the patient's residential area, and all results were negative.

On November 8, full-length genome sequencing of a specimen collected from the Tianjin COVID-19 patient was performed on the Illumina MiniSeq platform. Compared with the Wuhan reference sequence (EPI_ISL_402119)(*1*), a total of 9 nucleotide mutation sites were detected in the Tianjin strain, among which 6 (C241T, C1059T, C3037T, C14408T, A23403G, and G25563T) were detected as characteristic of L-lineage European branch II.1/lineage B.1(*2*)(Figure 1). In addition, the Tianjin strain had 3 unique nucleotide mutation sites (C601A, C4965T, and C26625T) and no sequence with more than 2 of these nucleotide mutation sites was retrieved in GISAID and Genbank database.

In addition, 2 Canadian strains (GISAID IDs: EPI_ISL_586371 and EPI_ISL_469240) circulating in March had 7 nucleotide mutation sites, and all 7 sites also appeared in the Tianjin strain, which included the 6 sites that defined European family of the L genotype II.1 and a unique site of C4965T or C26625T. Though the Tianjin strain was genetically closely related to these 2 Canadian strains, the similar viruses might have circulated in many countries.

Compared with recent strains spreading worldwide (with around 15 nucleotide mutation sites from the Wuhan reference strain), the number of mutation sites of the Tianjin strains was relatively low, which indicated that the virus may have been transmitting undetected through contamination of the cold chain product that may have occurred months ago and retained its infectivity.

From November 9 to 11, the Tianjijn Municipal Government completed comprehensive nucleic acid testing for imported frozen goods and all persons with contact. The municipal government also closed facilities found with abnormal frozen goods and isolated all suspected products.

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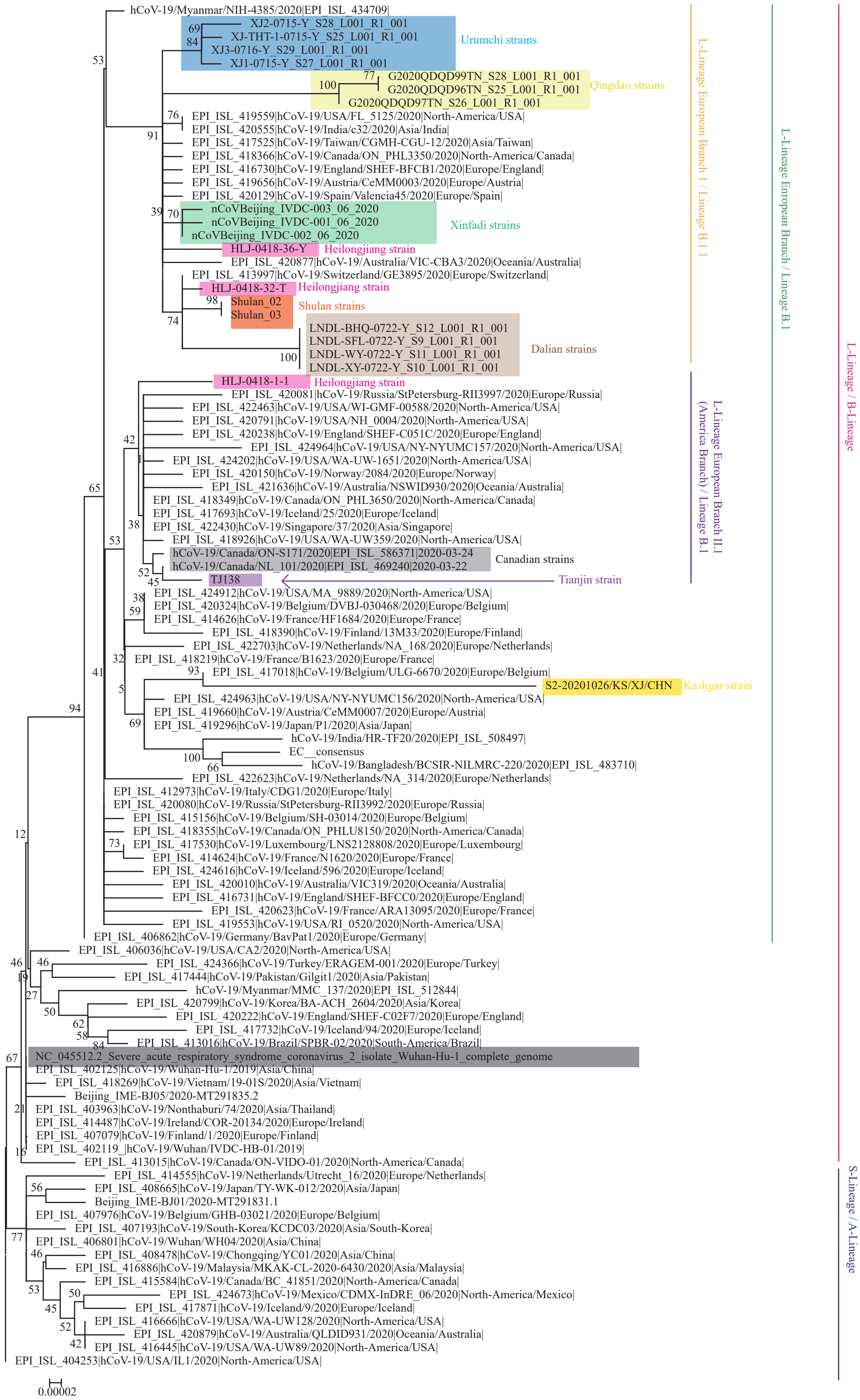

FIGURE 1. Phylogenetic tree based on the full-length genome sequences of the COVID-19 virus. The strains associated with specific outbreaks are as follows: Tianjin Municipality (purple); Kashgar Prefecture (yellow); Urumchi City (blue); Wuhan City in December 2019 (dark gray); Beijing Municipality Xinfadi Wholesale Market (green); northeastern China including Shulan City and Heilongjiang Province related to imported cases (orange and pink, respectively); and Dalian City (brown). The Canadian strains that had high genomic homology with the Tianjin strain were marked in light gray. The S(A)- or L(B)-lineage and sublineages of the COVID-19 virus were marked and colored on the right.

Perspectives

Applying an Automated-Alert System for Tuberculosis Control in Schools in China

Jun Cheng[1]; Hui Chen[1]; Xin Du[1]; Hui Zhang[1]; Yinyin Xia[1]; Canyou Zhang[1]; Yanlin Zhao[1]; Jianjun Liu[1,#]

Tuberculosis (TB) control in schools has been a major priority in China, and the implementation of strengthened active case finding and the "TB Prevention and Control in School Work Standard (2017 version)" have resulted in a decline in the reported incidence of active pulmonary TB in students from 27.92/100,000 students to 13.30/100,000 during 2008–2015, which followed a similar trend in the overall population. However, this reported incidence rose to 17.50/100,000 in 2019 (*1*–*2*), which ran counter to the continual reduction of TB incidence seen in the overall population (*3*) and indicated an increased percentage of students with TB. In 2019, TB cases in students accounted for 6.19% of all TB cases.

Disease surveillance exerts a key role in disease control by laying a foundation for policymaking and showing areas for improvement by revealing the current challenges, changing trends and characteristics of the diseases, and evaluating the effects of existing intervention. In January 2004, China's National Notifiable Disease Reporting System (NNDRS) was launched and became the world's largest internet-based communicable disease information system as it required the real-time reporting of 37 notifiable diseases into this system. Because TB is one of these notifiable diseases, the demographic and diagnostic information for every pulmonary TB patient is required to be reported within 24 hours, which allow obtaining precise data on the TB disease burden (*4*). Based on the initiative "Management specifications for infectious disease information reporting" launched by China's National Health and Family Planning Commission (now known as the National Health Commission) in 2015, patients that are teachers or students must also be reported with detailed information for their school (*5*).

The internet-based NNDRS provided a data source for discovering outbreaks of certain notifiable diseases and making early-stage alerts possible. Following multi stage research and pilots, the China Infectious Diseases Automated-Alert and Response System (CIDARS) was launched by China CDC on April 21, 2008 (*6*). Through using mathematical algorithms and data from the NNDRS, abnormal increased numbers and clusters of cases with certain notifiable diseases could be captured, and an alert signal could be automatically sent to the designated CDC staff at the county level. For active pulmonary TB cases in schools, requiring the reporting of occupations and detailed information on school names and accurate addresses in the NNDRS facilitates automated-alerts for TB outbreaks in specified schools. Single TB cases will trigger the alerts because TB is a chronic infectious disease, and these automated alerts for single TB cases in schools were started nationwide on July 6, 2018. As soon as a pulmonary TB patient is reported in the NNDRS as a student, teacher, or person aged 3–24 years (the age range for most students in China), an alert signal will be sent to local CDC staff automatically and the designated staff must identify if the person is a student or teacher and provide feedback in CIDARS within 24 hours.

Students concealing their active pulmonary TB status is a significant factor contributing to TB outbreaks in schools (*7*) as TB transmission probably occurs in schools due to close contact of students. The use of CIDARS dramatically decreased the risks of TB transmission due to increased sensitivity for capturing TB patients in schools, and mistakes in recording occupations can be revised based on the identification process (*8*) and TB response activities being promptly conducted, including TB patient management, close contact screening, isolation of suspected TB patients, preventative therapy for close contact at high risk of developing TB, and other control measurements. These control measures could decrease transmission significantly, and the automated-alert system also contributes to it by increasing sensitivity for identifying TB cases in schools and shortening the time needed to respond (*9*).

CIDARS is an immense repository of data, and information on workload and performance of alert signal response for county-level CDCs could be evaluated by using these data. From July 2018 (the start of CIDARS operation in TB) to the end of 2019, nearly 390,000 signals were sent, and county-level CDC staff finished responding to more than 380,000 signals with a median response time interval of 2.3 hours (*9*). However, nearly 10% of signals were finished beyond 24 hours, showing room for improvement. Data from the automated-alert system in 2020 showed an elevated response rate and shortened response time, and by fully utilizing CIDARS, more complete assessments can be made. First, trends in TB distribution in people aged 3–24 years can be more completely monitored by continuous surveillance. Second, the percentage of students concealing their status can be detected, which could increase the quality of reporting information by local health facilities and the effect of health education and promotion can be evaluated. Finally, schools with many TB cases can be quickly identified and targeted interventions could be deployed to prevent larger TB outbreaks.

Through its two years of operation, CIDARS has already shown a great contribution to TB outbreak response in schools. With the improvement of TB control work, this system could be used in more facilities, such as elder care institutions, hospitals, and others, to find signs of TB outbreaks and prevent transmission in these high-TB-risk areas as early as possible.

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Perspectives

Emerging Brucellosis Outbreaks Associated with Unpasteurized Milk in China

Dongri Piao[1]; Zhongjie Li[2]; Xiaowen Yang[1]; Guozhong Tian[1]; Hongyan Zhao[1]; Hai Jiang[1,#]

Brucellosis is caused by several species of *Brucella* and is one of the most common zoonotic diseases globally. Common species causing human brucellosis include *B. melitensis*, *B. abortus*, and *B. suis* (*1*). Although deaths due to *Brucella* infections are rare, infections can cause intermittent fevers, malaise, and muscle, joint, and back pain. If not treated effectively with antibiotics, infections can become chronic and difficult to cure (*2*).

UNSTERILIZED MILK INTAKE RAISES CONCERNS OF EMERGING BRUCELLOSIS OUTBREAKS

As a zoonotic disease, transmission to humans occurs primarily through direct contact with the placenta or fetus from infected animals or by indirect contact from infected animal byproducts such as milk, meat, and cheese (*3*). The primary transmission route of brucellosis was through occupational exposure based on the China National Surveillance Program (*4–5*). In recent years, China CDC has reported hundreds of cases of human brucellosis resulting from exposure to *Brucella melitensis* after the consumption of raw milk. During 2005–2018, there were 242 public health emergency events according to the annual brucellosis surveillance report. Among those, professional exposure was 92.2% (223/242) and food-borne transmission was 5.8% (14/242). There were 56 public health emergency events of brucellosis in 2019. Among those, 33 were related to animal husbandry, 8 to exposure to raw milk, and 8 to processing and marketing of animal products. In 2020, Wang et al. reported a food-borne outbreak of brucellosis caused by drinking raw goat milk in Wuhua County, Guangdong Province. A total of 30 cases were found and 21 *Brucella* strains were identified as *B. melitensis* bv.3 from the patient blood samples (*6*). Based on a review of the literature, Qin et al. also reported a food-borne outbreak of brucellosis caused by drinking unpasteurized ewe's milk in Pinggui County, Guangxi Zhuang Autonomous Region in 2016. A total of 122 cases were found and only one *Brucella* strain, *B. melitensis* bv.3, was identified from the index case's marrow sample. The MLVA-8 genotype of this strain was "42" and it belonged to the predominant genotype in China (*7*).

Some cases of the consumption of unpasteurized dairy products were also reported in endemic countries such as Asia, Middle East, Africa, Central and South America (*8–9*). Furthermore, in non-endemic countries, brucellosis has also been reported to occur after travel to and subsequent consumption of raw dairy products in endemic countries (*10*). Recently, the increase in the consumption of raw dairy products comes not only from cows, sheep, and goats, but also from camels, llamas, donkeys, horses, buffaloes, reindeer, and yaks, which poses an additional risk of brucellosis transmission (*11*). Interestingly, US CDC reported that human brucellosis outbreaks have been confirmed to be caused by exposure to the live-attenuated vaccine strain *Brucella abortus* RB51 following the consumption of raw milk (*12–13*). These messages demonstrated the need for intensified concern of raw milk acquired human brucellosis outbreak.

UNSTERILIZED MILK INCREASES THE RISK OF TRANSMISSION OF BRUCELLOSIS

According to the National Food Safety Standards for Sterilized Milk (GB 25190–2010) and Pasteurized Milk (GB 19645–2010), sterilization involves the heating of raw milk to a defined temperature for a specific period of time to inactivate live, disease-causing organisms such as *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella enterica*. The process has been invaluable in the improvement of the safety of milk for human consumption. As the main product of the Chinese dairy market, cow milk had been closely monitored by the Chinese government for the past few years. However, goat milk was often consumed by private individuals as a substitute milk product, and there had been little monitoring of goat milk (*14*). Particularly in rural areas, the emerging interest in natural foods and products has led to the increased preference for raw milk due to its acclaimed health benefits that are believed to be destroyed upon pasteurization. Local inhabitants lack awareness on the food-borne transmission of brucellosis when sheep's milk is contaminated with *Brucella*. The elderly, children, and persons with immune-compromised conditions are also high-risk populations because they are more likely to drink the raw milk. Therefore, legislation and supervision of raw milk and related products are in urgent needs. In order to master the status of *Brucella* contamination of raw milk and milk products and provide a basis for risk assessment, pilot sentinels were set up in 9 provincial-level administrative divisions (PLADs) (Shanxi, Inner Mongolia, Jilin, Heilongjiang, Henan, Guangdong, Sichuan, Shaanxi, and Gansu) by the China National Center for Food Safety Risk Assessment in 2020.

STRICT REGULATIONS ARE URGENTLY NEEDED

Field epidemiological investigations suggest that trade of unquarantined live animals from endemic areas may be the cause of the brucellosis outbreak in non-endemic areas. In the past decades, there were no outbreaks of brucellosis in southern China. As a result of advances in traffic and logistics, the risk associated with importing sick animals (mainly sheep) from high-risk areas to southern provinces has increased rapidly. In addition, insufficiently strict regulations of the sale of unpasteurized milk in some rural areas probably lead to brucellosis outbreaks. As family-based breeding is not generally supervised, the risk of infection associated with the sale or trade of sheep, meat, and dairy products privately from endemic areas is higher. Therefore, effective control of sheep and goat brucellosis will significantly reduce the risk of human brucellosis. We recommended the following preventative measures that should be taken by all stakeholders in China: 1) strengthening brucellosis information dissemination and dairy products marketing supervision, especially in non-endemic rural areas; and 2) improving veterinary and public health services surveillance, such as by preparing fast detection tests for the screening of suspected raw milk and milk products, and setting standard operating procedures for food-borne transmission risk assessment.

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