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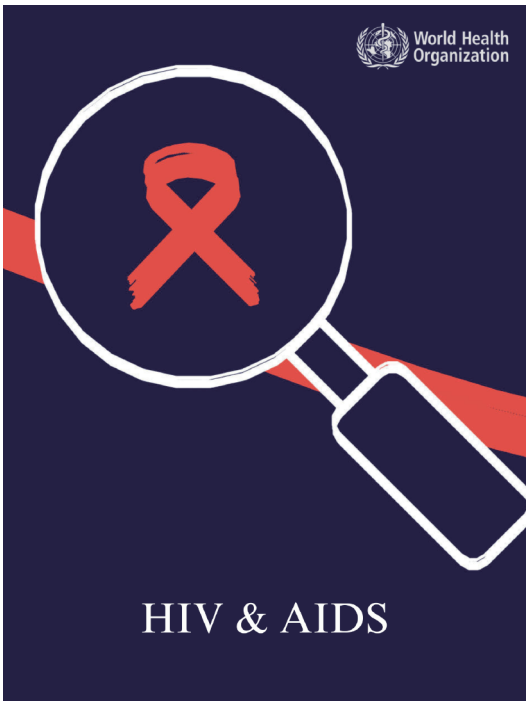

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Preplanned Studies

HIV Infection and Associated Factors Among Out-of-School MSM Aged 16–24 Years — 6 Cities and Tianjin Municipality, China, 2022–2023

Hui Liu[1,2,&]; Qiyu Zhu[1,&]; Lei Zhang[3]; Yujing Liu[1]; Peng Xu[1]; Mengjie Han[1,#]

Summary

What is already known about this topic?

Approximately 80% of newly diagnosed human immunodeficiency virus (HIV) cases among individuals aged 15–24 years in China are attributed to out-of-school youth.

What is added by this report?

This study presents findings on HIV prevalence and comprehensive insights into HIV service utilization, risky behaviors, and prevention knowledge among young out-of-school men who have sex with men (MSM) aged 16–24 years in China. This population exhibits a disproportionately high burden of HIV, with only 51.6% of HIV cases previously diagnosed.

What are the implications for public health practice?

HIV services should be expanded to include these key populations. Tailored interventions are needed to remove barriers to regular HIV services faced by young key populations.

Globally, there were an estimated 350,000 new human immunodeficiency virus (HIV) infections among youth aged 15–24 years in 2022 (*1*). In China, the majority of young people living with HIV were out-of-school youth, accounting for 77.8% of newly diagnosed HIV cases in the 15–24 age group in 2020 (*2*). Out-of-school young men who have sex with men (MSM) face a higher risk of HIV infection compared to MSM among college students (*3*) and encounter barriers when accessing HIV-related services. To address the specific vulnerabilities and health needs of out-of-school young MSM (YMSM), a survey was conducted in 6 cities and Tianjin Municipality to estimate HIV prevalence. A total of 1,407 participants were recruited, with an HIV prevalence of 4.4% (62/1,407). Among the 62 participants living with HIV, 51.6% had been previously diagnosed. Participants who had a history of past or current syphilis infection, inconsistent condom use during anal sex in the last 6 months, and a lack of awareness of post-exposure prophylaxis (PEP) had higher odds of HIV infection. These findings highlight the disproportionately high burden of HIV among out-of-school YMSM and the limited access they have to HIV preventive services. Improving access to HIV testing and care, as well as delivering tailored interventions for out-of-school YMSM, are urgently needed.

The survey was conducted between October 2022 and May 2023 in 7 major cities (Tianjin Municipality; Shenyang City, Liaoning Province; Fuzhou City, Fujian Province; Qingdao City, Shandong Province; Changsha City, Hunan Province; Shenzhen City, Guangdong Province; Haikou City, Hainan Province) with large populations of out-of-school YMSM and well-established community-based organizations (CBOs). Participants were recruited from MSM-visited venues, as well as online platforms such as WeChat and Microblog. To be eligible, YMSM had to have engaged in anal sex with a man in the past 6 months; be between the ages of 16 and 24, and not be currently enrolled as students. With the assistance of CBO staff, eligible participants completed an online, self-administered structured questionnaire that covered sociodemographic information, HIV knowledge, sexual behaviors, sexually transmitted infections (STIs), and utilization of HIV services. HIV knowledge was assessed using 8 questions from the "Chinese AIDS Sentinel Surveillance Implementation Plan". A score of six or more correct answers was considered comprehensive knowledge of HIV. All consenting participants underwent on-site rapid HIV and syphilis testing using NewScen HIV antibody rapid test kits (NewScen Coast Bio-Pharmaceutical, Tianjin, China) and NewScen syphilis antibody rapid test kits (NewScen Coast Bio-Pharmaceutical, Tianjin, China), respectively, led by qualified staff. For participants who received a positive result on rapid HIV testing and self-reported no prior diagnosis, further confirmatory HIV

testing was conducted. As rapid syphilis testing cannot distinguish between past and current infections, participants with a positive result were categorized as having either a past or current syphilis infection.

Categorical variables were analyzed using descriptive statistics, including proportions and 95% confidence intervals (*CI*s). Univariable logistic regression was conducted to assess the association between biobehavioral factors and HIV infection. Variables with a *P*-value of ≤0.10 in the univariable model were included in the multivariable logistic regression, along with demographic variables to account for potential confounding factors. To address the potential influence of HIV diagnosis on behavior change among out-of-school YMSM, a separate multivariable logistic regression analysis was conducted excluding previously diagnosed HIV cases. All statistical analyses were performed using R software (version 4.3.1, R Foundation for Statistical Computing, Vienna, Austria).

A total of 1,407 eligible participants were recruited for our study from different cities in China (Table 1): 298 participants from Tianjin, 206 from Shenyang, 192 from Fuzhou, 186 from Changsha, 183 from Qingdao, 179 from Shenzhen, and 163 from Haikou. Among the participants, 692 (49.2%) were between the ages of 23 and 24. Furthermore, 761 (54.1%) had completed vocational college or higher education, and 1,106 (78.6%) were employed full-time. In terms of sexual orientation, 1,287 (91.5%) identified as homosexual, 94 (6.7%) as bisexual, 23 (1.6%) as unsure, and 3 (0.2%) as heterosexual. Additionally, 641 (45.6%) participants reported having disclosed their sexual orientation.

A total of 62 participants (4.4%, 95% *CI*: 3.4%–5.6%) out of 1,407 were confirmed to have HIV through laboratory testing. Among them, 32 participants (51.6%, 32/62) had previously been diagnosed with HIV (Table 2). The prevalence of current or past syphilis was 4.9% (95% *CI*: 3.9%–6.2%), and the co-infection rate of syphilis and HIV was 1.1% (15/1,407). Within the past 12 months, 78.4% of participants (1,103/1,407) reported using HIV-related services. These included HIV infection risk assessment (49.6%, 698/1,407), receiving free condoms (52.5%, 738/1,407), pre-exposure prophylaxis (PrEP) (22.5%, 317/1,407), PEP (21.3%, 299/1,407), and HIV counseling and testing (56.2%, 791/1,407). Additionally, 47.5% of participants (669/1,407) reported not having consistent condom use (CCU) during anal sex in the

TABLE 1. Sociodemographic characteristics of out-of-school young MSM aged 16–24 years in 6 Cities and Tianjin Municipality, China (*N*=1,407).

Characteristics	*n*	Percentage (95% *CI*)
Region		
Tianjin	298	21.2 (19.1, 23.4)
Shenyang	206	14.6 (12.9, 16.6)
Fuzhou	192	13.6 (11.9, 15.6)
Qingdao	183	13.0 (11.3, 14.9)
Changsha	186	13.2 (11.5, 15.1)
Shenzhen	179	12.7 (11.0, 14.6)
Haikou	163	11.6 (10.0, 13.4)
Age, years		
16–18	79	5.6 (4.5, 7.0)
19–20	183	13.0 (11.3, 14.9)
21–22	453	32.2 (29.8, 34.7)
23–24	692	49.2 (46.5, 51.8)
Education		
≤Junior high school	234	16.6 (14.7, 18.7)
Senior high/vocational/secondary	412	29.3 (26.9, 31.8)
≥Vocational college	761	54.1 (51.4, 56.7)
Monthly income (CNY)		
<1,000	101	7.2 (5.9, 8.7)
1,000–3,000	251	17.8 (15.9, 20.0)
3,001–5,000	615	43.7 (41.1, 46.4)
>5,000	440	31.3 (28.9, 33.8)
Employment status		
Employed full time	1,106	78.6 (76.4, 80.7)
Employed part time	161	11.4 (9.9, 13.2)
Unemployed	140	10.0 (8.5, 11.7)
Local living time		
<1 year	128	9.1 (7.7, 10.8)
1–2 year	184	13.1 (11.4, 15.0)
>2 year	1,095	77.8 (75.5, 80.0)
Living situation		
Family	366	26.0 (23.8, 28.4)
Alone	597	42.4 (39.8, 45.1)
Friends/roommates	239	17.0 (15.1, 19.1)
Partner	105	7.5 (6.2, 9.0)
Dormitory	100	7.1 (5.8, 8.6)
Sexual orientation		
Homosexual	1,287	91.5 (89.9, 92.9)
Bisexual	94	6.7 (5.5, 8.1)
Heterosexual	3	0.2 (0.1, 0.7)
Not sure	23	1.6 (1.1, 2.5)
Disclosure of sexual orientation	641	45.6 (42.9, 48.2)

Abbreviation: MSM=men who have sex with men; *CI*=confidence interval; CNY=Chinese Yuan.

TABLE 2. HIV, syphilis, service engagement, individual level risks, and HIV knowledge of out-of-school young MSM aged 16–24 years in 6 Cities and Tianjin Municipality, China (*N*=1,407).

Characteristics	*n*	Percentage (95% *CI*)
HIV and STI prevalence		
HIV positive	62	4.4 (3.4, 5.6)
Previously diagnosed	32	2.3 (1.6, 3.2)
Newly diagnosed	30	2.1 (1.5, 3.1)
Past or current syphilis	69	4.9 (3.9, 6.2)
HIV service engagement in the past 12 months		
HIV infection risk assessment	698	49.6 (47.0, 52.3)
Received free condoms	738	52.5 (49.8, 55.1)
PrEP	317	22.5 (20.4, 24.8)
PEP	299	21.3 (19.2, 23.5)
HIV counseling and testing	791	56.2 (53.6, 58.8)
Individual-level HIV risks		
Number of anal sex partners in the past 6 months		
1	456	32.4 (30.0, 34.9)
2–5	691	49.1 (46.5, 51.8)
≥6	260	18.5 (16.5, 20.6)
Condom use during anal sex in the past 6 months		
CCU	738	52.5 (49.8, 55.1)
Not CCU	669	47.5 (44.9, 50.2)
Group sex behavior in the past 6 months	123	8.7 (7.3, 10.4)
Condom use during group sex in the past 6 months (*n*=123)		
CCU*	71	57.7 (48.5, 66.5)
Not CCU	52	42.3 (33.5, 51.5)
Heterosexual behavior in past 6 months	62	4.4 (3.4, 5.6)
Number of heterosexual partners in past 6 months (*n*=62)		
1	30	48.4 (35.7, 61.3)
2–5	28	45.2 (32.7, 58.2)
≥6	4	6.5 (2.1, 16.5)
Condom use during heterosexual behavior (*n*=62)		
CCU	20	32.3 (21.3, 45.5)
Not CCU	42	67.7 (54.5, 78.7)
Any drug use in the past 12 months	832	59.1 (56.5, 61.7)
Suffered any STI symptoms in the past 12 months	72	5.1 (4.1, 6.4)
Diagnosed any STI in the past 12 months	77	5.5 (4.4, 6.8)
HIV knowledge		
Comprehensive knowledge of HIV	1,242	88.3 (86.4, 89.9)
PrEP awareness	1,095	77.8 (75.5, 80.0)
PEP awareness	1,137	80.8 (78.6, 82.8)

Abbreviation: HIV=human immunodeficiency virus; MSM=men who have sex with men; *CI*=confidence interval; STI=sexually transmitted infection; PEP=post-exposure prophylaxis; PrEP=pre-exposure prophylaxis; CCU=consistent condom use.
* Consistent condom use and changing condoms between people.

past 6 months. Group sex behavior was reported by 8.7% of participants (123/1,407), which was nearly twice the prevalence of heterosexual behavior during the same period (4.4%, 62/1,407). Drug use within the past 12 months was reported by 59.1% of participants (832/1,407). Furthermore, 5.1% of participants (72/1,407) reported experiencing any symptoms of STIs within the past 12 months, while 5.5% (77/1,407) were diagnosed with an STI during the same period. The overall rate of comprehensive HIV knowledge was 88.3% (1,242/1,407), with 77.8% (1,095/1,407) and 80.8% (1,137/1,407) reporting awareness of PrEP and PEP, respectively.

In the multivariable analysis, we found that out-of-school YMSM with current or past syphilis infection had higher odds of HIV infection [adjusted odds ratio

TABLE 3. Adjusted logistic regression model of biobehavioral factors associated with HIV Infection and undiagnosed HIV infection among out-of-school young MSM aged 16–24 Years in 6 Cities and Tianjin Municipality, China.

Characteristics	HIV infection *vs.* HIV negative (*N*=1,407)			Undiagnosed HIV infection *vs.* HIV negative (*N*=1,375)		
	HIV infection *n* (%)	a*OR* (95% *CI*)*	*P* value	Undiagnosed HIV infection *n* (%)	a*OR* (95% *CI*)*	*P* value
Past or current syphilis						
No	47/1,338 (3.5%)	1 (ref)	–	21/1,312 (1.6%)	1 (ref)	–
Yes	15/69 (21.7%)	9.90 (3.86, 24.86)	<0.001	9/63 (14.3%)	19.70 (5.00, 80.08)	<0.001
HIV infection risk assessment in the past 12 months						
No	43/709 (6.1%)	1 (ref)	–	20/686 (2.9%)	1 (ref)	–
Yes	19/698 (2.7%)	0.54 (0.27, 1.06)	0.078	10/689 (1.5%)	0.63 (0.22, 1.71)	0.365
Received free condoms in the past 12 months						
No	43/669 (6.4%)	1 (ref)	–	19/645 (2.9%)	1 (ref)	–
Yes	19/738 (2.6%)	0.51 (0.25, 1.02)	0.062	11/730 (1.5%)	0.66 (0.23, 1.84)	0.425
PrEP in the past 12 months						
No	54/1,090 (5.0%)	1 (ref)	–	28/1,064 (2.6%)	1 (ref)	–
Yes	8/317 (2.5%)	1.03 (0.38, 2.53)	0.946	2/311 (0.6%)	0.37 (0.05, 1.71)	0.254
HIV counseling and testing in the past 12 months						
No	35/616 (5.7%)	1 (ref)	–	18/599 (3.0%)	1 (ref)	–
Yes	27/791 (3.4%)	0.94 (0.49, 1.80)	0.844	12/776 (1.5%)	1.77 (0.63, 5.10)	0.278
Condom use during anal sex in the past 6 months						
CCU	17/738 (2.3%)	1 (ref)	–	3/724 (0.4%)	1 (ref)	–
Not CCU	45/669 (6.7%)	3.06 (1.61, 6.01)	<0.001	27/651 (4.1%)	10.98 (3.08, 54.07)	<0.001
Group sex behavior in the past 6 months						
No	52/1,284 (4.0%)	1 (ref)	–	26/1,258 (2.1%)	1 (ref)	–
Yes	10/123 (8.1%)	1.66 (0.70, 3.63)	0.223	4/117 (3.4%)	1.21 (0.28, 4.10)	0.776
Suffered any STI symptoms in the past 12 months						
No	54/1,335 (4.0%)	1 (ref)	–	29/1,310 (2.2%)	1 (ref)	–
Yes	8/72 (11.1%)	1.78 (0.61, 4.70)	0.264	1/65 (1.5%)	0.51 (0.02, 4.10)	0.594
Diagnosed any STI in the past 12 months						
No	52/1,330 (3.9%)	1 (ref)	–	26/1,304 (2.0%)	1 (ref)	–
Yes	10/77 (13.0%)	0.66 (0.21, 1.96)	0.468	4/71 (5.6%)	0.48 (0.07, 2.60)	0.416
PrEP awareness						
No	20/312 (6.4%)	1 (ref)	–	15/307 (4.9%)	1 (ref)	–
Yes	42/1,095 (3.8%)	1.43 (0.64, 3.34)	0.397	15/1,068 (1.4%)	1.47 (0.41, 5.35)	0.554
PEP awareness						
No	24/270 (8.9%)	1 (ref)	–	18/264 (6.8%)	1 (ref)	–
Yes	38/1,137 (3.3%)	0.27 (0.12, 0.62)	0.002	12/1,111 (1.1%)	0.07 (0.02, 0.26)	<0.001

Abbreviation: HIV=human immunodeficiency virus; MSM=men who have sex with men; a*OR*=adjusted odds ratio; *CI*=confidence interval; CCU=consistent condom use; STI=sexually transmitted infection; PEP=post-exposure prophylaxis; PrEP=pre-exposure prophylaxis.
* Adjusted for region, age, education, monthly income, employment status, local living time, living situation, and disclosure of sexual orientation.

(a*OR*=9.90, 95% *CI*: 3.86–24.86]. Additionally, YMSM who reported inconsistent condom use during anal sex within the past 6 months also had higher odds of HIV infection (a*OR*=3.06, 95% *CI*: 1.61–6.01). On the other hand, YMSM who were aware of PEP had lower odds of HIV infection (a*OR*=0.27, 95% *CI*: 0.12–0.62) (Table 3). A sensitivity analysis, excluding data from previously diagnosed HIV cases, revealed no significant difference in the identified risk factors.

DISCUSSION

This study aims to provide a comprehensive analysis of HIV knowledge, risky behaviors, engagement with HIV services, and the prevalence of HIV among out-of-school YMSM in China. The study found that the HIV prevalence among participants was 4.4%. Higher odds of HIV infection were observed among participants who were infected with syphilis, reported inconsistent condom use during anal sex, and lacked awareness of PEP. The study also identified significant gaps in HIV detection and coverage of prevention services. Therefore, addressing the needs of out-of-school YMSM and removing barriers to HIV services should be a priority to control HIV transmission.

In a previous study that utilized meta-analysis, the pooled HIV prevalence among high school and college student MSM in China was calculated to be 3.8% (*4*). This prevalence was slightly lower than the 4.4% prevalence observed in this current study among out-of-school YMSM. Furthermore, only half of the participants living with HIV had previously been diagnosed, indicating a big gap compared to the first target of the 95-95-95 testing and treatment strategy (51.6% *vs*. 95%). The low detection rate may be attributed to limited engagement in HIV services, as only 56.2% (791/1,407) of participants reported undergoing HIV counseling and testing in the past 12 months. Consistent with other research studies (*5*–*6*), our findings suggest the use of a dual HIV and syphilis testing strategy, as participants infected with syphilis are more likely to be infected with HIV. Furthermore, participants who were aware of PEP exhibited lower odds of HIV infection, underscoring the importance of HIV prevention knowledge education. The proportion of participants with comprehensive knowledge of HIV was 88.3%, slightly below the 90% target for key populations (*7*). Given that a significant number of out-of-school youth do not continue their education beyond middle school, it is crucial to initiate curriculum-based HIV education no later than middle school.

This study has several limitations. First, there may be selection bias present in this survey. Our participants were recruited through on-site and online platforms of CBOs, which means that out-of-school YMSM that were not affiliated with CBOs were not included in the study. Second, the design of the study was cross-sectional, which means that we cannot infer causality from the results. Third, due to the limited availability of syphilis testing in CBOs, we were unable to conduct additional tests to determine the prevalence of past or current syphilis infection.

This study highlights the disparity in HIV services for out-of-school YMSM and emphasizes the significance of the HIV prevention cascade. Urgent action is required to implement innovative testing strategies to meet the first of the three 95 targets (*8*). Additionally, priority should be given to interventions that target this marginalized population to address risky behaviors. It is crucial to develop and implement evidence-based HIV programs that cater to their complex needs.

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Preplanned Studies

Prevalence of Vitamin A Deficiency in Children Aged 6 to 17 Years — Western and Central Rural Areas, China, 2012–2021

Peipei Xu[1]; Juan Xu[1]; Wei Cao[1]; Titi Yang[1]; Qian Gan[1]; Hongliang Wang[1]; Ruihe Luo[1]; Hui Pan[1]; Qian Zhang[1,#]

Summary

What is already known about this topic?

Vitamin A deficiency (VAD) is a leading global nutritional concern, ranking among the top four major nutritional deficiencies worldwide. The prevalence of VAD is unevenly distributed across various regions, both within China and globally.

What is added by this report?

The report adds valuable insights into the vitamin A nutritional status of rural students aged 6–17 years who participated in the Nutrition Improvement Programme for Rural Compulsory Education Students (NIPRCES). Over the decade from 2012 to 2021, there was a modest improvement in vitamin A status. The prevalence of VAD and sub-clinical VAD (SVAD) declined as the students aged. Throughout the majority of the survey years, the incidence of VAD was higher among males and western regions compared to females and central regions, respectively.

What are the implications for public health practice?

A comprehensive approach, incorporating dietary diversification, nutrition education, and food fortification, should be implemented to prevent VAD and SVAD especially in males, younger children and children in western areas.

Vitamin A is critical for the growth, development, visual function, and immune response of children, as along with other physiological processes (*1*). It is a leading cause of preventable childhood blindness and significantly contributes to both child morbidity and mortality (*2*). A World Health Organization (WHO) report from 2009 revealed that vitamin A deficiency (VAD) affects more than 190 million preschool-aged children globally, with a disproportionately higher prevalence in developing countries (*3–4*). Previous research has predominantly been focused on VAD in children under five and pregnant women (*4–5*), with limited data available for school-aged children. Nutrition Improvement Programme for Rural Compulsory Education Students (NIPRCES) is a government-funded plan aiming to improve malnutrition among children and adolescents in primary and secondary schools in Chinese rural areas (*6–7*). This paper presents findings on the prevalence of VAD and sub-clinical VAD (SVAD) among school-aged children in rural areas served by NIPRCES from 2012 to 2021. The results indicate a slight improvement, yet the issue remains significant and warrants continued attention.

From 2012 to 2017, annual surveys were carried out in 50 pilot counties across 22 provincial-level administrative divisions (PLADs) in rural China. This scope was expanded in 2021 to include 160 counties in all 31 PLADs. The surveys employed a stratified cluster sampling strategy, targeting approximately 360 students aged 6 to 17 years old within each county for the initial period. For the 2021 analysis, this study included data from 55 national pilot counties located in central and western China out of the expanded sample of 160 counties (*6*).

Morning fasting venous blood samples were collected from all participants to measure vitamin A levels. Serum was promptly separated, stored, and transported in darkness. Serum retinol concentrations were quantified utilizing High Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS). VAD and SVAD were identified according to the standards set out in the Chinese Method for Vitamin A Deficiency Screening (WS/T 553-2017); concentrations below 0.70 μmol/L indicated VAD, while concentrations ranging from 0.70 μmol/L to 1.05 μmol/L indicated SVAD (*8*). Statistical analysis was performed with SAS software (version 9.4, SAS Institute Inc., Cary, NC, USA). Serum retinol concentrations were reported as medians with 25th and 75th percentiles. The Wilcoxon test and the Kruskal-Wallis rank-sum test were applied to assess differences between groups.

The total number of subjects from 2012 to 2021 was 7,531, 8,586, 10,468, 12,143, 12,955, 6,224, and 18,023, respectively. Table 1 presents the serum retinol

levels across various age categories, sexes, and geographical locations. There was a notable increase in the median serum retinol concentration from 1.07 μmol/L in 2012 to 1.22 μmol/L in 2021. An age-associated rise in serum retinol was observed consistently over the study period (P<0.05). Females exhibited higher serum retinol levels than males from 2014 through 2021 (P<0.05), although the differences were not significant in 2012 and 2013. Geographically, serum retinol concentrations were higher in the western regions compared to central regions in 2012, 2015, and 2016, and lower in the years 2013, 2014, and 2021 (P<0.05).

The prevalence rates of SVAD and VAD fluctuated over the seven-year period, as illustrated in Figure 1. The highest occurrence of SVAD and VAD was recorded in 2013, at 38.1% and 4.1%, respectively, while the lowest rates were observed in 2016, at 20.0% for SVAD and 1.5% for VAD.

In Figure 2, prevalence of SVAD and VAD among different age groups from 2012 to 2021 is depicted. For the age group of 6–8 years, VAD prevalence decreased from 8.1% to 4.6%, and for the 15–17 years age group, it decreased from 2.6% to 1.7%.

The VAD in males from 2012 to 2021 was recorded as follows: 5.8%, 4.2%, 4.4%, 3.5%, 1.8%, 1.9%, and 3.5%, respectively. Correspondingly, the rates for females were 6.1%, 3.9%, 4.0%, 3.0%, 1.2%, 1.4%, and 3.4%. During the period from 2013 to 2021, the prevalence of VAD was consistently higher in males compared to females, evidencing a decline from 5.8% to 3.5% in males, and a decrease from 6.1% to 3.4% in females (Figure 2).

The VAD of western areas from 2012 to 2021 was 6.9%, 3.8%, 5.5%, 3.3%, 1.5%, 1.5% and 4.3%, and that of central areas was 4.8%, 3.2%, 2.0%, 3.1%, 1.6%, 2.0% and 1.0%, respectively. Notably, the VAD prevalence was higher in western regions compared to central regions in 2013, 2014, and 2021, but the differences were not statistically significant in 2012, 2015, 2016, and 2017 (Figure 2).

DISCUSSION

This study revealed a modest improvement in vitamin A status among students aged 6–17 years in the central and western regions of China enrolled in the NIPRCES over a decade (2012–2021), with VAD prevalence declining from 6.2% to 3.5%. Nonetheless, the rates of severe VAD (SVAD) and VAD reported here exceeded those found in two other contemporary nationwide surveys in China. The Chinese Health and Nutrition Survey (2010–2012) recorded VAD and SVAD prevalence rates of 5.5% and 18.8%, respectively, in rural areas, while the rates were 1.2% and 18.1% according to the China Nutrition and Health Surveillance of Children and Lactating Mothers (2016–2017) (*9*–*10*). Additionally, a 2017 survey in Beijing documented lower prevalence rates of 0.1% for VAD and 10.5% for SVAD, compared to our findings (*11*). Dietary intake, as the primary risk factor for VAD, is influenced by economic conditions, healthcare access, food fortification, and dietary habits (*3*–*4*). The areas surveyed in our study, with their less developed economies, limited transportation, and traditional diets relying heavily on plant-based foods, might contribute

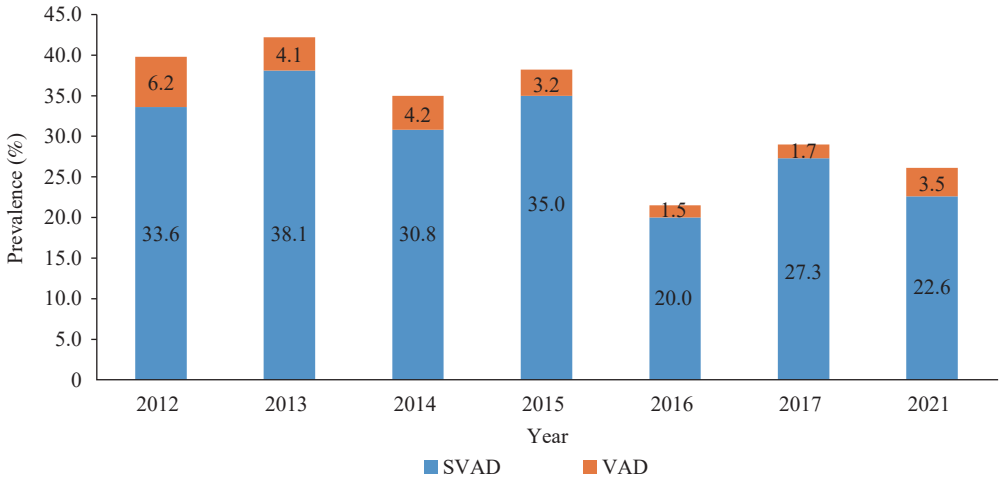

FIGURE 1. Prevalence of sub-clinical VAD and VAD in children aged 6 to 17 years from 2012 to 2021.
Abbreviation: VAD=vitamin A deficiency; SVAD=sub-clinical vitamin A deficiency.

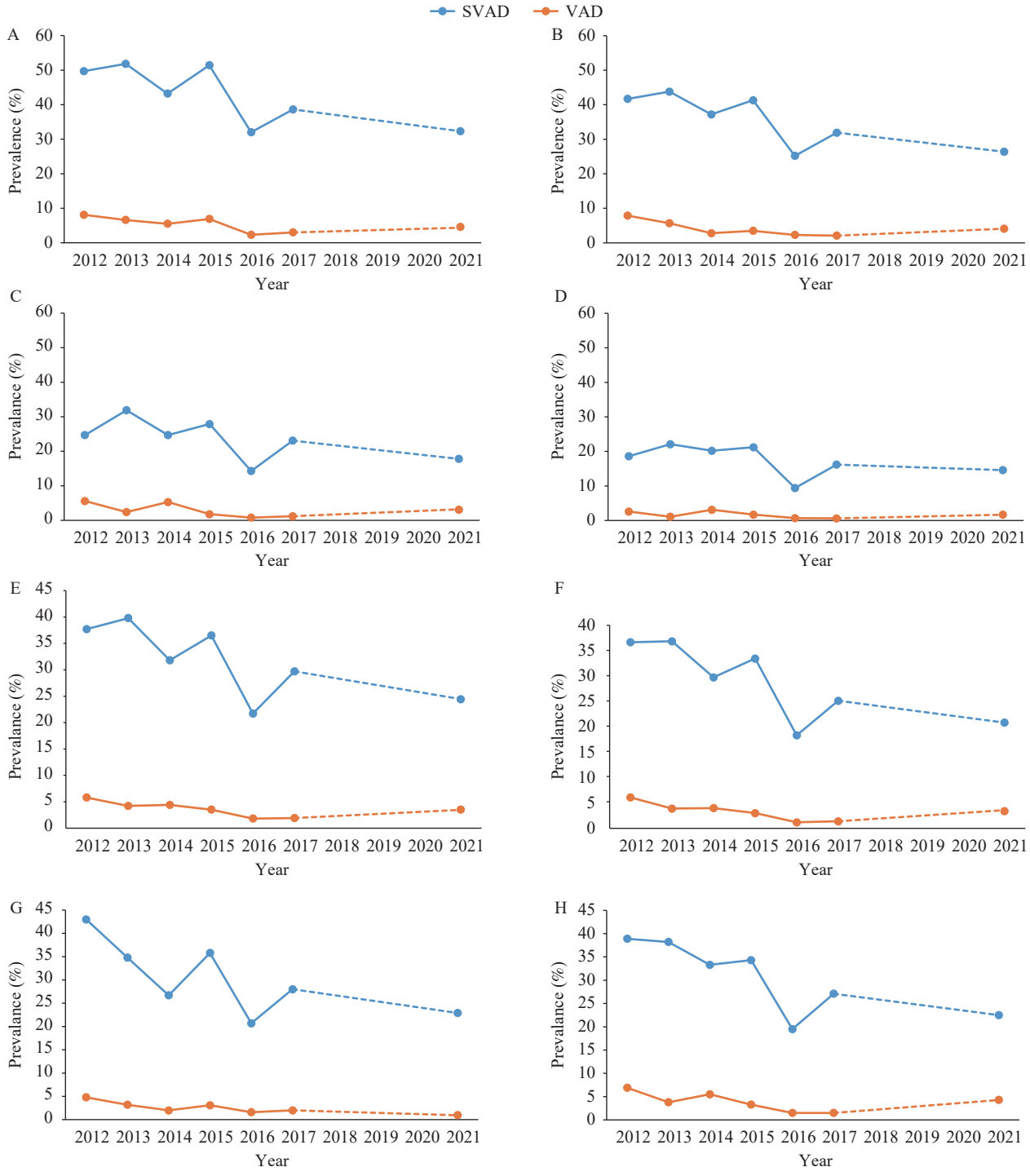

FIGURE 2. Prevalence of SVAD and VAD in different age groups, sexes, and areas from 2012 to 2021. (A) 6–8 years age group; (B) 9–11 years age group; (C) 12–14 years age group; (D) 15–17 years age group; (E) Male; (F) Female; (G) Central area; (H) Western area.
Abbreviation: VAD=vitamin A deficiency; SVAD=sub-clinical vitamin A deficiency.

to the observed higher VAD rates (*12*). Nevertheless, China exhibits lower VAD prevalence when compared to other developing nations, such as India, where VAD affects 19.3% of school-aged children as reported in the National Nutrition Survey 2016 (*5*,*13*). Furthermore, our results indicated a higher prevalence of VAD in the western regions compared to central areas, likely due to the aforementioned factors.

Our study revealed an increase in serum retinol concentration with age in both male and female

TABLE 1. Serum retinol concentrations of vitamin A (μmol/L) based on age, gender and region from 2012–2021.

Variable	2012			2013			2014			2015			2016			2017			2021		
	N	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}	*N*	P_{50}	P_{25}–P_{75}
Total	7,531	1.07	0.9–1.27	7,586	1.11	0.94–1.31	10,468	1.13	0.94–1.40	12,143	1.12	0.94–1.29	12,955	1.08	1.05–1.40	6,224	1.19	1.01–1.40	18,023	1.22	1.03–1.43
Gender*																					
Male	2,501	1.09	0.92–1.29	2,422	1.09	0.92–1.29	5,371	1.12	0.94–1.40	6,233	1.12	0.94–1.29	6,562	1.05	1.05–1.40	3,210	1.15	0.98–1.36	9,058	1.21	1.01–1.41
Female	2,424	1.11	0.91–1.31	2,328	1.11	0.93–1.31	5,097	1.15	0.95–1.40	5,910	1.12	0.94–1.33	6,393	1.12	1.05–1.40	2,973	1.19	1.01–1.40	8,965	1.24	1.05–1.46
Age group (years)*																					
6–8	730	0.99	0.86–1.16	792	1.00	0.86–1.16	1,907	1.05	0.87–1.26	2,101	0.98	0.84–1.15	2,261	1.05	0.91–1.22	1,003	1.08	0.94–1.26	3,081	1.12	0.95–1.32
9–11	1,221	1.05	0.88–1.23	1,378	1.05	0.89–1.23	3,017	1.08	0.94–1.33	3,907	1.05	0.91–1.22	4,092	1.05	0.98–1.40	2,035	1.12	0.98–1.33	5,980	1.17	1.00–1.37
12–14	1,121	1.19	0.99–1.38	1,192	1.14	0.98–1.36	3,561	1.19	0.98–1.46	3,792	1.15	0.98–1.36	4,248	1.26	1.05–1.40	2,113	1.22	1.05–1.40	6,000	1.28	1.08–1.48
15–17	770	1.30	1.08–1.54	700	1.26	1.06–1.49	1,983	1.23	1.05–1.54	2,343	1.22	1.05–1.43	2,304	1.40	1.05–1.47	1,057	1.29	1.12–1.50	2,879	1.36	1.13–1.59
Region																					
Central	2,990	1.06	0.9–1.25	2,910	1.13	0.96–1.33	3,999	1.19	0.99–1.47	5,492	1.08	0.94–1.29	5,373	1.05	1.05–1.40	1,384	1.19	0.98–1.36	4,642	1.22	1.05–1.43
Western	4,541	1.08	0.9–1.29	4,676	1.10	0.93–1.3	6,469	1.08	0.91–1.37	6,651	1.12	0.94–1.33	7,582	1.15	1.05–1.40	4,840	1.19	1.01–1.40	13,381	1.22	1.02–1.43

* Variables of age group and genders have some missing data in 2012, 2013, 2017 and 2021.

subjects, consistent with the findings reported in other studies (*9–11*,*13*). The WHO and data from various developing nations typically concentrate on the vitamin A nutritional status of children under five years old, where the incidence of VAD is relatively higher (*14*). Our data suggest that VAD in preschool children could persist into later childhood but may gradually improve with the diversification of diet that comes with age. Between 2012 and 2021, the prevalence of SVAD and VAD among the four age groups studied showed a marginal decline. Specifically, the prevalence of SVAD in the 6–8 year age group dropped from approximately 50% to one-third, mirroring the trend observed in VAD prevalence. This positive change could stem from the enhanced quality of school meals subsidized by the NIPRCES (*6*). Furthermore, from 2014 to 2021, male subjects exhibited a higher prevalence of VAD compared to females, aligning with findings from other Chinese studies (*12*). The period from 2012 to 2021 saw more pronounced reductions in SVAD and VAD among females compared to males. Consequently, there is a need to focus on improving the vitamin A nutritional status in males and younger children.

Our study is subject to several limitations. First, the sample size over the seven-year period was inconsistent, potentially affecting the comparability across different years. Second, the assessment of serum retinol levels was not conducted continuously between 2012 and 2021, precluding a comprehensive evaluation of the trend of VAD throughout the entire decade.

In conclusion, following the implementation of the NIPRCES in 2012, which offered meal subsidies to students in rural areas, there has been a marked improvement in the VAD nutritional status among rural children in China. Despite these advancements, the prevalence of VAD and SVAD remains relatively high, particularly among male students, younger children, and those residing in the western regions of the country. To address this issue, strategies such as providing expert nutritional planning for school meals, enhancing nutrition education to promote healthier eating habits, and the fortification of foods with vitamin A are essential steps toward eradicating VAD.

Conflicts of interest: No conflicts of interest.

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Outbreak Reports

Food-Borne Poisoning Accident from Amanitin Toxin in Wild Mushrooms — Xingtai City, Hebei Province, China, 2023

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Summary

What is already known about this topic?

Fatal poisonings caused by wild mushrooms containing amanita toxins pose a significant threat in the southern regions of China. These toxins primarily induce gastrointestinal symptoms initially, which are then followed by potentially life-threatening acute liver damage.

What is added by this report?

This report contributes to the existing knowledge on these cases of poisoning by documenting the second occurrences in Hebei Province and the first occurrences in Xingtai City. Five individuals reported consuming wild mushrooms from the same origin, and laboratory tests confirmed the presence of α-amanitin in their blood samples.

What are the implications for public health practice?

This underscores the risk associated with the collection and consumption of amanita toxin-containing mushrooms in Hebei. It is important to note that the identification of toxic and non-toxic mushrooms should not solely rely on personal experience or appearance.

On September 3, 2023, a presumed mass poisoning incident occurred in Xingtai City, Hebei Province, China. There were five patients affected, all experiencing different levels of liver damage. Fortunately, there were no reported fatalities. In response, the local CDC formed a dedicated task force to investigate the incident. Through comprehensive epidemiological investigation, laboratory toxin analysis, and biological examination of toxic samples, it was determined that the consumption of wild mushrooms containing α-amanitin was the cause of the poisoning event.

The use of official and self-media channels has been effective in raising awareness and providing education on the risks associated with wild mushroom poisoning. Additionally, a ban has been enforced on the collection and consumption of wild mushrooms. As a result of these measures, no new cases of mushroom poisoning have been reported in Hebei Province.

INVESTIGATION AND RESULTS

For this study, we defined cases as residents of Xindu District who consumed self-harvested mushrooms and subsequently experienced symptoms such as nausea, vomiting, abdominal pain, or bloating between September 3–4, 2023. We identified cases through the examination of outpatient emergency room registration records at medical establishments in Xindu District, along with physician consultations. On September 4, 2023, the Xindu District Health Commission in Xingtai, received a report from a city hospital about five consecutive suspected cases of food poisoning that morning. The patients, all members of the same family, presented with symptoms including nausea, vomiting, abdominal pain, and diarrhea. They had a history of consuming self-foraged wild mushrooms before the onset of symptoms, leading to the initial hypothesis of mushroom poisoning. To investigate the exact cause, the Xindu District Health Commission requested assistance from the Xindu District CDC.

The incident involved a group of five individuals who were connected by family ties. The group consisted of three males and two females, with ages ranging from 34 to 45 years. Specifically, on September 3, Case A, Case B, Case C, and Case D visited the Zhougong Mountain Scenic Area, where they collected approximately 500 grams of wild mushrooms. Case C, who had previous experience identifying and consuming wild mushrooms in Guizhou, confirmed that the collected mushrooms were edible. Later, Case E joined the group at Case B's home. At 6:50 p.m., they had dinner, which included the stir-fried collected mushrooms (Figure 1A), along

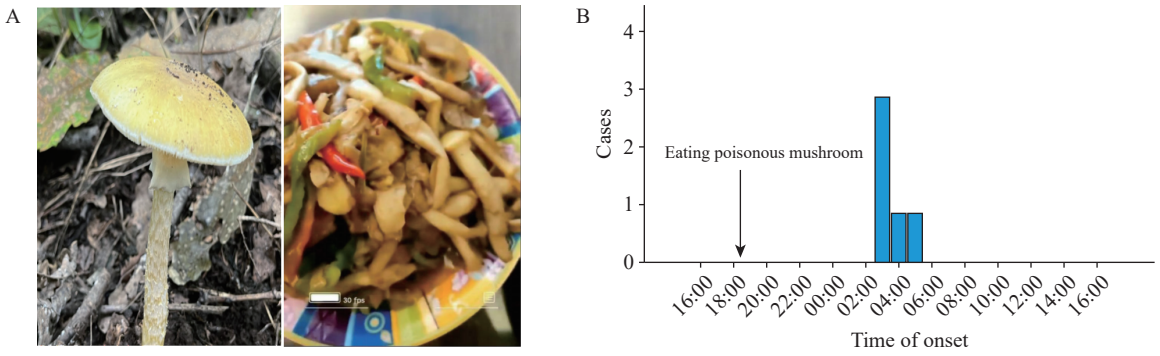

FIGURE 1. Amanita subjunquillea 's general appearance and time distribution of onset of accidental mushroom poisoning in Xingtai City, Hebei Province, 2023. (A) Amanita subjunquillea 's general appearance; (B) Time distribution of onset.
Note: The left part of panel A is *Amanita subjunquillea* collected from a case in A and the right part of panel A is cooked *Amanita subjunquillea*.

with stir-fried meat with potatoes, stir-fried meat with beans, and rice. It should be noted that the group frequently drank tap water from the municipal supply, which was boiled before consumption. There were no similar cases reported in the neighboring villages or medical facilities at the same time, indicating that contamination from an external source was unlikely.

Symptoms appeared early the next day, starting with Case A and followed by the other cases within a 2-hour period. Based on this pattern, it was tentatively concluded that the cause was toxin poisoning. The common factor among the patients was the consumption of self-harvested mushrooms during the evening meal on September 3. Therefore, it is highly likely that the mushrooms were the source of the incident.

The results of the epidemiological survey showed that all 5 individuals who consumed fried mushrooms had a 100% incidence rate, but there were no deaths. Among this group, four individuals had eaten a larger quantity of mushrooms, while one individual consumed a smaller amount. The initial clinical symptoms mainly included gastrointestinal issues such as nausea, vomiting, diarrhea, and abdominal pain. Case A exhibited symptoms at 03:06 a.m. on September 4, while the remaining cases developed symptoms within 2 hours thereafter (Figure 1B). The incubation period ranged from 8.5 to 11 hours (Table 1), with the frequency of vomiting and diarrhea being 6 or more times and 8 or more times, respectively, resulting in watery stools. The four individuals who consumed larger quantities of mushrooms also experienced fatigue and depression, whereas the individual who consumed a smaller amount did not exhibit these symptoms, indicating a correlation between symptom severity and mushroom consumption quantity.

Five cases arrived at the emergency department of a hospital in Xingtai City at approximately 6:00 a.m. on September 4th. Blood tests were conducted on these cases at 6:32 a.m. the same day. The blood samples were sent to the Institute of Microbiology of Zhejiang Province for analysis using online solid-phase extraction liquid chromatography-tandem mass spectrometry to detect and trace toxins. α-Amanita was found in all blood samples at levels ranging from 0.23–1.28 ng/mL. Other toxins were not detected in the samples (*1*). The laboratory results showed elevated levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT), total bilirubin (TBIL), direct bilirubin (DBIL), and lactate dehydrogenase (LDH), indicating liver dysfunction, with values predominantly within the ranges of 28.3–2,294.4 U/L, 26.3–2,902.1 U/L, 8.9–51.6 μmol/L, 2.8–19.0 μmol/L, and 202.8–2,305.0 U/L, respectively (Table 2). The treatment consisted of gastric lavage, catharsis, plasma exchange, blood purification, rehydration, and hepatoprotective measures aimed at removing toxins and providing symptomatic relief.

Epidemiological investigations, laboratory testing, and morphological identification were conducted to determine the cause of the incident. The National Institute of Occupational Health and Poison Control, China CDC, identified wild mushroom ingestion as the cause. The patients had harvested these mushrooms themselves from a pine forest at the summit of the Zhougong Mountain Scenic Area. The mushrooms were identified as *Amanita subjunquillea*.

PUBLIC HEALTH RESPONSE

An investigation was conducted on September 4 by

TABLE 1. Symptoms and course of aggregated cases of poisoning due to accidental ingestion of poisonous mushrooms in Xingtai City, Hebei Province, China, 2023.

Case	Gender	Age	Quantity of food consumed	α-amanita toxin (ng/mL)*	Early clinical symptoms						Course of disease			Outcome
					Vomiting	Diarrhea	Nausea	Abdominal pain	Mental depression	Pseudo-recovery period	Date of consumption	Incubation period (hours)	Date of damaged liver function	
A	m	34	+	0.23	Yes	Yes	Yes	Yes	No	No	Sep 3	8.5	Sep 4	Survival
B	f	45	++++	1.28	Yes	Yes	Yes	Yes	Yes	No	Sep 3	9	Sep 4	Survival
C	m	43	++	0.45	Yes	Yes	Yes	Yes	Yes	Yes†	Sep 3	9.5	Sep 11	Survival
D	f	41	+++	0.71	Yes	Yes	Yes	Yes	Yes	No	Sep 3	10.6	Sep 4	Survival
E	m	35	++	0.46	Yes	Yes	Yes	Yes	Yes	No	Sep 3	11	Sep 4	Survival

Abbreviation: Sep=September; m=male; f=female.
* Blood sample sampling time: 6:32 p.m., September 4, 2023.
† Pseudo-recovery period: Case C showed false healing 35–155 hours after exposure.

TABLE 2. Damaged liver function in aggregated cases of poisoning from accidental consumption of poisonous mushrooms in Xingtai City, Hebei Province, China, 2023.

Case	Course of disease	AST (U/L)	ALT (U/L)	TBIL (μmol/L)	DBIL (μmol/L)	LDH (U/L)	Hemoperfusion, CRRT, and plasma exchange
A	Onset*	63.0 ↑	103.0 ↑	25.4 ↑	6.3	218.4	Yes
	Maximun†	65.9 ↑	135.0 ↑	51.6 ↑	12.3 ↑	213.0	
B	Onset*	51.3 ↑	42.0 ↑	8.9	2.8	228.3	Yes
	Maximun†	626.5 ↑	491.2 ↑	29.3 ↑	19.0 ↑	717.0 ↑	
C	Onset*	33.7	33.7	10.6	3.2	388.0 ↑	Yes
	Maximun†	41.2 ↑	67.9 ↑	15.9	4.9	259.0 ↑	
D	Onset*	208.7 ↑	266.9 ↑	15.7	6.1	545.3 ↑	Yes
	Maximun†	2,294.4 ↑	2,902.1 ↑	29.5	11.6 ↑	2,305.0 ↑	
E	Onset*	28.3	26.3	21.1 ↑	6.5	202.8	Yes
	Maximum†	412.5 ↑	343.6 ↑	45.8 ↑	17.0 ↑	328.0 ↑	

Abbreviation: AST=aspartate aminotransferase; ALT=alanine aminotransferase; TBIL=total bilirubin; DBIL=direct bilirubin; LDH=lactate dehydrogenase; CRRT=continuous renal replacement therapy.
* Blood sample sampling time: 6:32 a.m., September 4, 2023; AST normal range: 13–35 U/L, ALT normal range: 7–40 U/L, TBIL normal range: 0–21 μmol/L, DBIL normal range: 0–7 μmol/L, LDH normal range: 120–250 U/L, ↑ indicates higher than normal.
† Maximum: The maximum in the course of disease. AST normal range: 13–35 U /L, AST normal range: 7–40 U/L, TBIL normal range: 0–23 μmol/L, DBIL normal range: 0–8 μmol/L, LDH normal range: 120–250U/L, ↑ indicates higher than normal.

the Hebei Province Field Epidemiology Training Program trainees and CDC professionals from the Xindu District to determine the source and nature of the poisoning, implement containment measures, and prevent future incidents. The investigation team revisited the location of the mushrooms and collected identical specimens. Patients were asked to identify the consistency of the mushrooms they had consumed, which were confirmed to be *Amanita subjunquillea*. Local authorities promptly initiated public education programs to raise awareness of the risks associated with consuming wild mushrooms and prohibited residents from foraging for and eating them. There have been no subsequent poisoning incidents in the area. The Hebei Provincial CDC recommends conducting educational campaigns on mushroom poisoning before and after the rainy season and installing warning signage in montane areas to discourage collection and consumption of wild mushrooms.

DISCUSSION

Wild poisonous mushrooms are more common in the southern region of China but are less frequently found in the north (*2–4*). Recent cases of food-borne poisoning in Hebei Province, linked to the consumption of wild mushrooms containing α-amanitin, suggest the presence of such mushrooms in certain northern areas. Interestingly, one affected individual (Case C) had a history of residing in the southern Guizhou region where mushroom foraging is common. While Case C expressed confidence in

distinguishing between toxic and non-toxic mushrooms, the majority of local residents reported difficulty in differentiating them based on appearance alone. Factors like climate variation between the northern and southern regions can lead to subtle differences in the appearance of the same mushroom species, increasing the risk of misidentification (*5*). It is therefore necessary to enhance education on identifying wild poisonous mushrooms, implement stricter policies on mushroom foraging, and increase the visibility of cautionary signage in specific areas. The low incidence of mushroom poisoning in certain areas should also serve as a reminder for the public to remain vigilant about this issue.

In China, more than 90% of all mushroom poisoning deaths are caused by amanitin-containing mushrooms (*6*). Due to the short half-life of amanitin in the bloodstream, it is essential to promptly initiate blood purification procedures in well-equipped healthcare institutions (*7*). Early sample collection is critical for rapid identification, accurate diagnosis, and appropriate treatment (*8*).

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Commentary Obituary

Zunyou Wu (1963–2023) Chief Epidemiologist, China CDC

Born in Huangshan city, Anhui Province in June 1963, Zunyou Wu passed away on October 27, 2023, in Beijing at the age of 60. Dr. Wu is the Chief Epidemiologist at China CDC, and served as the former director and researcher of the National Center for acquired immunodeficiency syndrome/sexually transmitted diseases (AIDS/STD) Control and Prevention (NCAIDS) at China CDC. Additionally, he was a member of the 14th National Committee of the Chinese People's Political Consultative Conference (CPPCC), and a member of the 15th Central Standing Committee of the China Association for Promoting Democracy (CAPD).

Dr. Wu earned a medical degree in 1985 and a master's degree in epidemiology in 1988 from Anhui Medical University, China. Subsequently, he pursued a master's degree and a doctorate degree in epidemiology at the University of California, Los Angeles (UCLA). Upon returning to China, Dr. Wu worked as a public health specialist, focusing his research on HIV/AIDS epidemiology, prevention and control strategies, and high-risk group behavior intervention.

From 1998 to 2001, Dr. Wu worked at the human immunodeficiency virus (HIV)/AIDS Prevention and Control Center of the Ministry of Health. Since 2001, he has been with NCAIDS, China CDC, and served as the director of NCAIDS from 2005 to 2017. Dr. Wu assumed the position of Chief Epidemiologist at China CDC in 2017. He was elected to the 15th Central Standing Committee of CAPD in 2022 and the 14th National Committee of CPPCC in 2023.

Dr. Wu has been involved in disease prevention and control for over 30 years, making significant contributions to combating major infectious diseases such as HIV/AIDS, hepatitis C, severe acute respiratory syndrome (SARS), and coronavirus disease 2019 (COVID-19). He is a leader in HIV prevention strategies and oversees prevention efforts among key populations in China. His significant contributions include preventing HIV transmission in plasma donors, implementing and expanding harm reduction programs to reduce HIV transmission among people who inject drugs, and proposing and advocating for the 'One4All' strategy, which shortens the HIV testing-to-treatment timeline and improves the survival of newly diagnosed HIV cases. Additionally, he led the development of the National HIV/AIDS Comprehensive Response Information Management System, which optimizes HIV case reporting, testing, treatment monitoring, and surveillance, promoting precise HIV prevention and control in China. His work has received international recognition and has influenced global best practices for HIV control.

In 2020, as the Chief Epidemiologist, Dr. Wu was involved in China's response to COVID-19. He conducted analyses on epidemic data from the Wuhan outbreak, contributing to the global understanding of COVID-19 epidemiology. Furthermore, his investigations into the COVID-19 outbreaks in Xinjiang Uygur Autonomous Region, Heilongjiang Province, and Beijing Municipality played a pivotal role in curbing the spread of the virus.

Dr. Wu has devoted himself to scientific research and talent training. He has presided over more than 40 research projects, including national science and technology projects, publishing 501 academic papers in infectious diseases, including 269 science citation index (SCI) papers. Additionally, he has trained a large number of talents in public health. Throughout his career, he has received several awards, such as the Nelson Mandela Award for Health Promotion, the title of the Most Beautiful Scientist, Advanced Individual in the Fight Against COVID-19 in the National Science and Technology System, Advanced Individual of the National Prevention and Control in HIV/AIDS, and Development Contribution Award for Public Health and Preventive Medicine, etc.

Dr. Wu dedicated to the well-being of the nation and its populace, embodying the diligent work ethic and strong sense of responsibility that epitomizes the spirit of scientists in this new era. He will be dearly remembered by all of us.

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