

# CHINA CDC WEEKLY



中国疾病预防控制中心周报 (英文)



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## Preplanned Studies

## Prevalence and Distribution of Diarrhea and Constipation Among Older Adults Aged 65 Years and Older — 31 PLADs, China, 2024

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### Summary

#### What is already known about this topic?

Diarrhea and constipation are common gastrointestinal disorders among older adults that significantly impact quality of life and increase healthcare burden.

#### What is added by this report?

Using nationally representative data from the 2024 China Survey of Aging and Health (CAHS), this study found that the weighted prevalence of diarrhea and constipation among adults aged  $\geq 65$  years in China was 14.2% and 16.4%, respectively, with notable regional and demographic variations.

#### What are the implications for public health practice?

This study provides an epidemiological profile of gastrointestinal disorders in older Chinese adults and identifies high-risk populations and regions to inform targeted prevention and management strategies.

## ABSTRACT

**Introduction:** Diarrhea and constipation are prevalent gastrointestinal conditions among older adults. This study examined the prevalence and demographic distribution of diarrhea and constipation among older adults in China for the development of targeted prevention strategies.

**Methods:** This study utilized data from the 2024 China Survey of Aging and Health (CAHS) covering 31 provincial-level administrative divisions (PLADs) and 41,859 older adults aged  $\geq 65$  years were included. Weighted prevalence estimates with 95% confidence intervals (CIs) were calculated. The Rao-Scott chi-square test was used to compare differences in prevalence across demographic subgroups.

**Results:** In 2024, the weighted prevalence of diarrhea and constipation among older adults in China was 14.2% (95% CI: 12.1, 16.6) and 16.4% (95% CI: 14.2, 18.9), respectively. The prevalence of diarrhea (16.8%) and constipation (20.8%) were the highest in

western China. Constipation prevalence showed a significant increasing trend with age ( $P < 0.001$ ), reaching 24.9% among adults aged  $\geq 80$  years, whereas no such age-related pattern was observed for diarrhea.

**Conclusions:** The burden of diarrhea and constipation in the older Chinese population is substantial. Prevention and management strategies should prioritize high-risk populations, particularly the oldest-old and residents of the western regions.

Gastrointestinal disorders, particularly diarrhea and constipation, are significant health concerns in older adults worldwide (1). These conditions can substantially impair quality of life, increase healthcare utilization, and lead to serious complications, including dehydration, malnutrition, and fecal impaction. With China's rapidly aging population, understanding the epidemiological characteristics of these conditions has become increasingly important for public health planning.

Diarrhea in older adults may result from infections, medications, dietary factors, or underlying diseases, whereas constipation is often associated with reduced physical activity, inadequate fiber intake, medication side effects, and age-related physiological changes (2–3). Both these conditions can significantly affect the health and well-being of older adults. This study utilized data from the 2024 China Survey of Aging and Health (CAHS) to examine the prevalence and demographic distribution of diarrhea and constipation among adults aged  $\geq 65$  years throughout China, providing evidence for targeted prevention and intervention strategies.

The CAHS uses a multistage stratified cluster sampling design across 31 provincial-level administrative divisions (PLADs) in China. Probability proportional-to-size sampling was used to ensure national and provincial representativeness. The

sampling framework comprised three sequential stages. First, the required sample size for each PLAD was calculated based on the standardized age distribution and sex ratio of the older population. Second, two to three representative survey cities were selected from each PLAD based on prefecture-level city gross domestic product rankings. Third, each prefecture-level city contributed to a minimum of two districts or counties, representing medium development levels. The CAHS successfully recruited 42,507 individuals aged  $\geq 65$  years. After excluding 648 participants with missing information on diarrhea and constipation status, 41,859 valid samples were included in the final analysis. A detailed description of the CAHS sampling design and methodology has been published previously (4).

Diarrhea and constipation status were assessed through face-to-face interviews conducted by trained interviewers, consistent with methodological approaches used in previous epidemiological studies on gastrointestinal disorders in older adults (5–6). Participants were defined as having diarrhea if they reported having been diagnosed with diarrhea by a medical institution within the past year or having self-reported core diarrhea symptoms (increased frequency of defecation, loose or watery stool consistency, or urgency to defecate). Similarly, participants were defined as having constipation if they reported being diagnosed with constipation by a medical institution within the past year or reported core constipation symptoms (such as reduced frequency of defecation, dry and hard stool consistency, straining during defecation, or feeling of incomplete evacuation). Data on age, sex, education, and household income were collected using standardized questionnaires. BMI was calculated from objectively measured height and weight. Current smoking status and alcohol consumption were defined as binary variables (yes/no, including former users).

Statistical analyses included sampling design, non-response adjustment, and post-stratification correction weights to ensure population representativeness. We computed weighted prevalence estimates with 95% confidence intervals (CIs) using survey-weighted methods and evaluated subgroup disparities through Rao-Scott  $\chi^2$  tests. All analyses were conducted using R software (version 4.4.2, R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at two-sided  $P < 0.05$ .

In 2024, the weighted prevalence of diarrhea and constipation among older adults aged  $\geq 65$  years in

China was 14.2% (95% CI: 12.1, 16.6) and 16.4% (95% CI: 14.2, 18.9), respectively (Tables 1–2). The prevalence of diarrhea was highest in western China (16.8%), while that of constipation was highest in western China (20.8%) and central China (19.4%). No significant differences were observed in the prevalence of diarrhea according to sex, age group, residence, education level, BMI, or household income (all  $P > 0.05$ ). However, constipation prevalence significantly increased with age ( $P < 0.001$ ), from 11.8% in the 65–69 years age group to 24.9% in adults aged  $\geq 80$  years. Constipation prevalence also varied significantly by region ( $P = 0.010$ ).

The age-stratified analysis by sex and residence revealed distinct patterns. For diarrhea, no significant age-related trends were observed across subgroups (all  $P > 0.05$ ). For constipation, significant age-related increases were observed in the total population ( $P < 0.001$ ), males ( $P = 0.018$ ), females ( $P = 0.003$ ), and urban residents ( $P < 0.001$ ), but not in rural residents ( $P = 0.303$ ) (Figure 1).

Provincial-level analysis revealed substantial geographic variation. For diarrhea, prevalence ranged from 3.5% in Guangdong to 31.0% in Yunnan. For constipation, prevalence ranged from 5.8% in Hainan to 47.7% in Inner Mongolia. Notable high-prevalence provinces for diarrhea included Yunnan (31.0%), Ningxia (30.3%), Qinghai (26.9%), Shanghai (26.4%), and Jiangsu (24.5%). For constipation, high-prevalence provinces included Inner Mongolia (47.7%), Qinghai (39.1%), Sichuan (32.1%), and Ningxia (31.0%) (Figure 1).

## DISCUSSION

This study found that the weighted prevalence of diarrhea and constipation among older adults aged  $\geq 65$  years in China in 2024 was 14.2% and 16.4%, respectively. These findings indicate that gastrointestinal disorders represent a substantial public health burden among China's aging population.

The observed prevalence rates are consistent with the global literature on gastrointestinal disorders in older adults. Previous studies have reported constipation prevalence ranging from 10% to 40% among older populations, depending on the definition used and the population studied (1,7). A multicenter study in four cities of China reported a constipation prevalence of 17.60% among older people aged  $\geq 65$  years, which is comparable to our findings (1).

Regional variations in prevalence were also notable.

TABLE 1. Characteristics of participants and prevalence of diarrhea among adults aged 65 years and older in China, 2024.

Characteristics	Sample size <i>N</i> (%)	Diarrhea		$\chi^2$	<i>P</i>
		<i>n</i> (%)	Weighted prevalence (95% <i>CI</i> )		
Total	41,859 (100.00)	4,816 (11.51)	14.24 (12.14, 16.64)		
Region				0.931	0.422
Eastern region	16,795 (40.12)	1,473 (8.77)	13.63 (10.18, 18.01)		
Central region	11,462 (27.38)	1,340 (11.69)	13.93 (10.69, 17.95)		
Western region	10,115 (24.16)	1,598 (15.80)	16.84 (12.59, 22.15)		
Northeastern region	3,487 (8.33)	405 (11.61)	10.63 (6.38, 17.20)		
Sex				0.117	0.733
Male	19,893 (47.52)	2,422 (12.18)	14.64 (11.64, 18.27)		
Female	21,966 (52.48)	2,394 (10.90)	13.90 (11.24, 17.07)		
Age group (years)				1.459	0.227
65–69	12,518 (29.91)	1,337 (10.68)	12.39 (9.19, 16.51)		
70–74	12,794 (30.56)	1,413 (11.05)	16.75 (12.45, 22.16)		
75–79	8,001 (19.11)	938 (11.72)	11.75 (9.02, 15.17)		
≥80	8,546 (20.42)	1,128 (13.20)	15.49 (11.65, 20.30)		
Residence				2.451	0.118
Urban	25,553 (61.05)	2,680 (10.49)	12.81 (10.51, 15.53)		
Rural	16,306 (38.95)	2,136 (13.10)	16.57 (12.76, 21.24)		
Education				0.192	0.824
Primary school and below	22,475 (53.69)	2,796 (12.44)	14.38 (11.57, 17.74)		
Junior high school	10,402 (24.85)	1,164 (11.19)	15.06 (11.17, 19.99)		
Senior high school and above	8,982 (21.46)	856 (9.53)	13.22 (9.63, 17.89)		
BMI (kg/m <sup>2</sup> )				0.474	0.673
<18.5	1,920 (4.59)	206 (10.73)	15.74 (9.21, 25.60)		
18.5–24.9	27,769 (66.34)	3,295 (11.87)	13.84 (11.42, 16.67)		
25.0–29.9	10,765 (25.72)	1,169 (10.86)	14.10 (10.33, 18.95)		
≥30	1,405 (3.36)	146 (10.40)	21.61 (8.27, 45.75)		
Monthly household income (CNY)				0.472	0.752
Q1 (<3,000)	11,437 (27.32)	1,273 (11.13)	14.00 (9.91, 19.43)		
Q2 (≥3,000 and <6,000)	11,468 (27.40)	1,461 (12.74)	12.46 (9.29, 16.52)		
Q3 (≥6,000 and <10,000)	7,989 (19.09)	781 (9.78)	14.65 (10.66, 19.79)		
Q4 (≥10,000)	4,703 (11.24)	566 (12.05)	17.16 (11.83, 24.23)		
Unwilling to disclose	6,262 (14.96)	735 (11.74)	14.24 (8.91, 21.98)		
Smoking				1.274	0.259
Yes	4,083 (9.75)	549 (13.45)	18.67 (11.06, 29.77)		
No	37,776 (90.20)	4,267 (11.30)	13.79 (11.71, 16.16)		
Alcohol consumption				3.729	0.054
Yes	3,007 (7.18)	477 (15.86)	22.04 (13.75, 33.38)		
No	38,852 (92.82)	4,339 (11.17)	13.70 (11.60, 16.11)		

Abbreviation: *CI*=confidence interval; CNY=Chinese Yuan.

TABLE 2. Characteristics of participants and prevalence of constipation among adults aged 65 years and older in China, 2024.

Characteristics	Sample size <i>N</i> (%)	Constipation			$\chi^2$	<i>P</i>
		<i>n</i> (%)	Weighted prevalence (95% <i>CI</i> )			
Total	41,859 (100.00)	6,617 (15.81)	16.4 (14.21, 18.85)			
Region				3.917	0.010	
Eastern region	16,795 (40.12)	2,105 (12.54)	12.45 (9.40, 16.33)			
Central region	11,462 (27.38)	2,141 (18.68)	19.41 (15.14, 24.54)			
Western region	10,115 (24.16)	1,731 (17.11)	20.75 (16.11, 26.31)			
Northeastern region	3,487 (8.33)	640 (18.35)	13.38 (9.06, 19.31)			
Sex				0.027	0.871	
Male	19,893 (47.52)	3,253 (16.35)	16.2 (13.16, 19.78)			
Female	21,966 (52.48)	3,364 (15.32)	16.57 (13.67, 19.95)			
Age group (years)				6.149	<0.001	
65–69	12,518 (29.91)	1,597 (12.76)	11.75 (8.46, 16.09)			
70–74	12,794 (30.56)	1,781 (13.92)	15.18 (11.39, 19.95)			
75–79	8,001 (19.11)	1,406 (17.57)	16.50 (12.69, 21.17)			
≥80	8,546 (20.42)	1,833 (21.45)	24.89 (19.61, 31.05)			
Residence				0.050	0.824	
Urban	25,553 (61.05)	3,981 (15.58)	16.19 (13.53, 19.27)			
Rural	16,306 (38.95)	2,636 (16.17)	16.73 (13.23, 20.93)			
Education				1.670	0.189	
Primary school and below	22,475 (53.69)	3,782 (16.83)	15.81 (12.98, 19.12)			
Junior high school	10,402 (24.85)	1,591 (15.30)	20.07 (15.52, 25.55)			
Senior high school and above	8,982 (21.46)	1,244 (13.85)	14.23 (10.30, 19.34)			
BMI (kg/m <sup>2</sup> )				0.539	0.645	
<18.5	1,920 (4.59)	304 (15.84)	17.35 (10.65, 26.99)			
18.5–24.9	27,769 (66.34)	4,329 (15.59)	15.73 (13.11, 18.77)			
25.0–29.9	10,765 (25.72)	1,718 (15.96)	17.09 (13.03, 22.10)			
≥30	1,405 (3.36)	266 (18.95)	22.49 (13.10, 35.83)			
Monthly household income (CNY)				1.278	0.278	
Q1 (<3,000)	11,437 (27.32)	1,721 (15.05)	16.63 (12.65, 21.55)			
Q2 (≥3,000 and <6,000)	11,468 (27.40)	1,805 (15.74)	16.97 (13.07, 21.74)			
Q3 (≥6,000 and <10,000)	7,989 (19.09)	1,209 (15.14)	13.16 (9.85, 17.36)			
Q4 (≥10,000)	4,703 (11.24)	759 (16.15)	14.38 (10.39, 19.57)			
Unwilling to disclose	6,262 (14.96)	1,123 (17.93)	22.21 (14.12, 33.14)			
Smoking				0.555	0.457	
Yes	4,083 (9.75)	758 (18.56)	19.43 (11.81, 30.28)			
No	37,776 (90.25)	5,859 (15.51)	16.08 (13.89, 18.55)			
Alcohol consumption				0.805	0.370	
Yes	3,007 (7.18)	565 (18.79)	13.82 (9.35, 19.97)			
No	38,852 (92.82)	6,052 (15.58)	16.58 (14.28, 19.17)			

Abbreviation: *CI*=confidence interval.

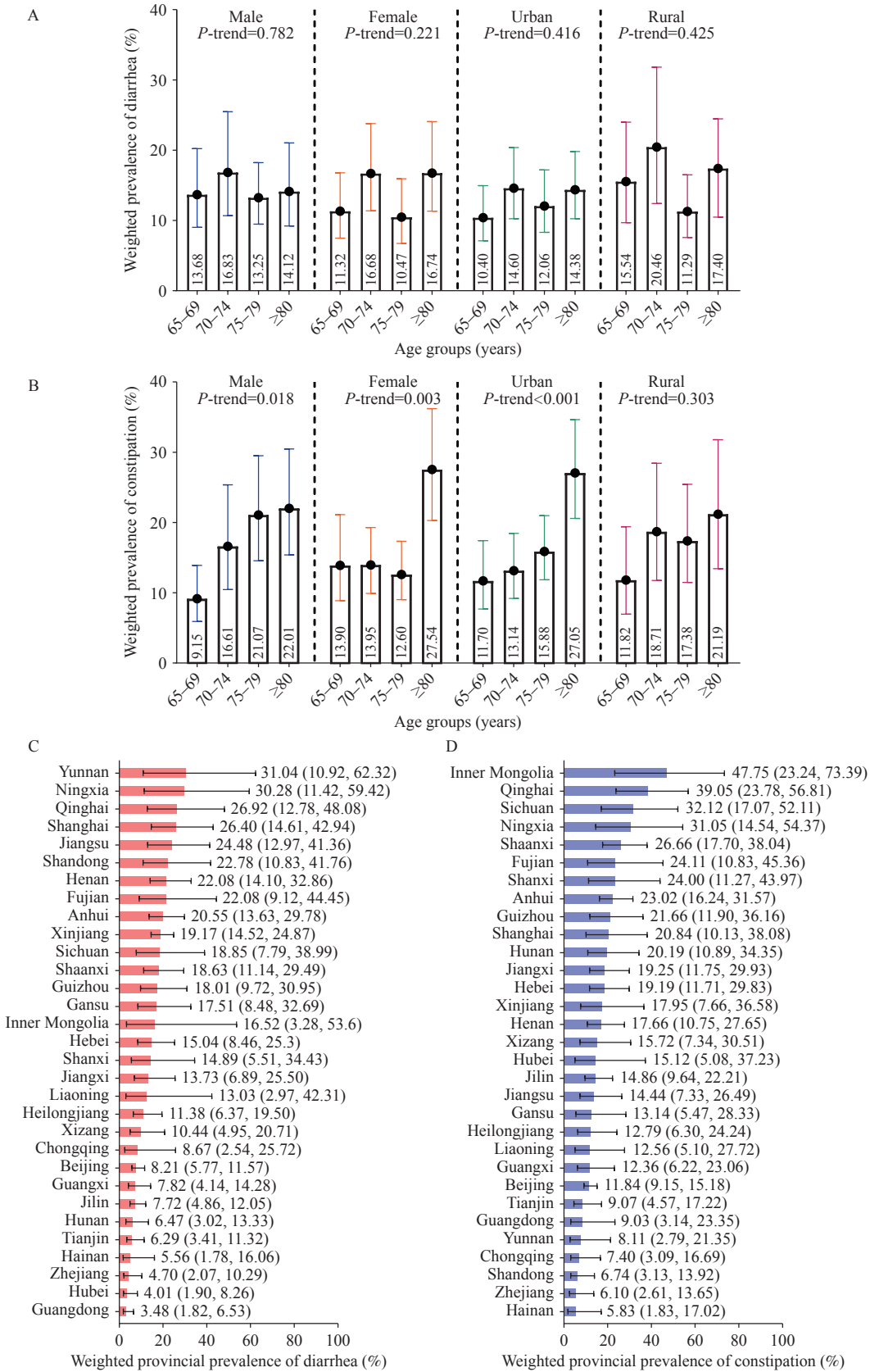


FIGURE 1. Age-stratified and provincial weighted prevalence of diarrhea and constipation among adults aged 65 years and older in China, 2024. (A) Prevalence of diarrhea by sex and residence; (B) Prevalence of constipation by sex and residence; (C) Prevalence of diarrhea; (D) Prevalence of constipation.

The highest prevalence of both diarrhea and constipation was observed in western China, which may reflect differences in dietary habits, access to healthcare, environmental factors, and socioeconomic development. Previous research has indicated that the prevalence of constipation in northern areas is significantly higher than that in southern areas, which may be attributed to different dietary habits (8). Inner Mongolia exhibited the highest constipation prevalence, possibly because of dietary patterns, climate conditions, and limited access to fresh vegetables and fruits.

The significant age-related increase in constipation prevalence, from 11.8% in the 65–69 years group to 24.9% in those aged  $\geq 80$  years, aligns with known physiological changes associated with aging, including decreased gastrointestinal motility, reduced physical activity, increased medication use, and changes in dietary patterns (9). Previous studies using CLHLS data have also demonstrated that functional impairment rates among individuals aged 85 and above are significantly higher, particularly among females and older populations residing in rural areas (9). These findings underscore the importance of targeted interventions for constipation among the oldest-old population. In contrast, diarrhea showed no significant age-related trend, with its prevalence fluctuating slightly across age groups rather than rising consistently. Unlike constipation's cumulative burden from reduced gut motility and inactivity, diarrhea triggers are episodic, aging-unrelated, and often linked to unhealthy lifestyle factors, such as poor dietary choices, explaining the lack of age-associated prevalence accumulation (10).

The findings in this report are subject to at least four limitations. First, the cross-sectional design captured disease status at a single time point, preventing the examination of temporal trends or causal relationships. Second, the reliance on self-reported measures introduces potential recall bias. Third, this study only reported the overall prevalence of diarrhea. Limited by the questionnaire, infectious and non-infectious diarrhea were not stratified, which requires further exploration with more detailed diagnostic information. Finally, potential influencing factors, such as medication use, dietary habits, and physical activity levels, were not included in this analysis. Future studies are warranted to explore the independent and interactive effects of these factors on diarrhea and constipation, particularly on the age-related mechanisms of functional constipation.

In conclusion, diarrhea and constipation are significant health burdens in China's older population, with notable regional and demographic variations. Prevention and management strategies should prioritize high-risk populations, particularly the oldest-old and residents of the western regions.

**Conflicts of interest:** No conflicts of interest.

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**Ethical statement:** The CAHS protocol was approved by the Ethics Committee of Beijing Hospital (approval number: 2021BJYEC-359-02).

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## REFERENCES

1. Du XS, Liu S, Jia PF, Wang XD, Gan JH, Hu WZ, et al. Epidemiology of constipation in elderly people in parts of China: a multicenter study. *Front Public Health* 2022;10:823987. <https://doi.org/10.3389/fpubh.2022.823987>.
2. Dawod E, Crawford CV. Common diarrheal illnesses in the elderly. *Clin Geriatr Med* 2021;37(1):103–17. <https://doi.org/10.1016/j.cger.2020.08.008>.
3. Cheever CR, Shams RB, Willingham KR, Sim H, Cook LM, Ahmidouch MY, et al. Understanding constipation as a geriatric syndrome. *Geriatr Nurs* 2025;61:440–8. <https://doi.org/10.1016/j.ger.2025.03.008>.

- gerinurse.2024.12.012.
4. Liu Y, Zhang YS, Shen J, Zhang C, Sang YC, Wang YJ, et al. Spatial distribution and clustering patterns of cognitive impairment among the older population - 31 PLADs, China, 2024. *China CDC Wkly* 2025;7(41):1302 - 7. <https://doi.org/10.46234/ccdcw2025.219>.
  5. Sun HZ, Qi L, Ming YW, Wang WC, Hu MN. Life's Simple 7 and its impact on chronic bowel disorders: a study on constipation and diarrhea in the U. S. adult population. *Front Med* 2025;12:1516210. <https://doi.org/10.3389/fmed.2025.1516210>.
  6. Zhuang HY, Guo Z, Li SG, Fu QX. Inverse association of alcohol consumption patterns with constipation and diarrhea: a population-based cross-sectional study. *BMC Gastroenterol* 2025;25(1):865. <https://doi.org/10.1186/s12876-025-04464-z>.
  7. Chen Z, Peng YY, Shi QY, Chen YJ, Cao LJ, Jia JN, et al. Prevalence and risk factors of functional constipation according to the rome criteria in China: a systematic review and meta-analysis. *Front Med* 2022;9:815156. <https://doi.org/10.3389/fmed.2022.815156>.
  8. Chu HK, Zhong LK, Li H, Zhang XJ, Zhang JZ, Hou XH. Epidemiology characteristics of constipation for general population, pediatric population, and elderly population in China. *Gastroenterol Res Pract* 2014;2014:532734. <https://doi.org/10.1155/2014/532734>.
  9. Su BB, Zhong PL, Chen C, Wu Y, Zheng XY. Activities of daily living-related functional impairment among population aged 65 and older - China, 2011-2050. *China CDC Wkly* 2023;5(27):593 - 8. <https://doi.org/10.46234/ccdcw2023.114>.
  10. Singh P, Mitsuhashi S, Ballou S, Rangan V, Sommers T, Cheng V, et al. Demographic and dietary associations of chronic diarrhea in a representative sample of adults in the United States. *Am J Gastroenterol* 2018;113(4):593 - 600. <https://doi.org/10.1038/ajg.2018.24>.

## Preplanned Studies

# Intraocular Pressure and Its Association with Ocular Biometrics in Children and Adolescents — 10 PLADs, China, 2020–2024

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## Summary

### What is already known about this topic?

Intraocular pressure (IOP) is essential for ocular homeostasis and glaucoma prevention. However, its developmental patterns and associations with refractive errors in children remain incompletely understood.

### What is added by this report?

This study identifies a biphasic IOP trajectory peaking in grade 6 (approximately age 12 years) ( $18.2 \pm 2.9$  mmHg) and a pubertal reversal in sexual dimorphism, with higher IOP in prepubertal girls vs. in boys from grade 10 onward, significant by grade 12 [mean difference  $-0.5$  mmHg; 95% confidence interval (CI):  $-0.9, -0.1$ ], while challenging uniform IOP–myopia causality through grade-stratified analyses.

### What are the implications for public health practice?

Findings support the implementation of grade- and sex-specific pediatric IOP monitoring to improve targeted prevention of pediatric glaucoma and promote overall ocular health. They also underscore the need for further research on IOP dynamics to better inform myopia management strategies.

assessed. Multivariable linear regression assessed associations between IOP and ocular parameters, adjusting for grade and sex.

**Results:** Mean IOP was  $17.6 \pm 3.0$  mmHg, showing a biphasic pattern, peaking at grade 6 ( $18.2 \pm 2.9$  mmHg) and declining thereafter. Girls had significantly higher IOP prepuberty [peak difference at grade 5:  $0.5$  mmHg; 95% confidence interval (CI):  $0.3, 0.7$ ], whereas boys exhibited higher IOP post-puberty (grade 12:  $-0.5$  mmHg; 95% CI:  $-0.9, -0.1$ ). IOP was higher in children with myopia ( $P < 0.01$ ) and was significantly associated with spherical equivalent ( $\beta = -0.04, P = 0.01$ ), corneal radius ( $\beta = 2.03, P = 0.04$ ), and anterior chamber depth ( $\beta = 0.42, P < 0.01$ ).

**Conclusion:** This study identified distinct grade- and sex-specific IOP patterns among Chinese children, including a novel pubertal reversal in sexual dimorphism. The findings challenge a simple causal IOP–myopia relationship and warrant further investigation. These results support the need for tailored pediatric IOP monitoring strategies to improve glaucoma prevention, enhance myopia control, and promote overall ocular health.

## ABSTRACT

**Introduction:** Intraocular pressure (IOP) is essential for ocular homeostasis and pediatric glaucoma prevention. However, its developmental patterns and associations with refractive error remain unclear. This study examined grade- and sex-specific IOP variations and their relationship with ocular biometrics in a large pediatric cohort.

**Methods:** This nationwide cross-sectional study included 65,209 students (grades 0–12) from 10 provincial-level administrative divisions (PLADs) in China between 2020 and 2024. IOP was measured using non-contact tonometry. Cycloplegic refraction and ocular biometry — including axial length, corneal radius, and anterior chamber depth — were also

Intraocular pressure (IOP), which is essential for ocular homeostasis, remains insufficiently studied in pediatric populations. IOP plays a pivotal role in the diagnosis and management of glaucoma, a leading cause of irreversible blindness worldwide, including among children (1). Early detection and screening are critical for preventing vision loss in pediatric glaucoma (1). Delayed diagnosis can impose substantial emotional and psychological burdens on both patients and their caregivers (1). Accurate assessment of IOP in children is therefore crucial for the timely detection of ocular hypertension and the prevention of childhood glaucoma, particularly given the absence of a universally accepted threshold for ocular hypertension in this age group (2).

Previous studies suggest that elevated IOP may

induce scleral stress and creep, potentially contributing to axial elongation and myopia progression (3). However, current evidence regarding the association between IOP and myopia remains inconsistent (4–5). This inconsistency underscores the need for a more nuanced understanding of IOP's role, which may vary according to refractive status and other ocular biometric parameters. Orthokeratology and low-concentration atropine eye drops — widely used strategies for myopia control — have been shown to modulate choroidal thickness and blood flow, suggesting a biomechanical pathway that may indirectly involve IOP (6).

Continuous IOP monitoring, alongside ocular biometric parameters such as axial length, may provide valuable insights for early detection and targeted interventions (7). However, most existing studies on IOP and ocular biometrics have focused on adults or relatively small, region-specific pediatric samples. To address this gap, the present study — conducted across 10 provincial-level administrative divisions (PLADs) in China — aimed to characterize grade- and sex-specific variations in IOP among school-aged children and to examine their associations with refractive error and ocular biometric parameters.

Between 2020 and 2024, the National Disease Control and Prevention Administration of China conducted a nationwide survey of hyperopia reserve across 10 PLADs: Beijing, Liaoning, Zhejiang, Shandong, and Guangdong (eastern China); Henan, Hunan, and Shanxi (central China); and Chongqing and Shaanxi (western China). The minimum sample size for each grade was estimated using the simple random sampling formula based on data from the 2020 national myopia survey. In most PLADs, two cities were selected according to economic development level (one more developed and one less developed). Within each PLAD, 15–20 kindergartens, 15–20 primary schools, 8–10 junior high schools, and 8–10 senior high schools were selected, maintaining a 1:1 urban-to-rural ratio for each school type. Classes were then randomly selected within each school, and all students in the selected classes were invited to participate with informed consent. Using a multistage cluster sampling design, a total of 67,260 students from senior kindergartens (Grade 0) through third-year high school (Grade 12) were selected.

IOP was measured using a non-contact tonometer (Topcon CT-800A; Topcon Co., Tokyo, Japan). Cycloplegic refraction was performed following 0.5% tropicamide administration (four instillations at 5-

minute intervals). Spherical equivalent (SE) was measured using an autorefractor (KR-800; Topcon Co., Tokyo, Japan). Cycloplegia and pupil dilation were assessed after an additional 30 minutes; full cycloplegia was defined as a pupil diameter  $\geq 6$  mm with the absence of the light reflex. Ocular biometric parameters, including axial length (AL), corneal radius (CR), and anterior chamber depth (ACD), were measured using the IOLMaster 500 (Carl Zeiss Meditec AG, Jena, Germany). Three consecutive measurements were obtained for each eye, and mean values were used for analysis.

All examinations were conducted by certified professionals to ensure measurement accuracy. Quality control included same-day random retesting of 5% of participants at each survey site. If the difference between repeated measurements was  $< 5.0$  mmHg for IOP,  $< 0.50$  diopters (D) for SE,  $< 0.05$  mm for AL,  $< 0.50$  D for CR, and  $< 0.20$  mm for ACD, the initial measurement was retained. If the difference exceeded these thresholds, corrective actions (e.g., optimizing the measurement environment or recalibrating instruments) were implemented, and measurements were repeated until criteria were met. If more than 5% of retested participants at a site exceeded these thresholds, all measurements from that day were considered invalid, and the survey was repeated. SE was calculated as spherical power plus half of the cylindrical power. Refractive status was classified as myopia ( $SE \leq -0.50$  D), emmetropia ( $-0.50$  D  $< SE < +0.50$  D), and hyperopia ( $SE \geq +0.50$  D). To ensure statistical independence, only right-eye measurements were included in the final analysis due to high interocular correlation.

Continuous variables are presented as means  $\pm$  standard deviations (SDs), and categorical variables are presented as frequencies and percentages. Between-group comparisons were conducted using *t*-tests or one-way analysis of variance for continuous variables and chi-square tests for categorical variables, as appropriate. Univariable and multivariable linear regression analyses were performed to assess associations between IOP and ocular parameters. All tests were two-tailed, and  $P < 0.05$  was considered statistically significant. Analyses were conducted using R software (version 4.5.2; R Foundation for Statistical Computing, Vienna, Austria).

A total of 65,209 of 67,260 students (97.0%) were included in the analyses (Supplementary Figure S1, available at <https://weekly.chinacdc.cn>). Of these, 33,652 (51.6%) were boys. The sample comprised

15,071 (23.1%) senior kindergarten students, 42,871 (65.7%) elementary school students, 4,247 (6.5%) middle school students, and 3,020 (4.6%) high school students.

IOP varied significantly across grade levels, with a mean±SD of 17.6±3.0 mmHg. From senior kindergarten (grade 0) through elementary school (grades 1–6), IOP increased progressively [17.0±2.9 mmHg in grade 0 *vs.* 18.2±2.9 mmHg in grade 6]. Thereafter, IOP declined gradually during secondary education (grades 7–12), reaching 17.3±3.0 mmHg in grade 12, with a slight rebound in grade 9. This biphasic pattern was observed in both sexes (Figure 1). Sex-specific differences in IOP were evident across developmental stages. Girls had significantly higher IOP than boys from grades 0–7, with the largest difference in grade 5 (mean difference, 0.5 mmHg; 95% CI: 0.3, 0.7). Although girls continued to exhibit slightly higher IOP in grades 8–9, these differences were not statistically significant. A reversal of the sex pattern occurred in later grades, with boys demonstrating higher IOP from grade 10 onward; this difference reached statistical significance in grade 12 (mean difference, -0.5 mmHg; 95% CI: -0.9, -0.1) (Table 1, Figure 2).

Overall, IOP differed significantly across refractive status groups ( $P<0.01$ ). Myopic participants had the highest mean±SD IOP [17.9±2.9 mmHg], followed by emmetropic participants [17.7±2.9 mmHg] and hyperopic participants [17.4±3.0 mmHg]. Grade-stratified analyses revealed distinct developmental patterns (Table 2). In senior kindergarten (grade 0),

emmetropic children had significantly higher IOP than hyperopic children ( $P=0.02$ ). Among elementary school students (grades 1–6), a gradient was observed (myopia > emmetropia > hyperopia; all pairwise comparisons  $P<0.05$ ). This association was not significant in lower secondary school (grades 7–9; all pairwise comparisons  $P>0.05$ ) but reversed in upper secondary school (grades 10–12), where emmetropic students had significantly lower IOP than hyperopic students ( $P=0.02$ ).

In univariable analyses, IOP was associated with several ocular biometric parameters, showing a negative correlation with SE and positive correlations with AL, CR, the AL/CR ratio, and ACD (all  $P<0.01$ ). In multivariable models adjusted for grade, sex, and ocular parameters, IOP remained significantly associated with SE ( $\beta=-0.04$ ; 95% CI: -0.06, -0.01;  $P=0.01$ ), CR ( $\beta=2.03$ ; 95% CI: 0.09, 3.96;  $P=0.04$ ), and ACD ( $\beta=0.42$ ; 95% CI: 0.34, 0.50;  $P<0.01$ ). Associations with AL and the AL/CR ratio were not statistically significant (Table 3).

## DISCUSSION

This large-scale, population-based study provides comprehensive evidence of grade- and sex-related variations in IOP among Chinese school-aged children and adolescents and elucidates its complex associations with refractive status and ocular biometric parameters. These findings enhance understanding of IOP dynamics during ocular development in childhood.

IOP followed a biphasic developmental pattern: it

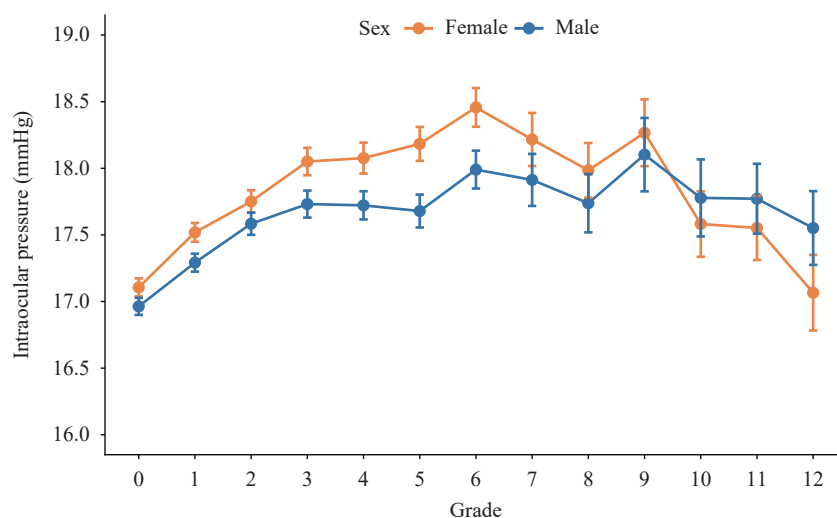


FIGURE 1. Sex-stratified trends in mean intraocular pressure by grade level among children and adolescents across 10 provincial-level administrative divisions in China, 2020–2024.

TABLE 1. Sex differences in intraocular pressure across grade levels among children and adolescents across 10 provincial-level administrative divisions in China, 2020–2024.

Grade	Intraocular pressure (Mean±SD)		Mean difference (95% CI)	P
	Female	Male		
0*	17.1±2.9	17.0±2.9	0.1 (0.0, 0.2)	<0.01
1	17.5±3.0	17.3±2.9	0.2 (0.1, 0.3)	<0.01
2	17.8±2.9	17.6±3.0	0.2 (0.0, 0.3)	0.01
3	18.1±3.1	17.7±3.1	0.3 (0.2, 0.5)	<0.01
4	18.1±2.9	17.7±2.8	0.4 (0.2, 0.5)	<0.01
5	18.2±3.0	17.7±3.0	0.5 (0.3, 0.7)	<0.01
6	18.5±2.9	18.0±3.0	0.5 (0.3, 0.7)	<0.01
7	18.2±3.0	17.9±3.0	0.3 (0.0, 0.6)	0.03
8	18.0±3.0	17.7±3.0	0.2 (−0.1, 0.5)	0.11
9	18.3±2.8	18.1±3.0	0.2 (−0.2, 0.5)	0.39
10	17.6±2.9	17.8±3.2	−0.2 (−0.6, 0.2)	0.31
11	17.6±2.9	17.8±3.1	−0.2 (−0.6, 0.1)	0.23
12	17.1±2.8	17.6±3.2	−0.5 (−0.9, −0.1)	0.02

Abbreviations: CI=confidence interval; SD=standard deviation.

\* Grade 0 means senior kindergarten.

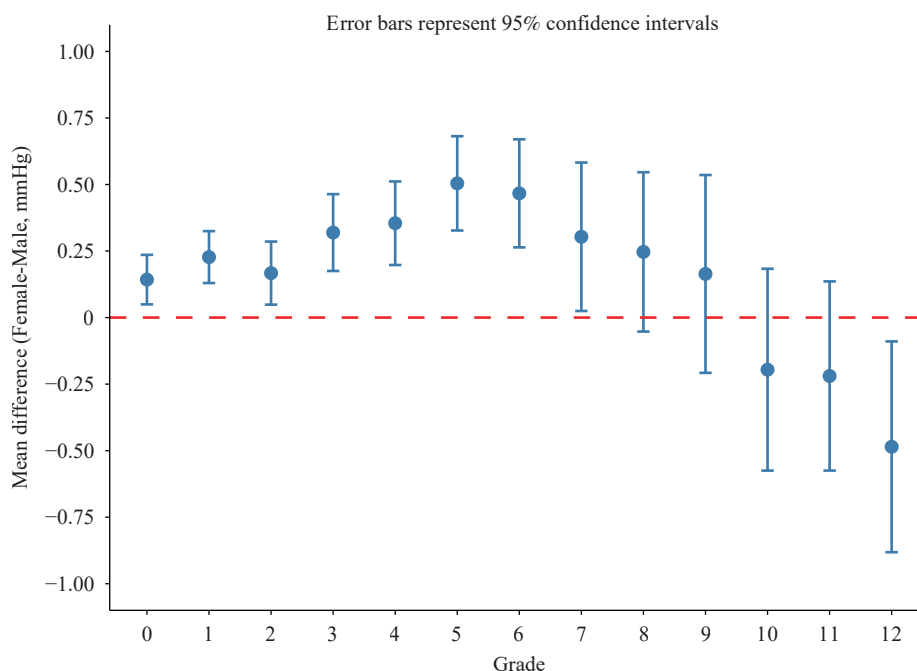


FIGURE 2. Sex differences in intraocular pressure across grade levels among children and adolescents across 10 provincial-level administrative divisions in China, 2020–2024.

increased to a peak in grade 6 (approximately 12 years of age), declined gradually through secondary education, and exhibited a transient elevation in grade 9 (approximately 15 years of age). This pattern partly aligns with previous studies in Chinese populations. The Shandong Study reported IOP peaks at ages 10

and 15 years (8), whereas the Mojiang Study identified peaks at ages 9 and 15 years (9). Notably, the present study's IOP measurements aligned closely with those from the Shandong cohort but were consistently higher than those reported in the Mojiang Study across all age groups. These discrepancies may reflect differences in

TABLE 2. Differences in intraocular pressure across refractive status among children and adolescents across 10 provincial-level administrative divisions in China, 2020–2024, stratified by educational stage.

Educational Stages	Refractive Status	Mean difference (95% CI)	P
Kindergarten	Emmetropia vs. Myopia	0 (–0.31, 0.30)	1.00
Kindergarten	Hyperopia vs. Myopia	–0.19 (–0.46, 0.08)	0.24
Kindergarten	Hyperopia vs. Emmetropia	–0.18 (–0.34, –0.03)	0.02*
Elementary school	Emmetropia vs. Myopia	–0.10 (–0.20, –0.01)	0.03*
Elementary school	Hyperopia vs. Myopia	–0.41 (–0.49, –0.33)	<0.01*
Elementary school	Hyperopia vs. Emmetropia	–0.30 (–0.39, –0.22)	<0.01*
Lower secondary school	Emmetropia vs. Myopia	–0.23 (–0.54, 0.09)	0.21
Lower secondary school	Hyperopia vs. Myopia	–0.14 (–0.53, 0.25)	0.68
Lower secondary school	Hyperopia vs. Emmetropia	0.09 (–0.39, 0.56)	0.90
Higher secondary school	Emmetropia vs. Myopia	–0.27 (–0.69, 0.15)	0.30
Higher secondary school	Hyperopia vs. Myopia	0.42 (–0.07, 0.90)	0.11
Higher secondary school	Hyperopia vs. Emmetropia	0.68 (0.07, 1.29)	0.02*

Abbreviation: CI=confidence interval.

Note: \*  $P < 0.05$ .

TABLE 3. Associations between intraocular pressure (mmHg) and ocular parameters among children and adolescents across 10 provincial-level administrative divisions in China, 2020–2024.

Variables	Univariable analysis		Multivariable analysis*	
	$\beta$ (95% CI)	P	$\beta$ (95% CI)	P
SE	–0.12 (–0.14, –0.11)	<0.01	–0.04 (–0.06, –0.01)	0.01
AL	0.21 (0.19, 0.23)	<0.01	–0.59 (–1.24, 0.06)	0.08
CR	0.18 (0.09, 0.27)	<0.01	2.03 (0.09, 3.96)	0.04
AL/CR	1.63 (1.44, 1.81)	<0.01	4.81 (–0.24, 9.86)	0.06
ACD	0.67 (0.60, 0.74)	<0.01	0.42 (0.34, 0.50)	<0.01

Note:  $\beta$ =regression coefficient reflecting the linear relationship between variables.

Abbreviation: SE=spherical equivalent; AL=axial length; CR=corneal radius; AL/CR=axial length to corneal radius ratio; ACD=anterior chamber depth; CI=confidence interval.

\* The multivariable analysis was adjusted for ocular parameters (SE, AL, CR, AL/CR, and ACD), grade, and sex.

population characteristics (e.g., ethnic composition), geographic factors (particularly Mojiang's high-altitude location), or measurement methodologies.

A novel finding is the grade-dependent reversal of the sex differences in IOP. Females exhibited higher IOP prepuberty (grades 0–7), whereas males showed higher IOP post-puberty. This transitional pattern has not been previously reported and contrasts with existing literature describing consistent sex-specific differences, with IOP persistently higher in either females (4,8–9) or males (10). This observed reversal may reflect hormonal influences on ocular hydrodynamics during development and warrants further investigation in prospective cohort studies.

The association between IOP and refractive status was complex and developmentally modulated. Although myopic participants had higher overall IOP, stratified analyses indicated that this relationship was

not consistent across grade groups. The absence of a uniform gradient (myopia > emmetropia > hyperopia) suggests that the role of IOP in refractive development may be context-dependent, potentially mediated by other growth-related factors or restricted to specific developmental windows.

The findings in this report are subject to at least two limitations. First, its cross-sectional design precludes causal inferences. Second, although non-contact tonometry was used for its practicality in pediatric populations (e.g., efficiency and reduced infection risk), the absence of Goldmann applanation tonometry and central corneal thickness measurements may have introduced measurement bias (11).

This study also has notable strengths. Because it was conducted in schools on a grade-by-grade basis, age-stratified analysis were not performed. This approach is supported by evidence suggesting that grade level may

have a stronger association with myopia than chronological age (12–13). A supplementary table reporting the mean age and SD for each grade is provided for reference (Supplementary Table S1, available at <https://weekly.chinacdc.cn/>).

This study underscores the public health importance of monitoring IOP as a potential target for myopia management in children and adolescents, expanding the focus beyond refractive correction to comprehensive ocular health, including the prevention of long-term complications (e.g., glaucoma). Finally, standardized protocols and nationwide sampling enhance the generalizability of the findings to similar populations.

In conclusion, using a large and representative sample, this study systematically characterizes the variation in IOP and its relationships with optometric parameters. The findings highlight the need for further research on IOP dynamics to inform myopia management strategies and support grade- and sex-specific IOP monitoring in pediatric populations to improve glaucoma prevention, myopia control, and overall ocular health.

**Conflicts of interest:** No conflicts of interest.

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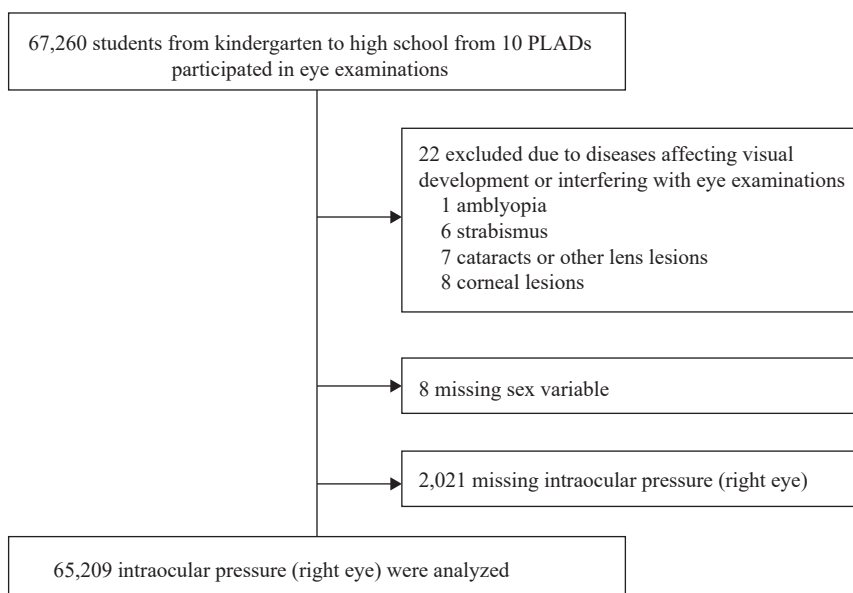
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## REFERENCES

- Lingham G, Thakur S, Safi S, Gordon I, Evans JR, Keel S. A systematic review of clinical practice guidelines for childhood glaucoma. *BMJ Open Ophthalmol* 2022;7(1):e000933. <https://doi.org/10.1136/bmjophth-2021-000933>.
- Han F, Wang Y. Research progress of intraocular pressure and its related influencing factors in children. *Chin J Exp Ophthalmol* 2022;40(4):351 – 6. <https://doi.org/10.3760/cma.j.cn115989-20200811-00581>.
- Wang PY, Kong KJ, Jiang JX, Jiang JW, Xie ZH, Lin FB, et al. Intraocular pressure is a promising target for myopia control. *J Transl Med* 2025;23(1):556. <https://doi.org/10.1186/s12967-025-06546-8>.
- Lee AJ, Saw SM, Gazzard G, Cheng A, Tan DTH. Intraocular pressure associations with refractive error and axial length in children. *Br J Ophthalmol* 2004;88(1):5 – 7. <https://doi.org/10.1136/bjo.88.1.5>.
- Yii FSL, He MG, Chappell F, Bernabeu MO, MacGillivray T, Dhillon B, et al. Higher intraocular pressure is associated with slower axial growth in children with non-pathological high myopia. *Eye* 2024;38(6):1208 – 14. <https://doi.org/10.1038/s41433-023-02872-7>.
- Du LF, He F, Tan HX, Gao N, Song WQ, Luo YX. Comparisons of three methods for myopia control in adolescents. *J Ophthalmol* 2022;2022:9920002. <https://doi.org/10.1155/2022/9920002>.
- Li SN, Li SM, Wang XL, Kang MT, Liu LR, Li H, et al. Distribution and associations of intraocular pressure in 7- and 12-year-old Chinese children: the Anyang Childhood Eye Study. *PLoS One* 2017;12(8):e0181922. <https://doi.org/10.1371/journal.pone.0181922>.
- Jiang WJ, Wu JF, Hu YY, Wu H, Sun W, Lu TL, et al. Intraocular pressure and associated factors in children: the Shandong children eye study. *Invest Ophthalmol Vis Sci* 2014;55(7):4128 – 34. <https://doi.org/10.1167/iovs.14-14244>.
- Han F, Li J, Zhao XH, Li XL, Wei PH, Wang Y. Distribution and analysis of intraocular pressure and its possible association with glaucoma in children. *Int Ophthalmol* 2021;41(8):2817 – 25. <https://doi.org/10.1007/s10792-021-01838-6>.
- Dusek WA, Pierscionek BK, McClelland JF. Age variations in intraocular pressure in a cohort of healthy Austrian school children. *Eye* 2012;26(6):841 – 5. <https://doi.org/10.1038/eye.2012.54>.
- Ito K, Tawara A, Kubota T, Harada Y. IOP measured by dynamic contour tonometry correlates with IOP measured by Goldmann applanation tonometry and non-contact tonometry in Japanese individuals. *J Glaucoma* 2012;21(1):35 – 40. <https://doi.org/10.1097/IJG.0b013e31820275b4>.
- Qin R, Liu Y, Li HT, Xiong Y, Gu F, Shi W, et al. Reference values of spherical equivalent for predicting the onset and progression of myopia among children and adolescents in China. *Br J Ophthalmol* 2025;109(11):1221 – 5. <https://doi.org/10.1136/bjo-2024-326815>.
- Liu Y, Qin R, Xiong Y, Gu F, Shi W, Liu JM, et al. Reference values of non-cycloplegic spherical equivalent for screening and predicting myopia among children and adolescents - China, 2020-2024. *China CDC Wkly* 2025;7(9):298 – 303. <https://doi.org/10.46234/ccdcw2025.048>.

## SUPPLEMENTARY MATERIAL



SUPPLEMENTARY FIGURE S1. Flow diagram of study participants.

Abbreviation: PLAD=provincial-level administrative division.

SUPPLEMENTARY TABLE S1. Age distribution of students by grade level across 10 provincial-level administrative divisions in China, 2020–2024.

Grade	Age, mean±SD, years				
	Total	Boys	Girls	Economically more developed	Economically less developed
0	6.0±0.4	6.0±0.4	6.0±0.4	5.9±0.3	6.1±0.4
1	6.9±0.4	6.9±0.4	6.9±0.4	6.9±0.4	7.0±0.4
2	7.9±0.4	7.9±0.4	8.0±0.4	7.9±0.4	8.0±0.4
3	9.0±0.4	9.0±0.4	9.0±0.4	9.0±0.4	9.0±0.4
4	10.0±0.4	10.0±0.4	10.0±0.4	10.0±0.4	10.0±0.4
5	11.0±0.4	11.0±0.4	11.0±0.4	11.0±0.4	11.0±0.4
6	12.0±0.4	11.9±0.4	12.0±0.4	11.9±0.4	12.0±0.4
7	13.0±0.4	12.9±0.4	13.0±0.5	12.9±0.4	13.0±0.5
8	14.0±0.4	14.0±0.5	14.0±0.4	14.1±0.4	14.0±0.5
9	14.9±0.4	14.9±0.4	14.9±0.4	14.8±0.4	14.9±0.4
10	16.0±0.5	16.0±0.5	16.0±0.5	15.9±0.5	16.0±0.5
11	16.9±0.6	16.8±0.6	16.9±0.5	16.8±0.5	16.9±0.6
12	17.9±0.6	17.6±0.4	18.0±0.6	17.7±0.3	17.9±0.6

Note: Economically, relatively more developed and less developed areas were classified based on per capita gross domestic product.

Abbreviation: SD=standard deviation.

\* Grade 0 means senior kindergarten.

## Preplanned Studies

## Unintentional Injury Incidence Among Children Aged 0–5 Years — Changsha City, Hunan Province, China, 2024–2025

Yuying Jing<sup>1</sup>; Yang Yuan<sup>1</sup>; Danrui Liu<sup>2</sup>; Li Li<sup>1,\*</sup>; Guoqing Hu<sup>1</sup>

### Summary

#### What's already known about this topic?

Unintentional injuries are a leading cause of morbidity and mortality in children. However, recent large population-based surveys in China remain limited.

#### What is added by this report?

This population-based survey reported a 12-month unintentional injury incidence of 9.12% [95% confidence interval (CI): 8.47, 9.81] among children aged 0–5 years. The incidence rates were higher in boys, preschoolers, and urban children than in girls, younger children, and rural children. Falls accounted for 69.2% of reported injuries, most of which occurred at home during play.

#### What are the implications for public health practice?

Home-based prevention efforts should prioritize boys and preschoolers.

emergency department or outpatient visits (40.1%) or self-care (54.6%). Commonly injured body parts included the head or neck (42.9%) and lower limbs (16.6%), with abrasions and open wounds being the most frequent outcomes.

**Conclusion:** Nonfatal injuries among young children remain a challenge in Changsha and require policy intention.

Unintentional injuries are the leading cause of death and disability in children worldwide. According to the Global Burden of Disease (GBD) 2023 estimates, they caused over 168,000 deaths and 15.9 million disability-adjusted life-years (DALYs) among children <5 years worldwide (1). In China, unintentional injuries accounted for 23% of all under-5 deaths in 2022 (2). Reliable, timely, and locally valid injury burden estimates are essential for targeting preventive strategies and allocating health resources. Currently, injury estimates in China rely largely on GBD studies or the hospital-based National Injury Surveillance System (NISS) (1–2). However, the GBD provides limited subnational details for local estimations. Meanwhile, the NISS, based on medically attended injuries from 310 hospitals across 109 counties or districts, merely provides injury case counts without population denominators. Furthermore, it does not capture injuries not treated in hospitals, missing about 40% of cases and underestimating the nonfatal injury burden (3). Population-based estimates with large samples of children <5 years are scarce in China. To our knowledge, the most recent study with a large sample estimating nonfatal injury morbidity was conducted in 2017 (4).

This study analyzed baseline data from an ongoing, cluster-randomized controlled trial evaluating a mobile health intervention to reduce unintentional injuries among children aged 0–5 years. The study design and sampling procedures are detailed in a previously

## ABSTRACT

**Introduction:** Unintentional injuries are a leading cause of morbidity and mortality in young children. However, recent population-based epidemiological data on Chinese children are limited.

**Methods:** Data were obtained from a baseline survey of an ongoing cluster-randomized controlled trial completed between August 2024 and February 2025. Injury was defined as an event requiring medical care, first aid by a nonmedical responder, or more than half a day of school absence. Adjusted odds ratios quantified these associations.

**Results:** Among 7,087 children, 646 injuries occurred in the prior year, yielding an incidence of 9.12% [95% confidence interval (CI): 8.47, 9.81]. Compared with infants <1 year, children aged 1–2 and 3–5 years were at greater risk of injury. Boys and urban children had higher injury incidence rates than girls and rural children, and falls accounted for 69.2% of all cases. The injury events mainly occurred at home (57.9%) and during play (78.5%), resulting in

published protocol (5). Briefly, a structured WeChat-based questionnaire was administered in Changsha, Hunan Province, China, from August 2024 to February 2025. Using urban–rural stratified sampling, eight urban streets and four rural towns were selected based on prespecified eligibility. Primary caregivers of children aged  $\leq 5$  years were recruited from these 12 clusters with the assistance of local healthcare institutions and kindergartens. Data were collected from the youngest child in each household if the family had two or more eligible children. A total of 7,097 caregivers submitted the questionnaire. After excluding 10 duplicate and incomplete records, 7,087 participants remained. This sample provided sufficient precision for estimating population-level injury incidence, with the anticipated 95% confidence interval half-width constrained to approximately  $\pm 1.0$  percentage points based on prior evidence (6).

The structured questionnaire gathered data on 1) caregiver and child sociodemographic characteristics and 2) the child's unintentional injury history in the past 12 months, including injury type, location, activity at the time of injury, post-injury care, injured body region, and nature of the injury. An injury event was defined (7) as any event meeting the following: 1) diagnosis and treatment at a healthcare facility; 2) first aid provided by a nonmedical responder; or 3) absence from school for more than half a day due to injury.

The primary outcome was the 12-month injury incidence rate, defined as the number of injury events in the past 12 months divided by the total number of children. Descriptive statistics and bar charts were used to summarize participant characteristics and subgroup patterns. The 95% confidence intervals (CI) were calculated using the Wilson score method. Statistical significance was assessed using the Pearson chi-square test for categorical comparisons. The adjusted odds ratios (aORs) were estimated using a multilevel mixed-effects logistic regression with a random intercept for the study site to account for clustering. Covariates were selected based on a literature review. All tests were two-sided ( $\alpha=0.05$ ). Subgroup analyses were conducted based on age and sex. All analyses were performed using SAS (version 9.4, SAS Institute, Cary, NC, USA).

Of the 7,087 children, 64.0% were aged 3–5 years, 53.2% were boys, and 59.2% resided in urban areas (Table 1). A total of 646 unintentional injuries were reported within the past 12 months, corresponding to an incidence rate of 9.12% (95% CI: 8.47, 9.81). The crude injury incidence was higher in urban areas

(9.99%; 95% CI: 9.11, 10.93) than in rural areas (7.85%; 95% CI: 6.93, 8.89). After using the combined study population as the standard, the age-standardized incidence was 9.94% in urban areas and 8.45% in rural areas. After controlling for covariates, boys, children living in urban areas, and older children (1–2 years and 3–5 years) had higher incidence rates than girls (aOR=1.67; 95% CI: 1.41, 1.98), those residing in rural areas (aOR=1.24; 95% CI: 1.01, 1.52), and those <1 year (aOR=2.15; 95% CI: 1.54, 2.99 and aOR=2.13; 95% CI: 1.58, 2.89) (Table 1). Subgroup analyses stratified by age and sex yielded results consistent with those of the main analysis (Supplementary Tables S1 and S2, available at <https://weekly.chinacdc.cn/>).

As shown in Figure 1A, falls were the most common cause of injury (69.2%), particularly among infants <1 year (75.5%) and children 1–2 years (76.1%). Children's homes were the primary injury settings (57.9%), especially for children aged 1–2 years (70.3%) and in rural areas (71.8%) (Figure 1B). Most injuries took place during play (78.5%) (Figure 1C). Post-injury care was commonly self-care or first aid (54.6%), followed by care in emergency departments or outpatient clinics (40.1%) (Figure 1D).

Head or neck, lower limbs, and hands or feet were the most frequently injured body regions, at 42.9%, 16.6%, and 14.4%, respectively. By nature, abrasions (42.4%) and open wounds (25.7%) were the most common outcomes of injuries (Figure 2).

## DISCUSSION

The incidence of unintentional injury in early childhood varies according to sex, age group, and urban–rural residence. Falls were the predominant injury type, with most injuries occurring at home during play and typically managed with self-care or first aid.

Although this survey estimate of injury incidence (9.12%) was numerically lower than the GBD 2023 national estimate for Chinese children <5 years (11.7%), these data are not directly comparable. The GBD provides a nationally aggregated, model-based estimate derived from multiple data sources (mortality, inpatient, and outpatient data) and may reflect a different case mix and severity spectrum compared to this community survey in Changsha. The survey estimate was also lower than the 34% reported in the 2017 Changsha study, which used a similar injury definition but sampled only urban areas and included

TABLE 1. Unintentional injury incidence among children aged 0–5 years — Changsha City, Hunan Province, China, 2024–2025.

Variable	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)
Total	7,087 (100.0)	9.12 (8.47, 9.81)	
Place			
Rural	2,891 (40.8)	7.85 (6.93, 8.89)	Ref
Urban	4,196 (59.2)	9.99 (9.11, 10.93)	1.24 (1.01, 1.52)*
Child age (years)			
<1	1,113 (15.7)	4.76 (3.66, 6.18)	Ref
1–2	1,440 (20.3)	9.58 (8.17, 11.21)	2.15 (1.54, 2.99)*
3–5	4,534 (64.0)	10.04 (9.19, 10.94)	2.13 (1.58, 2.89)*
Child sex			
Female	3,317 (46.8)	6.96 (6.15, 7.88)	Ref
Male	3,770 (53.2)	11.01 (10.05, 12.05)	1.67 (1.41, 1.98)*
Caregivers' characteristics			
Age group (years)			
<30	1,555 (21.9)	8.68 (7.38, 10.18)	Ref
30–39	4,571 (64.5)	9.34 (8.53, 10.22)	0.95 (0.77, 1.17)
≥40	961 (13.6)	8.74 (7.12, 10.69)	0.89 (0.66, 1.20)
Sex			
Female	5,695 (80.4)	9.11 (8.39, 9.89)	Ref
Male	1,392 (19.6)	9.12 (7.72, 10.75)	0.97 (0.78, 1.19)
Level of education			
Middle school or lower	1,243 (17.5)	8.85 (7.39, 10.56)	Ref
High school or equivalent	1,603 (22.6)	8.05 (6.81, 9.48)	0.83 (0.62, 1.09)
College or higher	4,241 (59.8)	9.60 (8.75, 10.52)	0.94 (0.73, 1.22)
Annual household income (CNY)			
<20,000	1,187 (16.7)	8.76 (7.28, 10.51)	Ref
20,000–49,999	1,463 (20.6)	8.13 (6.84, 9.65)	0.89 (0.67, 1.18)
50,000–99,999	2,134 (30.1)	9.56 (8.38, 10.88)	1.01 (0.78, 1.31)
≥100,000	2,303 (32.5)	9.51 (8.38, 10.78)	0.95 (0.72, 1.23)

Note: Multilevel logistic regression included the following covariates: location (urban or rural), child age, child sex, caregivers' characteristics (including age group, sex, level of education, and annual household income), and study sites (streets or towns) as a random intercept to control for clustering effects.

Abbreviation: OR=odds ratio; CI=confidence interval; CNY=Chinese Yuan.

\*  $P < 0.05$ .

children aged 0–6 years (8). Recent improvements in child injury prevention over the past several years may have contributed to this decline. By contrast, the survey estimate exceeded that of the 2017 multi-province survey (3.0% for non-school-aged children and 5.0% for preschool children), although both studies relied mainly on caregiver reports and the multi-province survey additionally incorporated kindergarten teacher reports (4). These differences are likely driven by variations in the sampling frames, case definitions, and estimation methods. Overall, our

findings provide an up-to-date, locally generated estimate for Changsha and highlight the need to standardize community-based injury measurements in China.

Age- and sex-specific patterns were consistent with those reported in previous studies (9–10). However, the observed urban-rural difference — a higher incidence in urban areas than in rural areas — contrasts with earlier findings that typically reported a heavier burden in rural settings (2–3,10). Four factors may help explain this observation. First, urban families

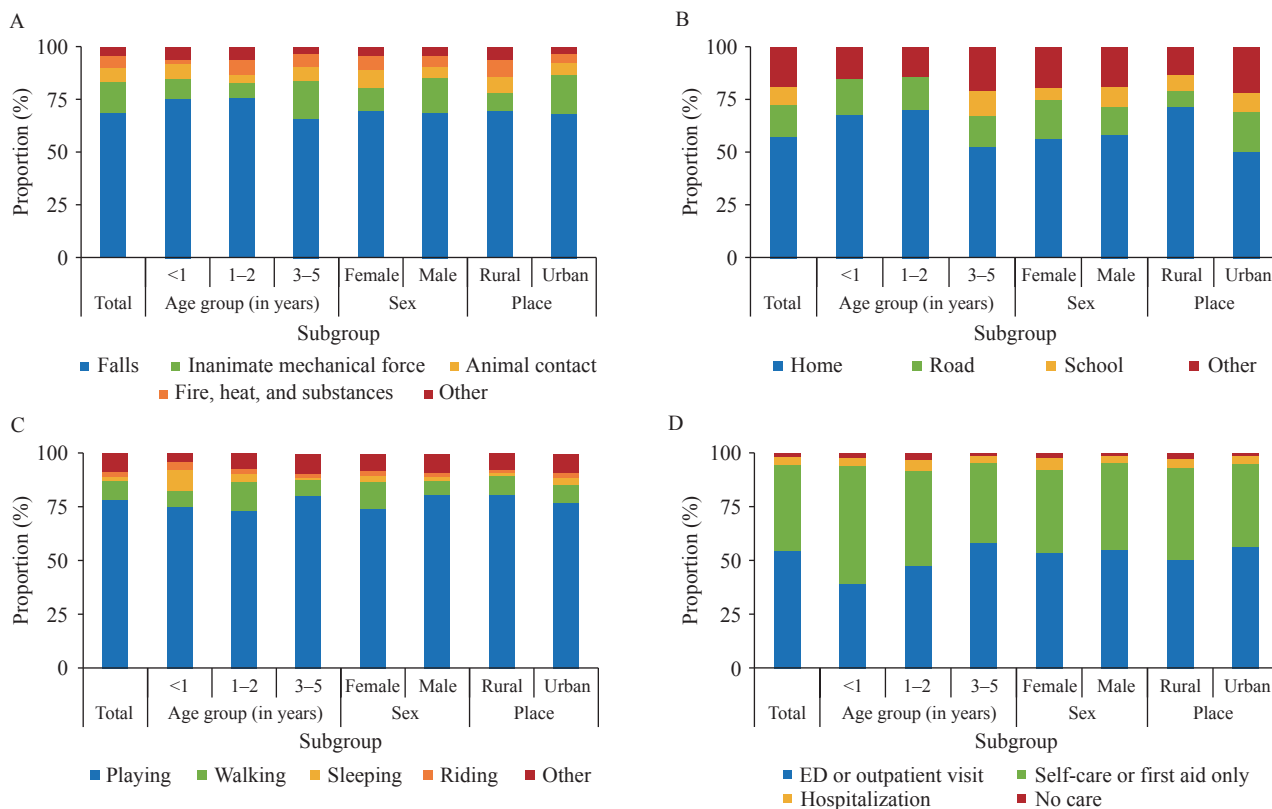


FIGURE 1. Distribution of external cause, location, activity, and treatment of unintentional injuries in children aged 0–5 years in Changsha City, Hunan Province, China, 2024–2025. (A) Injury type; (B) Injury location; (C) Activity at injury; (D) Post-injury care.

Note: In Figure 1A, total traffic-related injuries accounted for only 1.5% of events and were merged into the “Other” category. Abbreviation: ED=emergency department.

often rely on grandparents or other informal childcare facilities, which may be associated with a higher risk of injury. Second, urban caregivers may have greater access to health information and injury-related knowledge, which may increase their injury recognition and reporting. Conversely, grandparents living in rural areas may have underreported minor events. Therefore, the observed urban–rural differences may partly reflect differential ascertainment and differences in injury event reporting. Third, rapid urbanization in Changsha’s high-rise housing, more indoor play in confined spaces, and increasing private vehicle ownership may have shifted children’s exposure profiles toward urban, home, and traffic-related risks. Fourth, differences in the types (or spectra) of injuries contribute to the disparity in the incidence of urban–rural injuries.

Falls were the predominant injury mechanism (69.2%), which differs from that reported by the 2018 NISS for both urban and rural children (55.3% and 60.2%, respectively) (9). This is consistent with earlier community-based studies in Hunan and multi-

province surveys, which found that household interviews captured many mild, nonmedically attended fall events that were missed during hospital surveillance (3–4). As shown in this study, more than half of injury events were managed at home. Separately, the national mortality surveillance reports a different leading cause profile for fatal injuries (e.g., suffocation, drowning, and road traffic injuries) (10). Given the fundamental differences in outcome severity, these findings should not be directly compared; rather, they suggest that prevention priorities may differ between fatal and nonfatal injuries. These findings highlight falls in and around the home as a priority target for caregiver education, safe home modifications, and the integration of injury prevention content into routine child health services. Consistent with the Child Fall Intervention Technical Guidelines published by the Chinese Center for Disease Control and Prevention in 2011, relevant local authorities could consider providing home safety devices (e.g., window restrictors, anti-slip mats, and corner guards) to families with children aged 0–2 years, distributed through routine

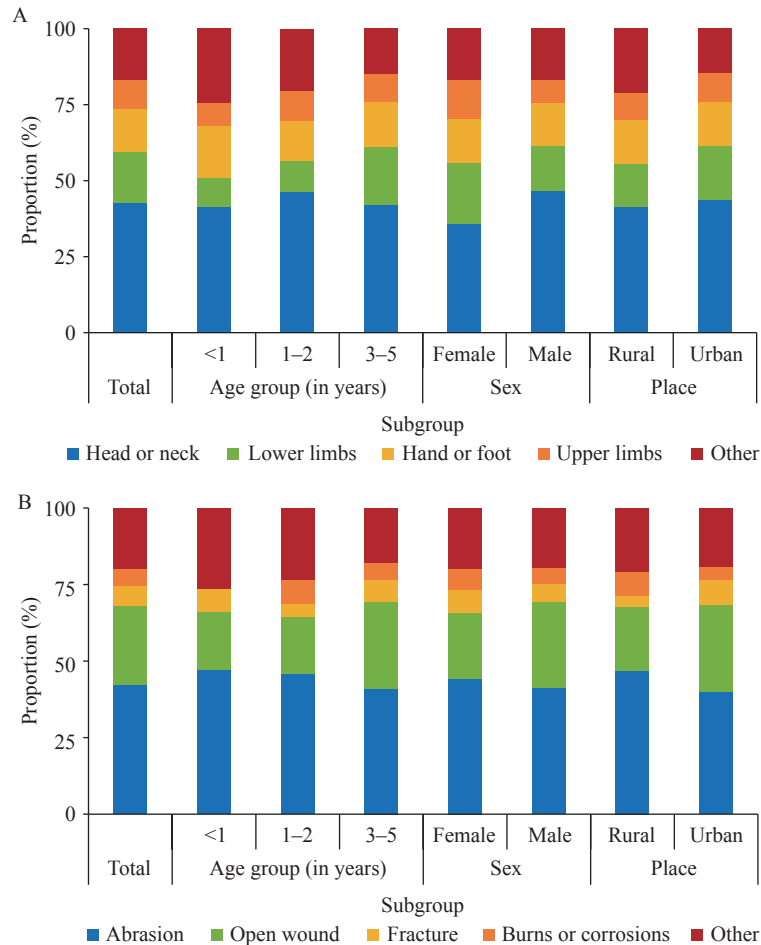


FIGURE 2. Distribution of body part and nature of unintentional injuries in children aged 0–5 years in Changsha City, Hunan Province, China, 2024–2025. (A) Injured body region; (B) Nature of injury.

community immunization visits at one, six, and 18 months.

This study has several limitations. First, injury information was collected from caregivers using a 12-month recall window; minor, quickly resolved, or non-care-seeking injuries were likely to be forgotten. Second, this survey did not cover additional behavioral or environmental factors, nor did it include conditions such as attention-deficit/hyperactivity disorder (ADHD) that may increase the risk of injury. Third, the data were collected from Changsha using a WeChat-based questionnaire, which may limit generalizability to other regions or households with limited digital access. Additionally, the WeChat recruitment process via mobile phones may overrepresent younger parents and exclude older caregivers (e.g., grandparents), introducing a potential sample selection bias. As the data were collected via caregiver self-reports, recall bias may have existed. Because this study did not analyze fatal injury data, the

results may differ from child unintentional injury mortality data.

This large community-based baseline survey provides updated, locally relevant estimates of nonfatal unintentional injuries among children <5 years of age in Changsha. Unintentional injuries remain common, with falls being the leading cause. Unlike earlier studies showing a higher burden in rural areas, this survey reported a higher incidence in urban settings, suggesting changing exposure patterns and the influence of caregiver arrangements. These findings demonstrate the importance of community-based reporting in capturing injuries that were not captured during hospital surveillance. Prevention efforts should focus on falls, home and play safety, and reducing urban-specific risks.

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## REFERENCES

- Institute for Health Metrics and Evaluation. GBD results. 2023. <https://vizhub.healthdata.org/gbd-results/>. [2025-10-19].
- He CH, Kang LN, Liu YX, Yu X, Li Q, Liang J, et al. Changes in the epidemiology of under-5 mortality in China from 2016 to 2022: an observational analysis of population-based surveillance data. *Lancet Public Health* 2024;9(12):e1059 – 69. [https://doi.org/10.1016/S2468-2667\(24\)00267-6](https://doi.org/10.1016/S2468-2667(24)00267-6).
- Wu Y, Zhang W, Zhang L, Schwebel DC, Ning PS, Cheng XJ, et al. Non-fatal injuries treated outside a hospital in Hunan, China: results from a household interview survey. *Eur J Public Health* 2017;27(2): 331 – 4. <https://doi.org/10.1093/eurpub/ckw114>.
- Jin Y, Ye PP, Deng X, Wang Y, Er YL, Ji CR, et al. Prevalence of injury among children in 28 counties of 6 provinces in China in 2017. *Chin J Epidemiol* 2021;42(8):1392 – 400. <https://doi.org/10.3760/cma.j.cn112338-20201112-01325>.
- Yuan Y, Jing YY, Li JY, He JY, Schwebel DC, Ning PS, et al. Evaluating the effectiveness of an intelligent mHealth intervention for child unintentional injury prevention: protocol for a cluster randomized controlled trial. *JMIR Public Health Surveill* 2025;11:e76195. <https://doi.org/10.2196/76195>.
- Wang ZY, Hu M, Yu TL, Yang J. Incidence of injuries and its influencing factors among children aged 0-6 years in urban area of Changsha City. *Chin J Health Stat* 2020;37(1):14-7. <https://d.wanfangdata.com.cn/periodical/CiBQZXXjpb2RpY2FsQ0hJU29scjkyMDI2MDMwNjE2NTI1NxpIemd3c3RqMjAyMDAxMDA0GghyOW1pYWZ4bg%3D%3D>. (In Chinese).
- Wang SY. Injury epidemiology. Beijing: People's Medical Publishing House. 2003. <http://find.nlc.cn/search/showDocDetails?docId=5249851467348765539&dataSource=ucs01&query=%20%E4%BC%A4%E5%AE%B3%E6%B5%81%E8%A1%8C%E7%97%85%E5%AD%A6>. (In Chinese).
- Ma YH, Song J, Hu M, Yang RS, Yang PZ. Risk factors of in-home unintentional injuries among 0-6-year-old children in Changsha city of China: a cross-sectional survey based on Bronfenbrenner's ecological system theory. *BMC Pediatr* 2022;22(1):598. <https://doi.org/10.1186/s12887-022-03661-z>.
- Er YL, Lu ZM, Wang Y, Ye PP, Duan LL. Analysis of the characteristics of injury among children aged 0-5 years: results from Chinese National Injury Surveillance System in 2018. *Chin J Sch Health* 2020;41(7):971 – 5. <https://doi.org/10.16835/j.cnki.1000-9817.2020.07.004>.
- Zhou JT, Zhao M, Huang H, Schwebel DC, Ning PS, Rao ZZ, et al. Injury mortality of children and adolescents aged 0-19 years - China, 2010-2021. *China CDC Wkly* 2024;6(14):294 – 9. <https://doi.org/10.46234/ccdcw2024.057>.

## SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Unintentional injury incidence stratified by child age among children aged 0–5 years in Changsha City, Hunan Province, China, 2024–2025.

Variable	<1 year			1–2 years			3–5 years		
	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)
Total	1,113	4.76 (3.66, 6.18)		1,440	9.58 (8.17, 11.21)		4,534	10.04 (9.19, 10.94)	
Place									
Rural	654 (58.8)	3.06 (1.99, 4.68)	Ref	921 (64.0)	8.58 (6.94, 10.56)	Ref	1,316 (29.0)	9.73 (8.24, 11.45)	Ref
Urban	459 (41.2)	7.19 (5.16, 9.92)	2.94 (1.52, 5.68)*	519 (36.0)	11.37 (8.92, 14.39)	1.93 (1.14, 3.27)*	3,218 (71.0)	10.16 (9.16, 11.25)	0.96 (0.75, 1.23)
Child sex									
Female	523 (47.0)	4.78 (3.26, 6.96)	Ref	651 (45.2)	7.83 (6.01, 10.15)	Ref	2,143 (47.3)	7.23 (6.21, 8.41)	Ref
Male	590 (53.0)	4.75 (3.30, 6.77)	0.99 (0.56, 1.76)	789 (54.8)	11.03 (9.03, 13.40)	1.49 (1.03, 2.17)*	2,391 (52.7)	12.55 (11.28, 13.94)	1.86 (1.51, 2.30)*
Caregivers' characteristics									
Age group (years)									
<30	389 (35.0)	3.60 (2.16, 5.95)	Ref	439 (30.5)	10.02 (7.55, 13.19)	Ref	727 (16.0)	10.59 (8.56, 13.04)	Ref
30–39	609 (54.7)	5.42 (3.88, 7.51)	1.16 (0.59, 2.26)	783 (54.4)	10.22 (8.29, 12.54)	0.91 (0.60, 1.38)	3,179 (70.1)	9.88 (8.89, 10.96)	0.90 (0.69, 1.19)
≥40	115 (10.3)	5.22 (2.41, 10.92)	0.91 (0.32, 2.56)	218 (15.1)	6.42 (3.86, 10.49)	0.48 (0.24, 0.94)*	628 (13.9)	10.19 (8.06, 12.80)	1.01 (0.70, 1.45)
Sex									
Female	908 (81.6)	4.41 (3.25, 5.94)	Ref	1,168 (81.1)	9.08 (7.56, 10.86)	Ref	3,619 (79.8)	10.31 (9.36, 11.34)	Ref
Male	205 (18.4)	6.34 (3.74, 10.55)	1.25 (0.63, 2.48)	272 (18.9)	11.76 (8.46, 16.14)	1.32 (0.85, 2.07)	915 (20.2)	8.96 (7.28, 10.99)	0.82 (0.63, 1.06)
Level of education									
Middle school or lower	236 (21.2)	6.36 (3.89, 10.22)	Ref	343 (23.8)	10.20 (7.43, 13.86)	Ref	664 (14.6)	9.04 (7.08, 11.46)	Ref
High school or equivalent	277 (24.9)	3.97 (2.23, 6.97)	0.50 (0.21, 1.16)	366 (25.4)	9.29 (6.72, 12.70)	0.79 (0.46, 1.35)	960 (21.2)	8.75 (7.12, 10.71)	0.93 (0.65, 1.34)
College or higher	600 (53.9)	4.50 (3.11, 6.47)	0.41 (0.18, 0.90)*	731 (50.8)	9.44 (7.53, 11.78)	0.76 (0.45, 1.29)	2,910 (64.2)	10.69 (9.62, 11.86)	1.20 (0.86, 1.69)
Annual household income (CNY)									
<20,000	261 (23.5)	4.98 (2.93, 8.33)	Ref	278 (19.3)	11.51 (8.27, 15.80)	Ref	648 (14.3)	9.10 (7.12, 11.57)	Ref
20,000–49,999	271 (24.3)	4.43 (2.55, 7.58)	1.02 (0.44, 2.33)	350 (24.3)	8.86 (6.31, 12.30)	0.75 (0.44, 1.28)	842 (18.6)	9.03 (7.27, 11.15)	0.97 (0.68, 1.40)
50,000–99,999	323 (29.0)	3.72 (2.14, 6.38)	0.84 (0.35, 1.97)	440 (30.6)	10.91 (8.33, 14.17)	0.85 (0.51, 1.41)	1,371 (30.2)	10.50 (8.99, 12.24)	1.14 (0.82, 1.58)
≥100,000	258 (23.2)	6.20 (3.85, 9.84)	1.22 (0.53, 2.83)	372 (25.8)	7.26 (5.04, 10.35)	0.48 (0.27, 0.87)*	1,673 (36.9)	10.52 (9.14, 12.08)	1.13 (0.81, 1.58)

Note: Injury incidence was calculated as "Injury incidence was calculated as the number of injury events in the past 12 months divided by the total number of children".

Adjusted ORs were estimated using multilevel mixed-effects logistic regression.

Abbreviation: OR=odds ratio, CI=confidence interval, CNY=Chinese Yuan.

\*  $P < 0.05$ .

SUPPLEMENTARY TABLE S2. Unintentional injury incidence among children aged 0–5 years stratified by sex in Changsha City, Hunan Province, China, 2024–2025.

Variable	Female			Male		
	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)	Number (%)	Incidence (%) (95% CI)	Adjusted OR (95% CI)
Total	3,317	6.96 (6.15, 7.88)		3,770	11.01 (10.05, 12.05)	
Place						
Rural	1,317 (39.7)	5.47 (4.36, 6.83)	Ref	1,574 (41.8)	9.85 (8.47, 11.42)	Ref
Urban	2,000 (60.3)	7.95 (6.84, 9.22)	1.51 (1.06, 2.15)*	2,196 (58.2)	11.84 (10.55, 13.26)	1.11 (0.86, 1.43)
Child age (years)						
<1	523 (15.8)	4.78 (3.26, 6.96)	Ref	590 (15.6)	4.75 (3.30, 6.77)	Ref
1–2	651 (19.6)	7.83 (6.01, 10.15)	1.72 (1.04, 2.84)*	789 (20.9)	11.03 (9.03, 13.40)	2.54 (1.63, 3.97)*
3–5	2,143 (64.6)	7.23 (6.21, 8.41)	1.37 (0.88, 2.16)	2,391 (63.4)	12.55 (11.28, 13.94)	2.85 (1.90, 4.30)*
Caregivers' characteristics						
Age group (years)						
<30	730 (22.0)	6.71 (5.11, 8.76)	Ref	825 (21.9)	10.42 (8.52, 12.70)	Ref
30–39	2,143 (64.6)	6.95 (5.95, 8.11)	0.87 (0.61, 1.25)	2,428 (64.4)	11.45 (10.24, 12.78)	0.99 (0.76, 1.30)
≥40	4,44 (13.4)	7.43 (5.34, 10.25)	1.02 (0.63, 1.66)	517 (13.7)	9.86 (7.58, 12.74)	0.83 (0.56, 1.21)
Sex						
Female	2,713 (81.8)	7.04 (6.14, 8.06)	Ref	2,982 (79.1)	11.00 (9.93, 12.17)	Ref
Male	604 (18.2)	6.62 (4.90, 8.89)	0.89 (0.62, 1.29)	788 (20.9)	11.04 (9.04, 13.42)	1.00 (0.77, 1.30)
Level of education						
Middle school or lower	591 (17.8)	6.60 (4.86, 8.89)	Ref	652 (17.3)	10.89 (8.72, 13.51)	Ref
High school or equivalent	700 (21.1)	5.86 (4.35, 7.85)	0.80 (0.50, 1.29)	903 (24.0)	9.75 (7.98, 11.85)	0.84 (0.59, 1.18)
College or higher	2,026 (61.1)	7.45 (6.39, 8.68)	0.89 (0.57, 1.37)	2,215 (58.8)	11.56 (10.29, 12.96)	0.97 (0.70, 1.35)
Annual household income (CNY)						
<20,000	570 (17.2)	6.14 (4.45, 8.42)	Ref	617 (16.4)	11.18 (8.93, 13.91)	Ref
20,000–49,999	688 (20.7)	5.81 (4.30, 7.82)	0.94 (0.58, 1.51)	775 (20.6)	10.19 (8.26, 12.52)	0.86 (0.61, 1.22)
50,000–99,999	963 (29.0)	6.96 (5.52, 8.74)	1.08 (0.70, 1.69)	1,171 (31.1)	11.70 (9.98, 13.67)	0.97 (0.71, 1.34)
≥100,000	1,096 (33.0)	8.12 (6.65, 9.89)	1.22 (0.78, 1.90)	1,207 (32.0)	10.77 (9.14, 12.65)	0.82 (0.59, 1.15)

Note: Injury incidence was calculated as "Injury incidence was calculated as the number of injury events in the past 12 months divided by the total number of children."

Adjusted ORs were estimated using a multilevel mixed-effects logistic regression analysis.

Abbreviation: OR=odds ratio, CI=confidence interval.

\*  $P < 0.05$ .

## Preplanned Studies

## Cigarette and E-Cigarette Use Among Adolescents Based on a Nationwide Survey — China, 2021

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### Summary

#### What is already known about this topic?

Adolescent cigarette and e-cigarette use remains common in China. Previous studies identified multiple individual-, family-, and school-related risk factors. However, national-level evidence distinguishing dual use from exclusive cigarette or e-cigarette use is limited.

#### What is added by this report?

A nationally representative survey of high-school students in 31 provincial-level administrative divisions in China produced updated estimates of tobacco use in 2021: dual (6.9%), cigarette (24.6%), e-cigarette (9.5%). Socio-ecological factors differed across statuses, and some preventive measures, including school-based tobacco education, had no associated use reduction.

#### What are the implications for public health practice?

Adolescent tobacco control should adopt differentiated strategies for dual/exclusive tobacco use, strengthen family/peer involvement, and improve school-based education program effectiveness.

6.5, 7.3] for dual use, 27.2% (95% CI: 25.0, 29.5) for overall tobacco, 9.5% (95% CI: 9.1, 10.1) for e-cigarettes, and 24.6% (95% CI: 23.9, 25.3) for cigarettes. Socioecological factors were heterogeneous across statuses. Some factors expected to reduce tobacco use were not associated with decreased use and were even associated with increased use.

**Conclusion:** It is important to focus on the shared and distinct factors influencing dual and exclusive cigarette/e-cigarette use to develop intervention measures. Integrating family involvement, peer-based approaches, and evidence-based school education into tobacco control programs may enhance the effectiveness of smoking prevention in adolescents.

## ABSTRACT

**Introduction:** The increasing availability of diverse tobacco products has led to increased tobacco use. This study analyzed prevalence and associated factors of different tobacco-use statuses among Chinese adolescents to support effective interventions for cigarette and e-cigarette use among adolescents in China.

**Methods:** A two-stage survey was conducted with a weighted sample of 15,000 high-school students from 31 provincial-level administrative divisions in mainland China. The prevalence of different tobacco-use statuses was also analyzed. Individual, school, family, and marketing exposure factors associated with different statuses were analyzed using multinomial logistic regression.

**Results:** Prevalences among Chinese high-school students were 6.9% [95% confidence interval (CI):

Recently, tobacco products used by adolescents have become increasingly diverse (1). The 2021 China National Youth Tobacco Survey found 16.7% of middle school students had ever used cigarettes, and 16.1% had ever used e-cigarettes (2). However, most previous studies have focused on either cigarette or e-cigarette use alone; evidence on dual and exclusive use statuses among Chinese adolescents remains limited. To develop effective strategies for preventing different statuses of adolescent use, it is essential to comprehensively understand associated factors.

An online survey of 16,365 high-school students in 31 provincial-level administrative divisions (PLADs) in China comprehensively collected information on tobacco-use status, individual characteristics, family and school environments, and e-cigarette marketing. This study analyzed the prevalence and associated socio-ecological factors of different tobacco-use statuses in this population. The findings are intended to inform effective interventions for controlling dual cigarette and e-cigarette use (dual use) and exclusive cigarette/e-cigarette use among adolescents in China and other countries with similar cultural and policy contexts.

A two-stage online survey was conducted among high-school students from July to September 2021 using the sample size calculator developed by Wang

et al. (3) to estimate the minimum required sample size. Based on the results of an online pilot survey of 104 conveniently sampled high-school students, the study set the proportion of current e-cigarette users among high-school students ( $p$ ) to 8.7% with a Type I error rate ( $\alpha$ ) of 0.05 and absolute error ( $d$ ) of 0.5%. The minimum sample size was thus estimated to be 12,206. To simplify sample size allocation, we increased the overall sample size goal to 15,000.

The first stage covered all 31 PLADs in China. The overall sample size goal was allocated to each PLAD based on the proportion of high-school students relative to the national total according to official statistics. The second stage employed stratified sampling based on sex, residence, and school type within each PLAD to obtain representative samples. The study allocated sample size goals to each stratum based on the proportion of high-school students in each stratum relative to the total number in the corresponding PLAD. To minimize sampling errors, strata with sample size goals below 30 were oversampled to ensure at least 30 students were surveyed per stratum.

Participants were recruited through the registered member network of KuRunData. The target group was identified using basic personal information. Randomly selected potential respondents received SMS messages and email invitations with unique survey links. Eligibility was verified through registered personal information, including school affiliation, date of birth, and IP-based location checks, and periodic authenticity tests by the platform. Initially, 21,085 students accessed the survey; 1,652 were excluded for incomplete responses and 3,068 for quality issues. These exclusions were due to substandard response quality, including logically abnormal or repetitive answers, completion in under five minutes, or because sample size targets for specific strata had been met. The final sample size was 16,365. The overall response rate was 77.6% (16,365/21,085).

Because the sample exceeded the predetermined goal of 15,000, respondents received sample weights to ensure alignment of the sample composition with official PLAD statistics on gender, residence, and school type. These weights were calculated by dividing the sample size goal by the number of respondents in each stratum. All analyses were performed on weighted samples unless otherwise stated.

Tobacco-use status was the outcome variable in the analysis and was classified into four use categories: dual, exclusive cigarette, exclusive e-cigarette, and no use. Use was determined based on self-reported frequency of cigarette/e-cigarette use in the last 30

days; one or more days of use were considered use. Dual use was defined as concurrent use of cigarettes and e-cigarettes. Thirty-seven potentially associated factors were examined as exposure variables, categorized into four groups: 5 individual characteristics, 11 family factors, 9 school factors, and 2 marketing exposure factors.

A multinomial logistic regression model incorporating all factors, adjusting for PLAD fixed effects, was fitted to identify associations between independent factors and tobacco-use status. To account for the survey's multistage sampling process, complex survey data analyses were performed for all statistical inferences of standard errors, 95% confidence intervals (CIs), and statistical significance, with standard errors clustered at the primary sampling unit level. Two-sided  $P < 0.05$  indicated statistical significance. All data analyses were conducted using Stata (version 17.0; StataCorp LLC, College Station, Texas, USA). Bivariate choropleth maps and forest plots were generated using R (version 4.3.0; R Foundation for Statistical Computing, Vienna, Austria).

The weighted sample consisted of 15,000 students, with approximately equal proportions of male (49.9%) and female (50.1%) participants and a median age of 17 (interquartile range: 16–18) years. Most students resided in urban areas (59.5%), attended general high schools (66.5%), and were in 12th grade (48.8%) (Table 1).

Dual-use prevalence was 6.9% (95% CI: 6.5, 7.3); 11.7% (95% CI: 11.0, 12.4) among male students, significantly higher than female students' 2.1% (95% CI: 1.8, 2.4). Regionally, a higher dual-use prevalence was observed in the eastern [e.g., Shanghai: 11.7% (95% CI: 4.4, 27.8), Beijing: 11.1% (95% CI: 4.9, 23.4)] and western [e.g., Xinjiang: 9.6% (95% CI: 4.4, 19.1)] regions (Figure 1). Prevalences of overall tobacco use, cigarette use (including dual and exclusive cigarette), and e-cigarette use (including dual and exclusive e-cigarette) were 27.2% (95% CI: 25.0, 29.5), 24.6% (95% CI: 23.9, 25.3), and 9.5% (95% CI: 9.1, 10.1), respectively (Figure 1).

Some factors showed consistent associations across different tobacco-use statuses; others exhibited varying effects depending on tobacco-use type. Among socio-ecological factors, consistent associations were found across use types for high parental educational attainment [secondary school *vs.* above secondary school: odds ratio (OR) dual use 0.70 (95% CI: 0.56, 0.87), exclusive cigarette use 0.75 (95% CI: 0.66, 0.85), exclusive e-cigarette use 0.73 (95% CI: 0.57, 0.92)], perceived favorable family economic status

TABLE 1. Sample characteristics by tobacco use status, weighted.

Characteristic	Full sample ( <i>n</i> <sub>weighted</sub> =15,000)	Dual use ( <i>n</i> <sub>weighted</sub> =1,029)	Exclusive cigarette use ( <i>n</i> <sub>weighted</sub> =2,655)	Exclusive e-cigarette use ( <i>n</i> <sub>weighted</sub> =398)	Nonuse of both ( <i>n</i> <sub>weighted</sub> =10,918)
Male, <i>n</i> (%)	7,483 (49.9)	874 (84.9)	2,351 (88.5)	287 (72.0)	3,971 (36.4)
Age (years), median (IQR)	17 (16, 18)	18 (17, 18)	17 (17, 18)	17 (16, 18)	17 (16, 18)
Age group (years), <i>n</i> (%)					
≤16	2,004 (13.4)	60 (5.8)	224 (8.4)	48 (12.1)	1,672 (15.3)
>16–17	5,374 (35.8)	207 (20.1)	629 (23.7)	109 (27.4)	2,765 (25.3)
>17–18	3,914 (26.1)	365 (35.4)	1,163 (43.8)	136 (34.1)	3,711 (34.0)
>18	3,914 (26.1)	398 (38.6)	639 (24.1)	105 (26.5)	2,771 (25.4)
Urban residence, <i>n</i> (%)	8,924 (59.5)	697 (67.7)	1,866 (70.3)	201 (50.5)	6,160 (56.4)
School type, <i>n</i> (%)					
General high schools	9,977 (66.5)	355 (34.5)	1,743 (65.6)	118 (29.6)	7,762 (71.1)
Vocational high schools	5,022 (33.5)	674 (65.5)	912 (34.4)	280 (70.4)	3,156 (28.9)
Grade, <i>n</i> (%)					
10th	3,069 (20.5)	130 (12.6)	382 (14.4)	81 (20.5)	2,476 (22.7)
11th	4,605 (30.7)	273 (26.6)	936 (35.3)	135 (34.0)	3,260 (29.9)
12th	7,326 (48.8)	626 (60.8)	1,336 (50.3)	181 (45.5)	5,182 (47.5)

Note: The presented results were derived from a weighted sample. *n* (%), frequency with percentage. Abbreviation: IQR=interquartile range.

[poor vs. good: 0.22 (95% CI: 0.14, 0.34), 0.58 (95% CI: 0.46, 0.74), 0.35 (95% CI: 0.21, 0.57)], paternal e-cigarette use [current use: 4.04 (95% CI: 3.16, 5.16), 2.02 (95% CI: 1.6, 2.44), 3.77 (95% CI: 2.71, 5.24)], attending vocational high schools [3.63 (95% CI: 2.99, 4.42), 1.36 (95% CI: 1.21, 1.53), 4.62 (95% CI: 3.62, 5.90)], close friends using e-cigarettes [more than half using: 27.62 (95% CI: 17.05, 44.73), 2.00 (95% CI: 1.30, 3.08), 9.25 (95% CI: 5.10, 16.79)]; less than half using: 13.70 (95% CI: 10.62, 17.66), 0.87 (95% CI: 0.73, 1.03), 6.15 (95% CI: 4.41, 8.59)], and free giveaways [1.99 (95% CI: 1.59, 2.50), 1.54 (95% CI: 1.27, 1.87), 1.84 (95% CI: 1.35, 2.50)].

Other factors demonstrated distinct or opposite patterns across tobacco-use statuses. Urban residence was positively associated with dual use and exclusive cigarette use [1.74 (95% CI: 1.43, 2.12), 1.89 (95% CI: 1.69, 2.12)] but negatively associated with exclusive e-cigarette use [0.75 (95% CI: 0.59, 0.96)]. Stricter family policies on cigarette/e-cigarette use were associated with decreased exclusive cigarette use [permitted in designated areas vs. prohibited completely: 1.34 (95% CI: 1.19, 1.51), permitted everywhere vs. prohibited completely: 1.43 (95% CI: 1.19, 1.72)] but not associated with dual and exclusive e-cigarette use (Figure 2).

Certain factors expected to reduce tobacco use, such as education about avoiding cigarettes [received during high school: dual use 0.93 (95% CI: 0.62, 1.38), exclusive cigarette use 0.93 (95% CI: 0.78, 1.10),

exclusive e-cigarette use 0.94 (95% CI: 0.64, 1.38); received before high school: 0.96 (95% CI: 0.60, 1.53), 0.87 (95% CI: 0.68, 1.11), 0.98 (95% CI: 0.58, 1.64)] and about avoiding e-cigarettes [received during high school: 1.38 (95% CI: 1.10, 1.25), 1.17 (95% CI: 1.03, 1.32), 1.34 (95% CI: 1.06, 1.71)]; received before high school: 1.06 (95% CI: 0.72, 1.57), 1.00 (95% CI: 0.74, 1.35), 1.18 (95% CI: 0.77, 1.81)], were not significantly associated with reduced tobacco use and may even be associated with increased use (Figure 2).

## DISCUSSION

Among a representative sample of Chinese high-school students, the estimated prevalence of e-cigarette use was 9.5%, comparable to the reported prevalence among adolescents aged 12–16 years in 68 countries (9.2%) (4). Dual-use prevalence was 6.9%, higher than in the United Kingdom (6.5%) (5) and Canada (3.8%)(6). Similarly, cigarette-use prevalence (24.6%) was higher than among individuals aged 15–24 years in 204 countries (12.7%) (7). This highlights concerns about tobacco use among Chinese adolescents, warranting implementation of effective prevention measures.

Influencing factors differed between dual and exclusive cigarette/e-cigarette use. While stricter family policies were associated with reduced exclusive cigarette use, they were not associated with reduced exclusive e-

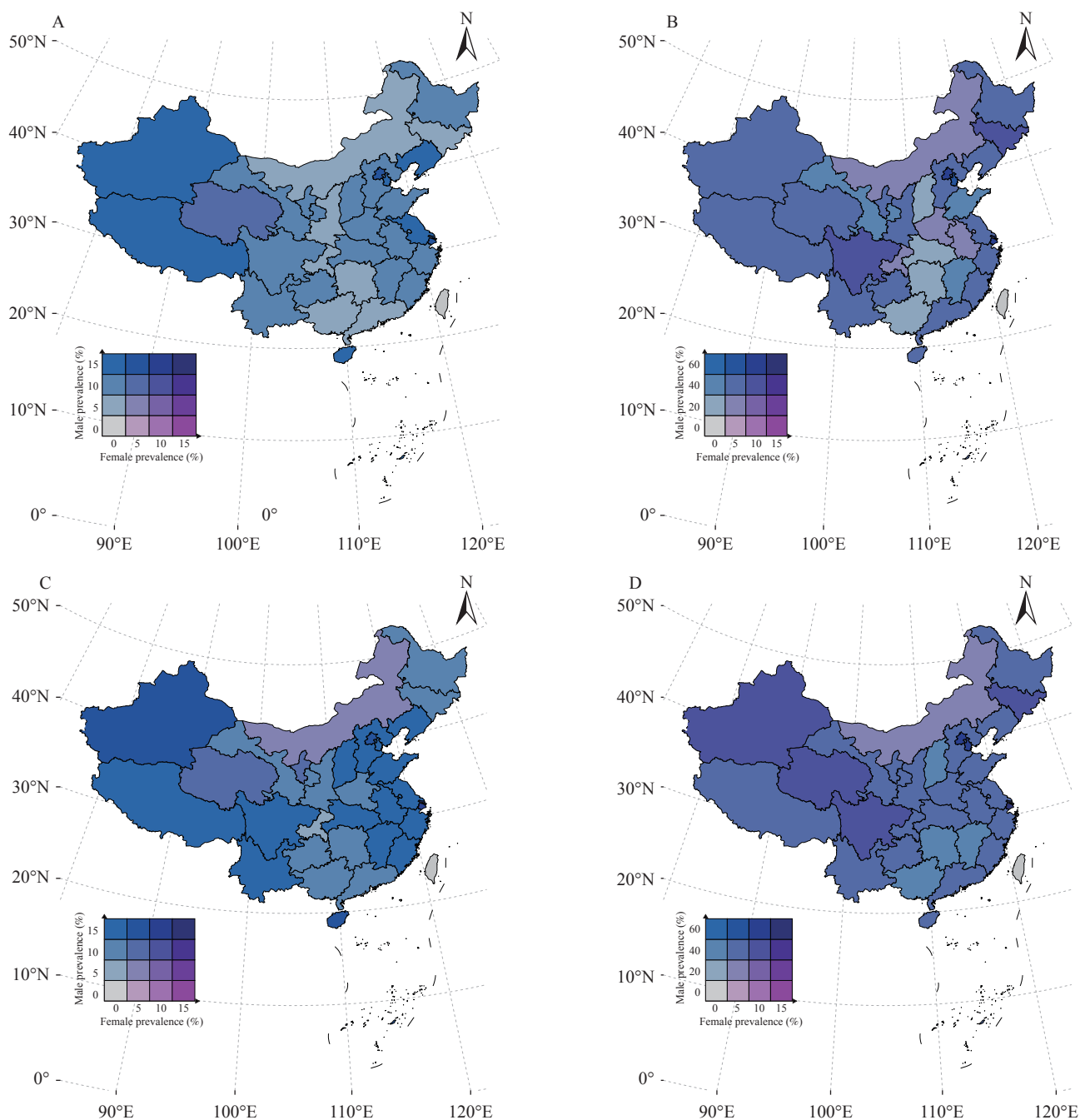


FIGURE 1. Weighted prevalence of different tobacco use statuses among high school students in China. (A) The prevalence of dual cigarette and e-cigarette use. (B) The prevalence of cigarette use. (C) The prevalence of e-cigarette use. (D) The prevalence of overall tobacco use includes either cigarette use or e-cigarette use.

Note: The presented results were derived from a weighted sample of school students from all 31 provincial-level administrative divisions in China.

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cigarette use. This may be because parents often target cigarettes and less often recognize e-cigarettes as harmful. Moreover, e-cigarettes are relatively new and easier to conceal (8). Multichannel promotion and family-school collaboration are needed to raise awareness among adolescents and their guardians.

Additionally, urban residence was positively associated with dual and exclusive cigarette use, consistent with previous research (9). However, a negative association was observed with exclusive e-cigarette use. Notably, the upper *CI* bound for the urban residence–exclusive e-cigarette use association

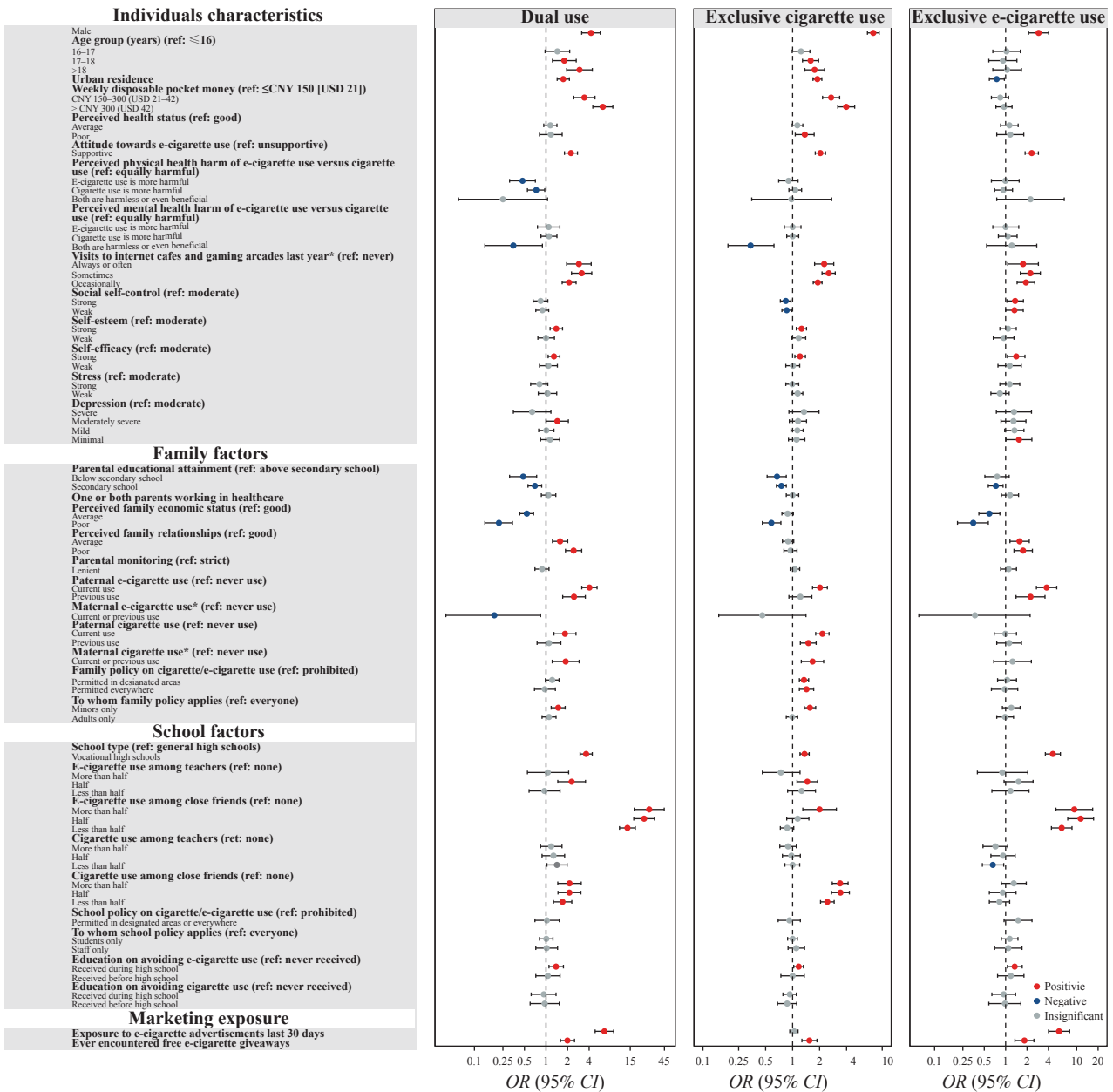


FIGURE 2. Factors associated with tobacco use status among high school students in China, weighted. Note: The presented results were derived from a weighted mutually adjusted multinomial logistic regression model with nonuse of cigarettes and e-cigarettes as the reference category. The model controlled for fixed effects of PLADs. Variance inflation factors for independent variables ranged from 1.1 to 2.4, indicating no significant multicollinearity. Effect sizes for associations are presented as ORs with 95% CIs.

Abbreviation: ref=reference; CNY=Chinese yuan; USD=United States dollar; OR=odds ratio; CI=confidence interval; PLAD=provincial-level administrative division.

\*Some categories of these variables were combined due to insufficient sample sizes.

was close to non-significance, suggesting a marginal association. Further investigation using large-scale cohort studies is necessary to better understand this association and its underlying mechanisms.

Close friends' use of these products had a stronger association than teachers' use with adolescent tobacco use, likely because tobacco use can spread through

social networks, and peer relationships, particularly with close friends, are more influential than student-teacher relationships (10). Therefore, interventions to curb tobacco use should leverage peer social networks. Addressing cigarette/e-cigarette use among adolescents' close friends can not only directly prevent further increases in adolescent tobacco use but

also indirectly reduce it through peer influence.

Moreover, some measures expected to reduce cigarette/e-cigarette use may be ineffective and even associated with increased use — for example, education in cigarette/e-cigarette use — showing that some antismoking messages may have unintended or opposite effects. This may reflect ineffective content or delivery, misleading messaging, or curiosity. Implementing comprehensive strategies including behavioral intervention programs, such as the “5As” approach (ask, advise, agree, assist, and arrange) may be effective to improving the effectiveness of school-based tobacco-control efforts. Future prevention programs should prioritize interactive and evidence-based approaches rather than traditional instruction, use age-appropriate messages, and engage peers and families to enhance long-term impact.

The findings in this report are subject to at least three limitations. First, data were obtained from an online survey of high-school students in China. Adolescents without internet access or who had dropped out of school were not captured, and voluntary participation may have led to overrepresentation of students more interested in tobacco use. Second, self-report may have introduced bias due to inaccurate recall, underreporting, or overreporting. Finally, the study had a cross-sectional design. Thus, our findings should be interpreted as associations rather than causal relationships.

In conclusion, using a nationally representative sample, this study revealed the prevalence of different tobacco use types among high-school students in China. Socioecological factors played both shared and distinct roles across statuses. Targeted interventions, such as strengthening parental awareness and leveraging peer influence, are necessary to discourage different tobacco-use statuses among adolescents in China.

**Ethical statement:** Approved by the Ethics Committee of the Institute of Basic Medical Sciences, CAMS and PUMC (No. 2021071). In accordance with the committee’s requirements, electronic informed consent was obtained from all participants and the requirement for informed consent was waived.

**Conflict of interest:** No conflicts of interest.

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## REFERENCES

- Lamb N. E-cigarettes. *Lancet* 2019;393(10174):876. [https://doi.org/10.1016/S0140-6736\(18\)33196-9](https://doi.org/10.1016/S0140-6736(18)33196-9).
- Chinese Center for Disease Control and Prevention. 2021 national youth tobacco survey among secondary school students. Chinese Center for Disease Control and Prevention, 2022. [https://en.chinacdc.cn/in\\_focus/202206/t20220628\\_259886.html](https://en.chinacdc.cn/in_focus/202206/t20220628_259886.html). [2025-10-10].
- Wang XF, Ji XG. Sample size estimation in clinical research: from randomized controlled trials to observational studies. *Chest* 2020;158(1s):S12-20. doi:10.1016/j.chest.2020.03.010.
- Sun JH, Xi B, Ma CW, Zhao M, Bovet P. Prevalence of E-cigarette use and its associated factors among youths aged 12 to 16 years in 68 countries and territories: global youth tobacco survey, 2012–2019. *Am J Public Health* 2022;112(4):650 – 61. <https://doi.org/10.2105/ajph.2021.306686>.
- Kasza KA, Ambrose BK, Conway KP, Borek N, Taylor K, Goniewicz ML, et al. Tobacco-product use by adults and youths in the United States in 2013 and 2014. *N Engl J Med* 2017;376(4):342 – 53. <https://doi.org/10.1056/NEJMsa1607538>.
- Azagba S. E-cigarette use, dual use of e-cigarettes and tobacco cigarettes, and frequency of cannabis use among high school students. *Addict Behav* 2018;79:166 – 70. <https://doi.org/10.1016/j.addbeh.2017.12.028>.
- Reitsma MB, Flor LS, Mullany EC, Gupta V, Hay SI, Gakidou E. Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and initiation among young people in 204 countries and territories, 1990–2019. *Lancet Public Health* 2021;6(7):e472 – 81. [https://doi.org/10.1016/s2468-2667\(21\)00102-x](https://doi.org/10.1016/s2468-2667(21)00102-x).
- Adkison SE, O’Connor RJ, Bansal-Travers M, Hyland A, Borland R, Yong HH, et al. Electronic nicotine delivery systems: international tobacco control four-country survey. *Am J Prev Med* 2013;44(3):207 – 15. <https://doi.org/10.1016/j.amepre.2012.10.018>.
- Agaku IT, Filippidis FT, Vardavas CI, Oduko OA, Awopogba AJ, Ayo-Yusuf OA, et al. Poly-tobacco use among adults in 44 countries during 2008–2012: evidence for an integrative and comprehensive approach in tobacco control. *Drug Alcohol Depend* 2014;139:60 – 70. <https://doi.org/10.1016/j.drugalcdep.2014.03.003>.
- Wang Y, Duan ZS, Weaver SR, Self-Brown SR, Ashley DL, Emery SL, et al. Association of e-cigarette advertising, parental influence, and peer influence with US adolescent e-cigarette use. *JAMA Netw Open* 2022;5(9):e2233938. <https://doi.org/10.1001/jamanetworkopen.2022.33938>.

## Methods and Applications

## National and Regional Lifetime Risk of Developing and Dying from Lung Cancer — China, 2023

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## ABSTRACT

**Introduction:** Lung cancer is the most commonly diagnosed malignancy and the leading cause of cancer-related mortality in China. However, the lifetime risk (LTR) of lung cancer in China remains poorly understood. This study aimed to provide national and regional estimates of LTR of lung cancer in China in 2023.

**Methods:** Lung cancer incidence and mortality data were sourced from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2023. Population data were obtained from the China Statistical Yearbook and national census records. The lung cancer LTR was calculated using a standardized approach that accounts for multiple primary cancers.

**Results:** In 2023, the LTR of developing lung cancer in China was 6.52% [95% uncertainty interval (UI): 6.28, 6.56], while the LTR of dying from lung cancer was 5.98% (95% UI: 5.57, 6.26). Sex-specific analysis indicated that males had a higher risk, with 8.28% (95% UI: 7.74, 8.38) for developing and 7.61% (95% UI: 6.71, 8.19) for death, compared to 4.52% (95% UI: 4.30, 4.74) and 4.14% (95% UI: 3.81, 4.51), respectively, in females. The remaining LTR of lung cancer declined as the age at diagnosis increased. Marked geographic disparities were observed; the highest LTR was found in the northeastern region, followed by the eastern, northern, south-central, and southwestern regions, while the northwestern region had the lowest risk.

**Conclusion:** The estimated LTR of lung cancer in China is approximately one in 15 individuals and one in 17 deaths. The substantial regional variations in lung cancer risk highlight the need for targeted cancer control strategies and tailored healthcare planning.

In 2022, lung cancer was the leading cause of cancer worldwide and in China, accounting for

25.2%–28.5% of all malignant tumor-related deaths in China (1–2). With approximately 733,000 deaths annually, averaging over 2,000 deaths per day, lung cancer represents a major public health challenge (3). These figures underscore the importance of developing intuitive population-level indicators that reflect nationwide incidence and mortality rates of the disease.

The lifetime risk (LTR) of cancer is defined as the cumulative probability that an individual will be diagnosed with or die from cancer over the course of their lifetime, explicitly accounting for life expectancy and competing risks of death (4–6). Crucially, to avoid overestimating China’s rapidly aging population, LTR calculations should be adjusted for multiple primaries (AMP). This approach shifts the focus from a “tumor-based” to a “person-based” metric, providing a rigorous and realistic measure of the cumulative disease burden specifically.

Currently, there is limited research assessing the cumulative burden of lung cancer in China from an LTR perspective at both national and regional levels. To address this gap, this study aimed to estimate the LTR of lung cancer development and death across China using data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2023.

## METHODS

## Cumulative Risk

The cumulative risk is calculated by the formula:

$$\text{Cumulative risk} = 1 - e^{-\text{cumulative rate}} \quad (1)$$

$$\text{Cumulative rate} = \sum_{i=1}^A W_i R_i \quad (2)$$

$A$  denotes the age bands typically used, 74, for the cumulative rate.  $W_i$  denotes the width of the  $i$ th age interval.  $R_i$  denotes age-specific incidence rates.

## The “AMP” Method

The AMP method was used to calculate the LTR, which accounts for deaths from other causes and

applies a correction to routinely published incidence data to adjust for potential overestimation caused by recording multiple primary tumors within the same individual (6–7). This characteristic makes the AMP method particularly suitable for estimating the risks of all cancers, less survivable cancers, or specific cancers prone to multiple primary sites using routinely released data for the 5-year age group.

$$S = \int_0^{\infty} \lambda_c(a) S_0(a) da = \sum_{i=1}^f \frac{R_i}{R_i + M_i - D_i} \tilde{S}_0^*(a_i) \times \left(1 - \exp\left(-\frac{w_i}{N_i} (R_i + M_i - D_i)\right)\right) \quad (3)$$

$$\tilde{S}_0^*(a_i) = \exp\left(-\sum_{j=1}^{i-1} \frac{R_j + (M_j - D_j)}{N_j}\right) \quad (4)$$

where for the age group  $i$ :  $R_i$  indicates the annual number of cancer cases (When estimating the risk of developing lung cancer,  $R_i$  is the annual number of cases. When estimating the risk of dying from lung cancer,  $R_i$  is the annual number of deaths);  $M_i$  indicates the annual number of deaths;  $D_i$  indicates the annual number of cancer-related deaths;  $N_i$  indicates the population;  $w_i$  denotes the width of the age group  $i$ .  $\lambda_c$  indicates the cancer incidence rate;  $\tilde{S}_0^*(a_i)$  denotes the probability of being alive and cancer-free at age  $a_i$ . The 95% uncertainty intervals (UIs) were derived from the 2.5th and 97.5th percentiles of each estimate distribution.

Data on lung cancer incidence and mortality were obtained from GBD 2023 and stratified by sex and age group (0–4, 5–9, ..., 90–94, and >95 years). Detailed population data for each province stratified by age group were not available for the non-census years. Therefore, the most recent authoritative dataset from the Seventh National Population Census conducted in 2020 was utilized to represent provincial age structures in this study.

This study estimated the LTR of lung cancer at both national and regional levels. The regional analysis encompassed geographic areas eastern, northern, northeastern, northwestern, south-central, and southwestern China. The eastern region includes Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong provincial-level administrative divisions (PLADs); northern region includes Beijing, Tianjin, Hebei, Shanxi, and Inner Mongolia PLADs; the northeastern region includes Liaoning, Jilin, and Heilongjiang PLADs; northwestern region includes Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang PLADs; south-central region includes Henan, Hubei,

Hunan, Guangdong, Guangxi, and Hainan PLADs; southwestern region includes Chongqing, Sichuan, Guizhou, Yunnan, and Xizang PLADs. All analyses were performed using R software (version 4.5.1, R Foundation for Statistical Computing, Vienna, Austria).

## RESULTS

In 2023, the LTRs of developing and dying from lung cancer in the overall Chinese population were 6.52% (95% UI: 6.28, 6.56) and 5.98% (95% UI: 5.57, 6.26), respectively (Tables 1–2). Substantial regional variations in LTR had been observed across China. The Northeast region exhibited the highest LTRs for both developing and dying from lung cancer, at 7.86% (95% UI: 6.77, 8.50) and 7.42% (95% UI: 6.24, 8.18), respectively — markedly exceeding the national averages. In contrast, the Northwest region recorded the lowest LTRs, at 4.00% (95% UI: 3.59, 4.84) for developing lung cancer and 3.87% (95% UI: 3.37, 4.75) for death. This regional pattern remained consistent across sex groups.

At the national level, the LTRs of lung cancer were higher in males [development: 8.28% (95% UI: 7.74, 8.38); death: 7.61% (95% UI: 6.71, 8.19)] than in females [development: 4.52% (95% UI: 4.30, 4.74); death: 4.14% (95% UI: 3.81, 4.51)]. Similar sex disparities were observed across all regions (Tables 1–2).

The LTR of lung cancer varies according to age and sex from birth to 95 years and above. Overall, LTR gradually declined with advancing age (Tables 1–2, Figure 1). The risk of developing lung cancer was very low from birth to age 40, resulting in nearly identical LTR estimates when measured from birth to death versus from age 40 to death [national estimates for development: 6.52% (95% UI: 6.28, 6.56) vs. 6.59% (95% UI: 6.36, 6.64); death: 5.98% (95% UI: 5.57, 6.26) vs. 6.06% (95% UI: 5.64, 6.35)]. Starting from age 70, the LTR was 5.17% (95% UI: 4.85, 5.22) for developing and 5.00% (95% UI: 4.60, 5.21) for dying from lung cancer. Sex-specific differences in LTR were also evident starting from the ages of 40, 50, 60, and 70 years (Supplementary Figures S1–S2, available at <https://weekly.chinacdc.cn/>), with males consistently exhibiting a significantly higher risk of development.

To evaluate the consistency and added value of the LTR estimates, a sensitivity analysis was conducted comparing the LTR with the standard cumulative risk (0–74 years) metric (Figure 2). An approximately

TABLE 1. Lifetime risks (% , 95% uncertainty interval) of developing lung cancer within selected age intervals by sex in 2023.

Region	Lifetime (birth–death)	Age: 40–death	Age: 50–death	Age: 60–death	Age: 70–death
Lung cancer incidence (total population)					
China	6.52 (6.28, 6.56)	6.59 (6.36, 6.64)	6.57 (6.33, 6.62)	6.26 (5.99, 6.32)	5.17 (4.85, 5.22)
Eastern	7.36 (6.55, 8.02)	7.43 (6.61, 8.11)	7.41 (6.58, 8.10)	7.11 (6.29, 7.78)	5.97 (5.24, 6.54)
Northern	6.44 (5.83, 7.10)	6.50 (5.89, 7.18)	6.49 (5.87, 7.17)	6.26 (5.64, 6.92)	5.28 (4.73, 5.85)
Northeastern	7.86 (6.77, 8.50)	7.91 (6.81, 8.57)	7.89 (6.77, 8.55)	7.59 (6.47, 8.26)	6.28 (5.24, 6.89)
Northwestern	4.00 (3.59, 4.84)	4.06 (3.64, 4.92)	4.03 (3.61, 4.89)	3.80 (3.40, 4.61)	3.08 (2.74, 3.72)
South–central	6.15 (5.51, 6.81)	6.21 (5.56, 6.89)	6.18 (5.53, 6.87)	5.86 (5.23, 6.51)	4.75 (4.21, 5.27)
Southwestern	5.74 (5.06, 6.41)	5.84 (5.14, 6.54)	5.80 (5.10, 6.50)	5.37 (4.71, 6.03)	4.33 (3.79, 4.85)
Lung cancer incidence (males)					
China	8.28 (7.74, 8.38)	8.43 (7.87, 8.54)	8.46 (7.88, 8.57)	8.14 (7.52, 8.28)	6.73 (6.06, 6.89)
Eastern	9.71 (8.27, 10.85)	9.86 (8.37, 11.04)	9.89 (8.39, 11.09)	9.57 (8.07, 10.75)	8.04 (6.66, 9.07)
Northern	7.77 (6.76, 8.75)	7.90 (6.85, 8.92)	7.93 (6.86, 8.98)	7.72 (6.64, 8.75)	6.52 (5.53, 7.42)
Northeastern	8.80 (6.71, 9.95)	8.89 (6.77, 10.09)	8.92 (6.77, 10.15)	8.66 (6.50, 9.91)	7.17 (5.22, 8.33)
Northwestern	5.20 (4.54, 6.37)	5.32 (4.63, 6.54)	5.32 (4.63, 6.56)	5.08 (4.41, 6.26)	4.11 (3.57, 5.04)
South–central	8.02 (6.85, 9.00)	8.15 (6.94, 9.17)	8.17 (6.95, 9.22)	7.84 (6.63, 8.85)	6.37 (5.33, 7.20)
Southwestern	7.32 (6.07, 8.44)	7.52 (6.21, 8.71)	7.53 (6.21, 8.75)	7.04 (5.81, 8.20)	5.63 (4.64, 6.58)
Lung cancer incidence (females)					
China	4.52 (4.30, 4.74)	4.54 (4.32, 4.77)	4.49 (4.26, 4.71)	4.25 (4.02, 4.47)	3.61 (3.35, 3.81)
Eastern	4.71 (4.01, 5.45)	4.73 (4.03, 5.48)	4.68 (3.98, 5.42)	4.46 (3.79, 5.17)	3.88 (3.28, 4.50)
Northern	4.91 (4.18, 5.70)	4.93 (4.19, 5.72)	4.88 (4.14, 5.66)	4.69 (3.97, 5.43)	4.04 (3.40, 4.69)
Northeastern	6.86 (5.58, 7.93)	6.88 (5.58, 7.95)	6.81 (5.53, 7.88)	6.52 (5.26, 7.56)	5.46 (4.31, 6.37)
Northwestern	2.68 (2.28, 3.27)	2.70 (2.29, 3.30)	2.65 (2.25, 3.24)	2.47 (2.10, 3.02)	2.07 (1.76, 2.52)
South–central	4.02 (3.37, 4.73)	4.03 (3.38, 4.75)	3.97 (3.33, 4.68)	3.74 (3.13, 4.41)	3.12 (2.60, 3.70)
Southwestern	3.89 (3.25, 4.49)	3.92 (3.27, 4.53)	3.85 (3.22, 4.46)	3.56 (2.97, 4.12)	3.01 (2.49, 3.49)

linear divergence was observed, where the LTR consistently exceeded the cumulative risk (0–74) in regions with a higher life expectancy. This pattern underscores the fact that the standard 0–74 metric may underestimate the disease burden in aging populations. Specifically, in 2023 (national life expectancy: 78.6 years), the cumulative risks for incidence (3.50%) and mortality (2.93%) in the 0–74 age group were significantly lower than their corresponding LTRs, confirming that extending the observation window to the full lifespan captures a substantial portion of late–life risks.

## DISCUSSION

This study provides the first comprehensive estimate of the LTR of developing and dying from lung cancer at both the national and regional levels in China. In 2023, the LTR of lung cancer in the overall Chinese population corresponded to one in 15 cases of

development and one in 17 deaths, with considerable geographic heterogeneity. Marked regional disparities were identified, with the highest risk in the northeastern region, followed by the eastern and northern regions, whereas the northwestern region had the lowest risk. LTR declined steadily with increasing age at diagnosis, with notable differences emerging after 40 years of age. Nationally and regionally, males consistently exhibited approximately twice the lifetime risk as females.

The calculated LTR for lung cancer was lower than the estimates reported in recent global studies based on the GLOBOCAN and World Population Prospects data (5,8–9), despite employing an identical calculation methodology. This discrepancy is primarily attributable to the heterogeneity of the data sources. GLOBOCAN estimates, largely derived from cancer registries in regions with well–established diagnostic accessibility, tend to capture higher detection rates characteristic of developed areas. In contrast, this study

TABLE 2. Lifetime risks (% , 95% uncertainty interval) of dying from lung cancer within selected age intervals by sex in 2023.

Region	Lifetime (birth–death)	Age: 40–death	Age: 50–death	Age: 60–death	Age: 70–death
Lung cancer death (total population)					
China	5.98 (5.57, 6.26)	6.06 (5.64, 6.35)	6.05 (5.63, 6.34)	5.84 (5.41, 6.11)	5.00 (4.60, 5.21)
Eastern	6.74 (5.85, 7.51)	6.81 (5.91, 7.60)	6.81 (5.90, 7.60)	6.59 (5.70, 7.36)	5.71 (4.93, 6.36)
Northern	5.93 (5.25, 6.66)	5.99 (5.30, 6.74)	5.99 (5.30, 6.75)	5.84 (5.15, 6.58)	5.10 (4.49, 5.70)
Northeastern	7.42 (6.24, 8.18)	7.48 (6.28, 8.25)	7.48 (6.27, 8.26)	7.28 (6.07, 8.06)	6.28 (5.18, 7.01)
Northwestern	3.87 (3.37, 4.75)	3.94 (3.43, 4.84)	3.93 (3.41, 4.84)	3.76 (3.26, 4.63)	3.18 (2.76, 3.86)
South–central	5.45 (4.74, 6.19)	5.51 (4.79, 6.27)	5.50 (4.78, 6.26)	5.27 (4.57, 5.99)	4.43 (3.82, 5.01)
Southwestern	5.35 (4.59, 6.06)	5.45 (4.67, 6.19)	5.44 (4.65, 6.17)	5.12 (4.39, 5.83)	4.31 (3.69, 4.89)
Lung cancer death (males)					
China	7.61 (6.71, 8.19)	7.76 (6.83, 8.35)	7.80 (6.86, 8.40)	7.57 (6.63, 8.18)	6.47 (5.57, 6.97)
Eastern	8.91 (7.21, 10.17)	9.05 (7.31, 10.36)	9.09 (7.33, 10.43)	8.87 (7.11, 10.18)	7.68 (6.09, 8.82)
Northern	7.17 (5.92, 8.32)	7.29 (6.01, 8.49)	7.34 (6.03, 8.57)	7.19 (5.88, 8.43)	6.26 (5.03, 7.34)
Northeastern	8.17 (5.92, 9.56)	8.27 (5.98, 9.70)	8.31 (5.99, 9.78)	8.13 (5.81, 9.65)	6.98 (4.95, 8.41)
Northwestern	5.04 (4.22, 6.28)	5.16 (4.31, 6.47)	5.18 (4.32, 6.51)	5.01 (4.16, 6.30)	4.23 (3.51, 5.23)
South–central	7.19 (5.84, 8.32)	7.31 (5.92, 8.49)	7.34 (5.94, 8.55)	7.10 (5.70, 8.27)	5.96 (4.73, 6.94)
Southwestern	6.83 (5.49, 7.91)	7.03 (5.62, 8.18)	7.06 (5.64, 8.23)	6.70 (5.36, 7.82)	5.59 (4.49, 6.51)
Lung cancer death (females)					
China	4.14 (3.81, 4.51)	4.17 (3.83, 4.54)	4.13 (3.80, 4.50)	3.98 (3.65, 4.34)	3.52 (3.20, 3.85)
Eastern	4.30 (3.52, 5.03)	4.33 (3.53, 5.07)	4.29 (3.51, 5.03)	4.15 (3.39, 4.86)	3.73 (3.04, 4.38)
Northern	4.50 (3.71, 5.30)	4.53 (3.73, 5.33)	4.50 (3.70, 5.30)	4.37 (3.59, 5.15)	3.93 (3.21, 4.63)
Northeastern	6.62 (5.22, 7.82)	6.65 (5.24, 7.86)	6.61 (5.20, 7.82)	6.42 (5.02, 7.60)	5.64 (4.36, 6.75)
Northwestern	2.59 (2.12, 3.25)	2.61 (2.13, 3.28)	2.58 (2.11, 3.25)	2.46 (2.01, 3.08)	2.15 (1.75, 2.71)
South–central	3.48 (2.86, 4.16)	3.50 (2.88, 4.19)	3.46 (2.85, 4.14)	3.31 (2.72, 3.96)	2.90 (2.38, 3.48)
Southwestern	3.61 (2.95, 4.26)	3.64 (2.97, 4.31)	3.60 (2.94, 4.27)	3.40 (2.77, 4.03)	2.99 (2.43, 3.55)

employed GBD 2023, which uses modeling to account for broader regional variations, potentially yielding a more conservative national baseline.

Substantial regional variations in LTR were observed, with consistently higher risks in the northeastern, eastern, and northern regions. This pattern is likely driven by the combined effects of increased life expectancy in developed regions and higher exposure to risk factors, including tobacco use (notably in the northeastern China) and air pollution (10–11). Conversely, lower risks in the southwestern and northwestern regions may be attributed to higher competing mortality from non-cancer causes and potential underdiagnosis due to limited access to healthcare. These findings underscore the need for regionally tailored policy interventions. In high-risk areas, priorities should include strengthening early screening programs such as low-dose CT scans. In lower-risk regions, efforts should focus on controlling traditional risk factors. It is also critical to address gaps

in the healthcare infrastructure through policies that promote medical alliances and telemedicine, thereby enhancing primary care capacity.

Overall, the ratio of the LTR of death to the development of lung cancer in China was 0.92, with similar ratios observed in most regions. This pattern may be partly attributed to the limited availability and uptake of early screening methods for lung cancer. As many individuals do not undergo regular screening, it is difficult to detect the disease at an early stage. These high ratios highlight the need for public health policies that prioritize the development and dissemination of early diagnostic technologies and address therapeutic bottlenecks (12–13).

It was observed that the LTR of lung cancer was consistently higher in males than in females, by approximately two-fold, both nationally and across all regions. This disparity is likely directly related to historically higher smoking rates among males, combined with biological differences, differential

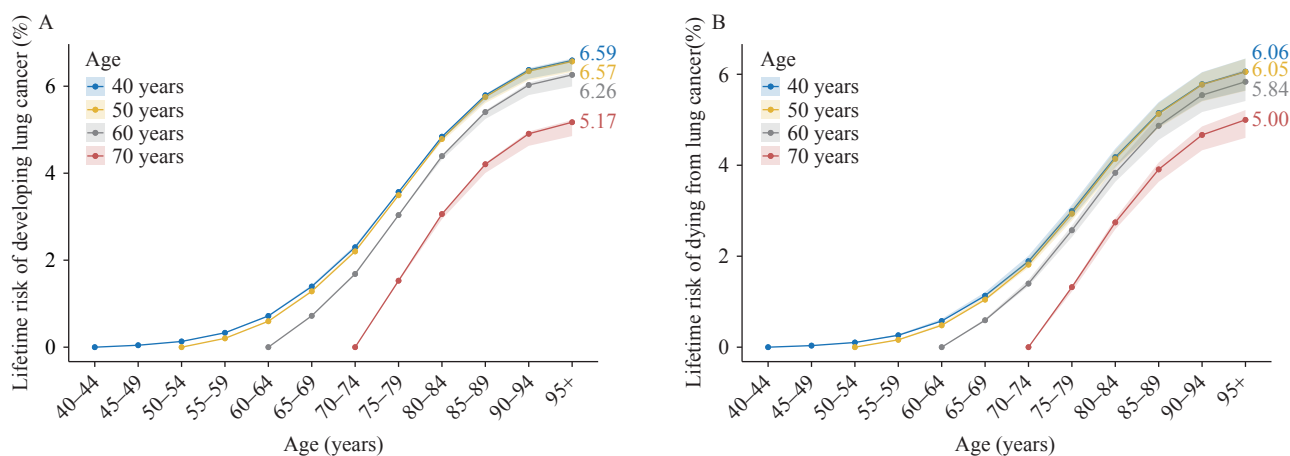


FIGURE 1. Lifetime risks (%) of developing or dying from lung cancer within selected age intervals in China, 2023 (both sexes). (A) Developing lung cancer; (B) Dying from lung cancer.

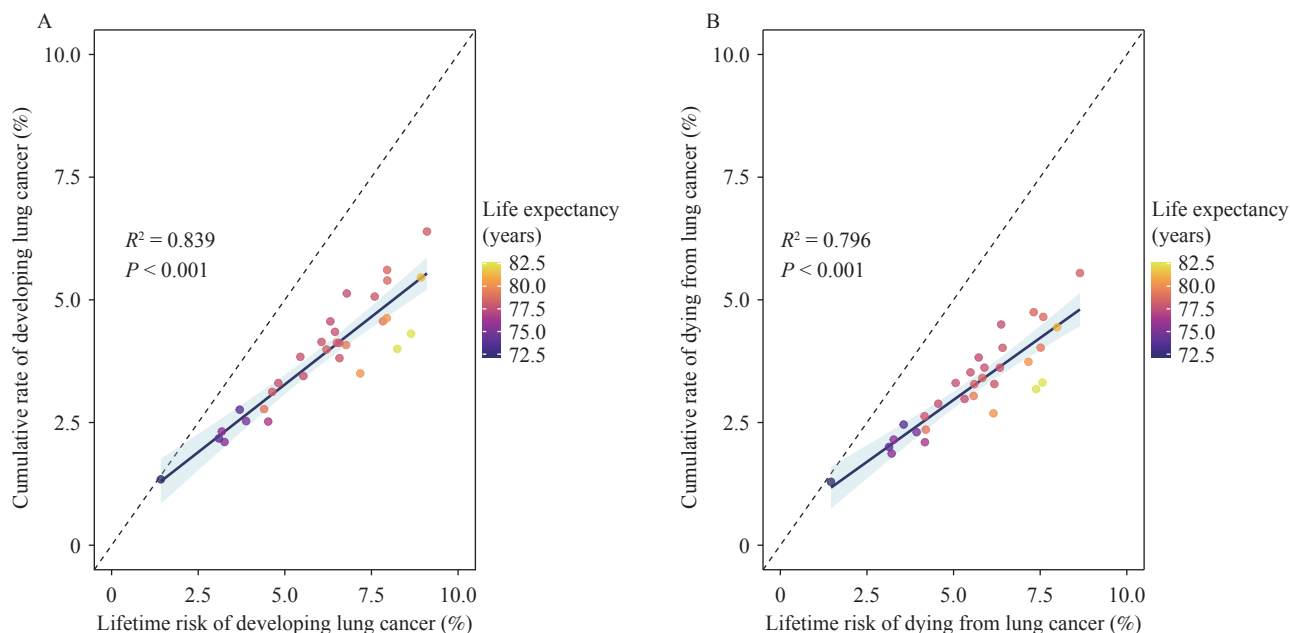


FIGURE 2. Comparison between lifetime risk and cumulative risk (0–74 years) of lung cancer in China, 2023 (both sexes). (A) Lifetime risk of developing lung cancer versus cumulative incidence rate; (B) Lifetime risk of dying from lung cancer versus cumulative mortality rate.

Note: Each circle represents a province. The color gradient indicates life expectancy at birth, ranging from purple (lower life expectancy) to yellow (higher life expectancy). The solid blue curve denotes the fitted trend using linear regression, with the shaded area representing the 95% *UI*.  $R^2$  and  $P$  values indicate the goodness of fit and statistical significance, respectively. Abbreviation: *UI*=uncertainty interval.

exposure to behavioral risk factors, and variations in health awareness (14–15). These findings offer a clear direction for improving the precision of public health interventions. Estimates of age-conditional probabilities provide further insights into prevention and control. The relatively low lifetime risk of lung cancer before the age of 40 in the Chinese population suggests that cancer screening in younger adults may have limited cost-effectiveness. These age-specific risk

estimates also provide evidence for defining appropriate target ages and intervals when designing lung cancer screening programs.

This study had several limitations. First, the LTR calculated using the AMP is typically based on historical registration data and may not be able to predict future risk trends. Second, the distribution of certain key risk factors, which could help further explain regional disparities, was not incorporated.

Finally, the ratio of lifetime mortality to the incidence risk in this study was higher than that in registry-based reports. This likely reflects the GBD's comprehensive coverage of under-registered regions with poorer prognoses, unlike urban-focused registries. Thus, these results represent the aggregate population burden rather than the clinical survival rates.

In conclusion, this study provides a comprehensive quantification of the LTR of lung cancer in China, offering valuable evidence for health system planning and targeted prevention strategies across different regions.

**Conflicts of interest:** No conflicts of interest.

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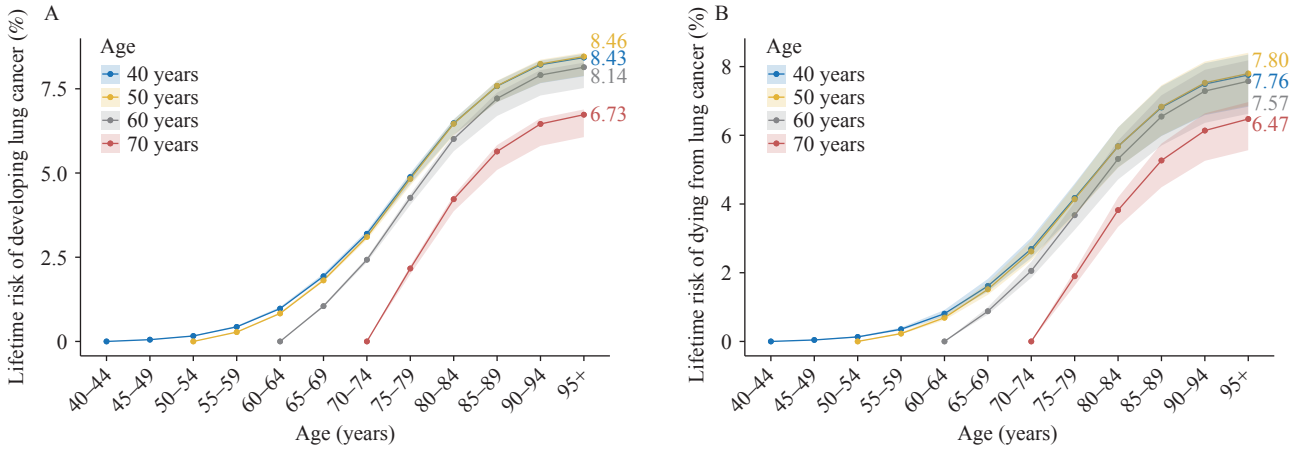
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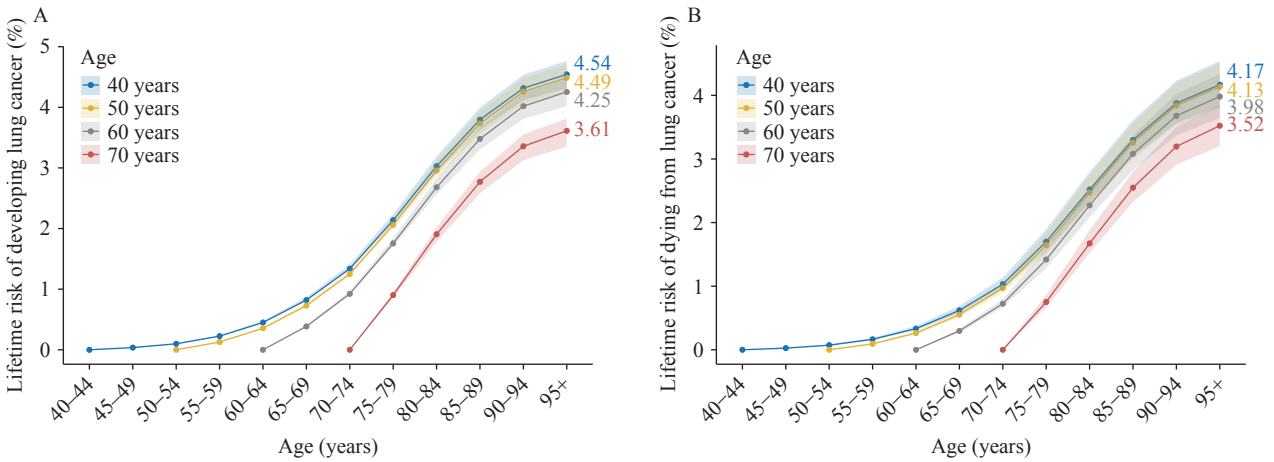
## REFERENCES

- Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2024;74(3):229 – 63. <https://doi.org/10.3322/caac.21834>.
- Han BF, Zheng RS, Zeng HM, Wang SM, Sun KX, Chen R, et al. Cancer incidence and mortality in China, 2022. *J Natl Cancer Cent* 2024;4(1):47 – 53. <https://doi.org/10.1016/j.jncc.2024.01.006>.
- Zhou JL, Xu Y, Liu JM, Feng LL, Yu JM, Chen DW. Global burden of lung cancer in 2022 and projections to 2050: incidence and mortality estimates from GLOBOCAN. *Cancer Epidemiol* 2024;93:102693. <https://doi.org/10.1016/j.canep.2024.102693>.
- Wang SM, Zheng RS, Li JY, Zeng HM, Li L, Chen R, et al. Global, regional, and national lifetime risks of developing and dying from gastrointestinal cancers in 185 countries: a population-based systematic analysis of GLOBOCAN. *Lancet Gastroenterol Hepatol* 2024;9(3):229 – 37. [https://doi.org/10.1016/S2468-1253\(23\)00366-7](https://doi.org/10.1016/S2468-1253(23)00366-7).
- Zheng RS, Wang SM, Zhang SW, Zeng HM, Chen R, Sun KX, et al. Global, regional, and national lifetime probabilities of developing cancer in 2020. *Sci Bull (Beijing)* 2023;68(21):2620 – 8. <https://doi.org/10.1016/j.scib.2023.09.041>.
- Ahmad AS, Ormiston-Smith N, Sasieni PD. Trends in the lifetime risk of developing cancer in Great Britain: comparison of risk for those born from 1930 to 1960. *Br J Cancer* 2015;112(5):943 – 7. <https://doi.org/10.1038/bjc.2014.606>.
- Sasieni PD, Shelton J, Ormiston-Smith N, Thomson CS, Silcocks PB. What is the lifetime risk of developing cancer?: the effect of adjusting for multiple primaries. *Br J Cancer* 2011;105(3):460 – 5. <https://doi.org/10.1038/bjc.2011.250>.
- Wang HD, Dwyer-Lindgren L, Lofgren KT, Rajaratnam JK, Marcus JR, Levin-Rector A, et al. Age-specific and sex-specific mortality in 187 countries, 1970-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012;380(9859):2071 – 94. [https://doi.org/10.1016/S0140-6736\(12\)61719-X](https://doi.org/10.1016/S0140-6736(12)61719-X).
- Li M, Wen X, Liang X, Liu MW, Zhang L, Zheng R. Global, regional, and national lifetime risk of developing and dying from lung cancer in 2022: A population-based study in 185 countries. *Chin Med J (Engl)* 2024;137(24):3101 – 7. <https://doi.org/10.1097/CM9.00000000000003368>.
- GBD 2023 Disease and Injury and Risk Factor Collaborators. Burden of 375 diseases and injuries, risk-attributable burden of 88 risk factors, and healthy life expectancy in 204 countries and territories, including 660 subnational locations, 1990-2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet* 2025;406(10513):1873 – 922. [https://doi.org/10.1016/S0140-6736\(25\)01637-X](https://doi.org/10.1016/S0140-6736(25)01637-X).
- Yin P, Brauer M, Cohen AJ, Wang HD, Li J, Burnett RT, et al. The effect of air pollution on deaths, disease burden, and life expectancy across China and its provinces, 1990-2017: an analysis for the Global Burden of Disease Study 2017. *Lancet Planet Health* 2020;4(9):e386 – 98. [https://doi.org/10.1016/S2542-5196\(20\)30161-3](https://doi.org/10.1016/S2542-5196(20)30161-3).
- Fernandez-Bussy S, Funes-Ferrada R, Yu Lee-Mateus AY, Vaca-Cartagena BF, Barrios-Ruiz A, Valdes-Camacho S, et al. Transforming lung cancer diagnosis: the role of robotic-assisted bronchoscopy in early detection and staging. *Lung Cancer* 2025;206:108646. <https://doi.org/10.1016/j.lungcan.2025.108646>.
- Li JN, Zhu LP, Kwok HF. Nanotechnology-based approaches overcome lung cancer drug resistance through diagnosis and treatment. *Drug Resist Updat* 2023;66:100904. <https://doi.org/10.1016/j.drup.2022.100904>.
- Li WZ, Liang HR, Wang W, Liu J, Liu XW, Lao S, et al. Global cancer statistics for adolescents and young adults: population based study. *J Hematol Oncol* 2024;17(1):99. <https://doi.org/10.1186/s13045-024-01623-9>.
- Leiter A, Veluswamy RR, Wisnivesky JP. The global burden of lung cancer: current status and future trends. *Nat Rev Clin Oncol* 2023;20(9):624 – 39. <https://doi.org/10.1038/s41571-023-00798-3>.

**SUPPLEMENTARY MATERIAL**



SUPPLEMENTARY FIGURE S1. Lifetime risks (%) of developing or dying from lung cancer within selected age intervals among males in China, 2023. (A) Lung cancer incidence; (B) Lung cancer mortality.



SUPPLEMENTARY FIGURE S2. Lifetime risks (%) of developing or dying from lung cancer within selected age intervals among females in China, 2023. (A) Lung cancer incidence; (B) Lung cancer mortality.

## Notifiable Infectious Diseases Reports

## Reported Cases and Deaths of National Notifiable Infectious Diseases — China, February 2026\*

Diseases	Cases	Deaths
Plague	0	0
Cholera	0	0
COVID-19	19,453	1
SARS-CoV	0	0
Acquired immune deficiency syndrome <sup>†</sup>	2,668	1,165
Hepatitis	111,021	88
Hepatitis A	939	0
Hepatitis B	96,310	39
Hepatitis C	10,900	49
Hepatitis D	24	0
Hepatitis E	2,392	0
Other hepatitis	456	0
Poliomyelitis	0	0
Human infection with noval influenza virus	4	0
Measles	131	0
Epidemic hemorrhagic fever	180	0
Rabies	10	15
Japanese encephalitis	0	0
Dengue	94	0
Monkey pox <sup>§</sup>	27	0
Anthrax	14	0
Dysentery	1,503	0
Tuberculosis	44,105	111
Typhoid fever and paratyphoid fever	183	0
Meningococcal meningitis	13	0
Pertussis	666	0
Diphtheria	0	0
Neonatal tetanus	0	0
Scarlet fever	1,197	0
Brucellosis	3,447	0
Gonorrhea	7,640	0
Syphilis	43,817	2
Leptospirosis	2	0
Schistosomiasis	2	0
Malaria	348	0
Influenza	394,141	1
Mumps	3,142	0

Continued

Diseases	Cases	Deaths
Rubella	32	0
Acute hemorrhagic conjunctivitis	1,297	0
Leprosy	22	0
Typhus	40	0
Kala azar	28	0
Echinococcosis	264	0
Filariasis	0	0
Hand, foot and mouth disease	22,708	1
Infectious diarrhea <sup>¶</sup>	194,710	0
<b>Total</b>	<b>852,909</b>	<b>1,384</b>

\* According to the National Bureau of Disease Control and Prevention.

† The number of deaths of Acquired immune deficiency syndrome (AIDS) is the number of all-cause deaths reported in the month by cumulative reported AIDS patients.

§ Since September 20, 2023, Monkey pox was included in the management of Class B infectious diseases.

¶ Infectious diarrhea excludes cholera, dysentery, typhoid fever and paratyphoid fever.

The number of cases and cause-specific deaths refer to data recorded in National Notifiable Disease Reporting System in China, which includes both clinically-diagnosed cases and laboratory-confirmed cases. Only reported cases of the 31 provincial-level administrative divisions in the Chinese mainland are included in the table, whereas data of Hong Kong Special Administrative Region, Macau Special Administrative Region, and Taiwan, China are not included. Monthly statistics are calculated without annual verification, which were usually conducted in February of the next year for de-duplication and verification of reported cases in annual statistics. Therefore, 12-month cases could not be added together directly to calculate the cumulative cases because the individual information might be verified via National Notifiable Disease Reporting System according to information verification or field investigations by local CDCs.

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