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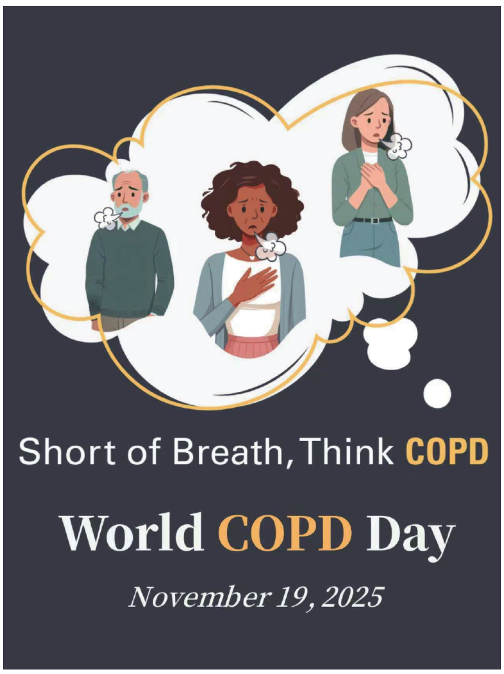

Healthy China

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Healthy China

Investing in Primary Care to Reduce the Burden of Chronic Obstructive Pulmonary Disease

Ting Yang[1,2,3,4,#]; Jing Wu[5]; Chunhua Chi[6]

ABSTRACT

The recent inclusion of chronic obstructive pulmonary disease (COPD) in China's national basic public health services (NBPHS) represents a historic milestone — marking the first time a chronic respiratory disease has been incorporated into this programme. This article examines the medical and socio-economic significance of integrating COPD management into the NBPHS, evaluates current efforts to address the disease burden, and discusses their alignment with broader health objectives outlined in *Healthy China 2030*.

COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms accompanied by structural abnormalities of the airways and/or alveoli (*1*). Acute exacerbations — episodes of symptom worsening beyond normal day-to-day variation — can irreversibly diminish lung function and increase the frequency of subsequent exacerbations. Furthermore, patients with COPD face elevated risks of both respiratory and cardiovascular events that may result in premature mortality (*2*).

As the most prevalent chronic respiratory disease globally, COPD now affects more than 300 million individuals worldwide and accounted for 3.3 million deaths in 2019 (*3*). China's efforts to combat this disease carry particular global significance, as approximately one-third of all COPD-related deaths worldwide occur within the country (*4*).

Prevalence of COPD in China

COPD ranks as the third most prevalent non-communicable disease in China(*5*), following hypertension and type 2 diabetes, and currently affects 99.9 million people (*6*). Substantial regional disparities in disease burden exist, with higher prevalence rates observed in rural areas and among populations with lower educational attainment (*7*). At the provincial level, economically less developed regions demonstrate elevated COPD prevalence (*8*). The disease burden increases markedly with age, particularly in adults aged 50 years and above, with prevalence rates of 12.8% in males and 5.7% in females (*9*).

Approximately 71% of patients experience exacerbations — defined as sustained worsening of symptoms beyond the usual stable state (*10*) — which significantly elevates the risk of cardiovascular complications, including acute coronary syndrome, heart failure decompensation, cerebral ischemia, arrhythmias, and cardiovascular-related mortality (*11*). The age-standardized mortality rate (ASMR) in China reached 45.90 per 100,000 population in 2021, with rural regions experiencing significantly higher mortality rates compared to urban areas (*12*).

Socio-Economic Burden of COPD in China

COPD accounts for 10% of all health service expenditures in China, with inpatient hospitalizations representing the largest component of COPD-related costs (*13*). A regional study from northeastern China documented a doubling of COPD hospitalizations between 2005 and 2015 (*14*).

The disease substantially affects patients' working lives and economic productivity. Evidence demonstrates that compared with individuals with hypertension or hypercholesterolemia, COPD patients in China experience significantly higher rates of work absenteeism, presenteeism, and overall impairment in work performance and daily activities (*15*). Projections indicate that over the next three decades, China's economic losses attributable to COPD will reach 1.363 trillion (US dollars), representing nearly 30% of the total global economic burden from this disease (*16*).

Against this backdrop of substantial health and financial burden, the China Central Committee and State Council published the *Healthy China Initiative (2019–2030)* (*17*), which proposed comprehensive actions to improve population health. The *Healthy China* framework recognized the critical need to "improve the ability and level of prevention and treatment of chronic respiratory diseases, and strengthen the allocation of relevant diagnosis and treatment equipment" in primary care settings. Key initiatives include investigating the inclusion of COPD management in the National Basic Public Health Service (NBPHS) list and establishing ambitious targets to enhance local-level treatment capacity. The *Healthy China* initiative specifies that these improvements will be achieved through expanded access to nebulized inhalation facilities, oxygen therapy equipment, non-invasive ventilators, and comprehensive long-term disease management programs in primary care facilities.

Investing in Primary Care to Prioritise COPD

The inclusion of COPD in the NBPHS represents a strategic shift toward enhanced primary care involvement in disease management. This policy decision draws upon substantial evidence from pilot programmes, expert consultations, and international best practices.

International experience demonstrates the effectiveness of primary care-based COPD management. Canada's integrated primary care programme, for instance, has significantly reduced acute care burden while improving patient outcomes: quality of life improved in 43% of patients, physician visits decreased by 33.1%, emergency department presentations fell by 9.6%, and hospitalisations declined by 6.8% (*18*), all while achieving substantial cost savings (*19*).

Expanding primary care capacity for COPD management offers considerable economic advantages through more targeted patient interventions. Population-based COPD screening strategies have proven cost-effective in China, with incremental cost-effectiveness ratios (ICERs) ranging from 8,034 to 13,209 USD per quality-adjusted life year (QALY) — well below the willingness-to-pay threshold of 38,441 USD/QALY (*20*).

Healthy China and COPD

Over the past decade, China has implemented a comprehensive series of policy interventions and public health initiatives designed to improve COPD prevention, diagnosis, and management outcomes nationwide. The following table summarizes these key developments (Table 1):

The *Healthy China* framework provides critical support for sustained improvements in COPD prevention and treatment. As a disease that imposes a substantial and growing clinical and economic burden on China, COPD presents significant health equity challenges through disproportionate unmet needs across different populations.

The inclusion of COPD management within the National Basic Public Health Programme represents another important milestone toward achieving *Healthy China 2030* goals. These include an anticipated decline in premature death rates from respiratory diseases to 8.1 per 100,000 and a potential increase in disease awareness to 30%. This policy enables China's primary care services to assume a pivotal role in addressing the COPD burden, reflecting a broader structural shift

TABLE 1. Summary of policies and projects introduced to improve respiratory care for the Chinese population.

Year	Policy
2012	COPD incorporated into the National Work Plan for the Prevention and Treatment of Chronic Diseases
2014	COPD monitoring integrated into the national chronic disease and nutrition surveillance system
2017	Medium and Long-Term Plan for the Prevention and Treatment of Chronic Diseases in China (2017–2025) recommends incorporating pulmonary function testing into routine physical examinations for individuals aged 40 years and older
2017	COPD incorporated into the national tiered diagnosis and treatment initiative
2017	"Happy Breath" initiative launched to promote standardized COPD diagnosis and treatment protocols
2019	*Healthy China Action Plan* – mortality rate targets established for chronic respiratory diseases
2020	Supplementary funding allocated to equip primary healthcare centers with spirometry equipment
2021	COPD incorporated into the national prevention and treatment program for chronic non-communicable diseases
2021	COPD management integrated into the local Basic Public Health Services List in Xishui County, emphasizing coordinated care alongside hypertension and diabetes programs
2024	Pilot programs established in eight regions to develop and evaluate implementation pathways and service delivery models for COPD within the NBPHS framework
2024	Announcement of COPD management in the National Basic Public Health Services

Abbreviation: COPD=chronic obstructive pulmonary disease.

toward preventive and equitable healthcare delivery.

Looking forward, successful nationwide implementation of the COPD NBPHS project will require addressing current capacity and capability limitations in China's primary care system. Key priorities include extensive training for general practitioners, strengthened collaboration between primary care facilities and tertiary hospitals, and improved access to inhaled medications and lung function testing equipment.

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Preplanned Studies

Cardiovascular Morbidity and Mortality Attributable to Potentially Inappropriate Medication Use Among Primary Prevention Populations — China, 2015–2023

Zhenping Zhao[1]; Mei Zhang[1]; Limin Wang[1]; Maigeng Zhou[1,#]

Summary

What is already known about this topic?

Potentially inappropriate medication (PIM) use is a global challenge. The World Health Organization's 2017 *Medication Without Harm* initiative set a target to reduce medication-related harm by 50% within five years. However, trends and disease burden related to PIM use in China have remained unclear.

What is added by this report?

This study found that from 2015 to 2023, the prevalence of PIM use and the associated cardiovascular disease mortality and morbidity nearly halved. Nonetheless, substantial disparities persist across sex, age, urban–rural status, and geographic region. Inner Mongolia and Tianjin exhibited the most pronounced reductions after 2018.

What are the implications for public health practice?

Develop population-based systems to monitor medication use. Integrate rational-use training and public education into essential public health services, and strengthen implementation at the primary care level, particularly in northern and northeastern provinces.

ABSTRACT

Introduction: This study aimed to quantify potentially inappropriate medication (PIM) use for primary cardiovascular disease (CVD) prevention in China and its attributable mortality and morbidity.

Methods: Data from the 2015, 2018, and 2023 China Chronic Disease and Risk Factor Surveillance were analyzed for adults aged ≥30 years without diagnosed CVD. PIM use was defined according to guideline adherence for aspirin, statins, antihypertensives, and glucose-lowering agents. Population attributable fractions (PAFs) were calculated using weighted prevalence and relative risks, and CVD outcomes were derived from the Global Burden of Disease 2023.

Results: From 2015 to 2023, PIM prevalence for primary CVD prevention declined by half, with larger relative reductions observed among women and older adults. The number of PIM-attributable CVD deaths decreased by 39%, and its rank among CVD risk factors dropped from 17th to 21st after 2018. Before 2018, 15 provinces showed increases in PIM-attributable CVD mortality and morbidity, but subsequent declines occurred in 30 provinces for mortality and 28 for morbidity, with Inner Mongolia and Tianjin showing the largest improvements.

Conclusion: Despite marked progress, disparities persist across regions and populations. Establishing population-based PIM surveillance and implementing targeted interventions in high-burden areas are essential to further reduce preventable CVD morbidity and mortality.

In 2017, the World Health Organization launched the *Medication Without Harm* initiative, aiming to reduce severe avoidable medication-related harm by 50% within five years (*1*). However, China's progress toward this target remains unclear. As cardiovascular diseases (CVD) remain the leading cause of death in China, improving primary prevention is essential for reducing CVD morbidity and mortality (*2*–*3*). This study quantified potentially inappropriate medication (PIM) use for primary CVD prevention, its population attributable fractions (PAFs), and the corresponding CVD mortality and morbidity.

The China Chronic Disease and Risk Factor Surveillance (CCDRFS) was conducted in 2015, 2018, and 2023 across 302 surveillance points in 31 provinces using a multistage stratified cluster sampling method to obtain nationally representative data. Residents aged ≥18 years were invited to participate, with response rates exceeding 97% in all surveys. Detailed methods have been reported elsewhere (*4*).

PIMs for CVD prevention were defined among participants without a history of CVD as follows: 1) aspirin use inconsistent with guideline recommendations (2019 Chinese Expert Consensus on the Use of Aspirin for the Primary Prevention of Cardiovascular Diseases; 2020 Chinese Guideline for the Primary Prevention of Cardiovascular Diseases); 2) statin use inconsistent with guideline recommendations (2020 Chinese Guideline for the Primary Prevention of Cardiovascular Diseases; 2023 Chinese Guideline for Lipid Management in Adults); 3) absence of antihypertensive therapy among individuals aware of having hypertension with uncontrolled blood pressure (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥90 mmHg), without contraindications to therapy and without intention to modify lifestyle; or 4) absence of oral glucose-lowering drugs or insulin among individuals with diagnosed diabetes and uncontrolled glycemia (fasting blood glucose ≥7.0 mmol/L or hemoglobin A1c ≥6.5%), without contraindications to therapy and without intention to modify lifestyle.

All calculations were weighted according to the sampling scheme, with post-stratification adjustments based on Chinese population estimates from the National Bureau of Statistics. Relative risks associated with PIM use were estimated using Cox proportional hazards models. Mortality and morbidity data for CVDs were obtained from the Global Burden of Disease 2023 study. Statistical analyses were conducted using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA), and data visualization was performed with Python software (version 3.11; Python Software Foundation, Wilmington, DE, USA).

This study included 473,324 community-dwelling adults aged ≥30 years without diagnosed CVDs or related hospitalizations (157,565 in 2015, 155,245 in 2018, and 160,514 in 2023). Among the 157,565 participants enrolled in 2015 and linked to hospitalization and mortality records through 2020, 2,097 deaths and 17,037 CVD events occurred over five years. In each survey, the proportion of men (42.8%–47.0%) was lower than that of women. The proportions of older adults (mean age increased from 53.8 to 58.5 years), urban residents (39.8% to 45.7%), and individuals with hypertension (40.4% to 51.9%), diabetes (9.1% to 25.6%), and dyslipidemia (36.8% to 41.7%) all increased over the study period. The distributions of participants by region and education remained relatively stable across survey years.

PIM prevalence for primary CVD prevention declined by nearly half (47.7%), from 4.4% in 2015 to 2.3% in 2023. Men and women showed similar declines, with slightly lower levels in women by 2023. PIM prevalence rose with age — especially ≥50 years — but decreased across all age groups. Initially, urban prevalence exceeded rural levels, but by 2023 the rates converged, with rural slightly higher. Regionally, the North and Northeast consistently had the highest PIM levels, and the South and Southwest the lowest, though all regions showed declines (Table 1).

Overall, PAFs for CVD morbidity attributable to PIM use exceeded those for mortality. Mortality PAFs increased with age, while morbidity PAFs peaked at ages 50–69 years. Mortality PAFs were consistently higher in men, whereas morbidity PAFs were similar between sexes. Both declined by about half from 2015 to 2023. Urban PAFs initially exceeded rural values but converged by 2023. Relative reductions were greater in women, and absolute declines were largest among older adults. Regionally, PAFs were highest in the North and Northeast and lowest in the South and Southwest (Table 1).

PIM use showed a clear downward trend in its contribution to CVD-related deaths. Its rank among causes of CVD deaths was 17th in both 2015 and 2018, declining to 21st in 2023, indicating a relative reduction compared with other risk exposures. The absolute burden also decreased substantially — by approximately 39%, from 1.0 million deaths in 2015 to 0.6 million in 2023 — with a more pronounced decline after 2018 (Figure 1).

The study examined provincial disparities in trends of PIM–attributable CVD deaths and incidence between 2015–2018 and 2018–2023. From 2015 to 2018, 15 provinces exhibited increasing trends in PIM-attributable CVD deaths and incidence. After 2018, however, most provinces experienced declines, except Gansu for deaths and Gansu, Guangdong, and Yunnan for incidence. The most substantial reductions in CVD mortality and incidence were observed in Inner Mongolia and Tianjin during 2018–2023 (Figure 2).

DISCUSSION

To our knowledge, this is the first study to reveal national trends and provincial variations in PIM use attributable to CVD deaths and incidence in China, which yielded four main findings. First, we observed substantial improvement in medication management

TABLE 1. Prevalence and population attributable fractions of mortality and morbidity due to potentially inappropriate medication use among adults receiving primary prevention for cardiovascular disease, China, 2015–2023.

Characteristics	2015			2018			2023		
	*P** (95% *CI*)	PAF (95% *CI*)†		*P** (95% *CI*)	PAF (95% *CI*)†		*P** (95% *CI*)	PAF (95% *CI*)†	
		Mortality	Morbidity		Mortality	Morbidity		Mortality	Morbidity
Total	4.4 (3.9–4.8)	3.0 (2.3–3.6)	3.2 (3.0–3.4)	3.7 (3.4–4.0)	2.5 (2.0–3.0)	2.7 (2.6–2.9)	2.3 (2.1–2.4)	1.6 (1.2–1.9)	1.7 (1.6–1.8)
Sex									
Male	4.3 (3.7–4.8)	3.7 (3.1–4.3)	3.2 (2.9–3.5)	3.7 (3.4–4.0)	3.2 (2.7–3.8)	2.8 (2.5–3.0)	2.4 (2.2–2.6)	2.1 (1.8–2.5)	1.8 (1.7–2.0)
Female	4.4 (4.1–4.8)	1.7 (0.7–2.8)	3.3 (3.0–3.6)	3.7 (3.3–4.0)	1.4 (0.6–2.3)	2.8 (2.5–3.0)	2.1 (1.9–2.3)	0.8 (0.3–1.3)	1.6 (1.5–1.7)
Age group (years)									
30–34	0.8 (0.6–1.1)	0.6 (0.4–0.7)	0.1 (0.0–1.2)	0.9 (0.5–1.2)	0.6 (0.5–0.7)	0.1 (0.0–1.3)	0.6 (0.4–0.9)	0.4 (0.4–0.5)	0.1 (0.0–1.0)
35–39	1.6 (1.2–2.0)	1.1 (0.9–1.3)	1.9 (1.1–2.7)	1.3 (1.0–1.6)	0.9 (0.7–1.1)	1.6 (0.9–2.2)	0.3 (0.2–0.5)	0.2 (0.2–0.3)	0.4 (0.2–0.6)
40–44	2.1 (1.7–2.5)	1.5 (1.2–1.8)	2.0 (1.3–2.7)	2.0 (1.7–2.4)	1.4 (1.1–1.7)	1.9 (1.3–2.6)	0.9 (0.6–1.2)	0.6 (0.5–0.8)	0.9 (0.6–1.2)
45–49	3.4 (2.8–3.9)	2.3 (1.8–2.8)	2.5 (1.9–3.2)	3.2 (2.7–3.6)	2.2 (1.7–2.6)	2.4 (1.7–3.0)	1.5 (1.2–1.8)	1.0 (0.8–1.3)	1.2 (0.8–1.5)
50–54	4.8 (4.3–5.3)	3.2 (2.6–3.9)	3.6 (3.0–4.3)	4.8 (4.1–5.4)	3.2 (2.6–3.9)	3.6 (2.9–4.3)	2.5 (2.1–2.8)	1.7 (1.4–2.1)	1.9 (1.6–2.3)
55–59	6.3 (5.4–7.2)	4.2 (3.4–5.1)	2.9 (2.1–3.8)	5.6 (4.9–6.2)	3.8 (3.0–4.5)	2.6 (1.9–3.3)	3.5 (3.1–3.9)	2.4 (1.9–2.9)	1.7 (1.2–2.1)
60–64	7.6 (6.8–8.5)	5.1 (4.0–6.1)	3.0 (2.2–3.8)	6.9 (6.3–7.6)	4.6 (3.7–5.6)	2.8 (2.0–3.5)	4.5 (4.1–5.0)	3.1 (2.4–3.7)	1.8 (1.3–2.3)
65–69	8.8 (7.6–9.9)	5.8 (4.6–6.9)	3.1 (2.2–4.0)	8.4 (7.4–9.4)	5.5 (4.4–6.7)	3.0 (2.1–3.8)	5.2 (4.7–5.7)	3.5 (2.8–4.3)	1.9 (1.3–2.4)
≥70	10.1 (8.0–12.3)	6.6 (5.3–7.9)	2.2 (1.4–3.1)	8.1 (7.2–9.1)	5.4 (4.3–6.5)	1.8 (1.1–2.5)	6.9 (6.1–7.6)	4.6 (3.7–5.5)	1.5 (0.9–2.1)
Residency									
Urban	4.9 (4.2–5.6)	3.3 (2.6–4.0)	3.6 (3.4–3.8)	3.8 (3.4–4.2)	2.6 (2.1–3.1)	2.8 (2.7–3.0)	2.2 (2.0–2.4)	1.5 (1.2–1.8)	1.6 (1.5–1.7)
Rural	3.7 (3.4–4.0)	2.5 (2.0–3.0)	2.7 (2.6–2.9)	3.5 (3.2–3.9)	2.4 (1.9–2.9)	2.6 (2.5–2.8)	2.3 (2.1–2.5)	1.6 (1.3–1.9)	1.8 (1.6–1.9)
Subnational region§									
Central	4.0 (3.0–5.0)	2.7 (2.2–3.3)	3.0 (2.8–3.1)	3.7 (3.0–4.4)	2.5 (2.0–3.0)	2.7 (2.6–2.9)	2.5 (2.1–2.8)	1.7 (1.3–2.1)	1.9 (1.7–2.0)
East	4.6 (3.7–5.4)	3.1 (2.5–3.7)	3.4 (3.2–3.6)	3.4 (2.9–3.8)	2.3 (1.8–2.8)	2.5 (2.4–2.7)	1.8 (1.6–2.0)	1.2 (1.0–1.5)	1.3 (1.2–1.4)
North	6.5 (5.8–7.2)	4.3 (3.5–5.2)	4.7 (4.5–5.0)	6.2 (5.3–7.1)	4.2 (3.3–5.0)	4.5 (4.3–4.8)	3.9 (3.3–4.5)	2.7 (2.1–3.2)	2.9 (2.7–3.1)
Northeast	5.7 (4.3–7.2)	3.9 (3.1–4.6)	4.2 (4.0–4.5)	5.5 (4.2–6.7)	3.7 (2.9–4.4)	4.0 (3.8–4.3)	2.7 (2.0–3.4)	1.8 (1.5–2.2)	2.0 (1.9–2.1)
Northwest	5.0 (4.0–5.9)	3.4 (2.7–4.1)	3.7 (3.5–3.9)	4.2 (3.2–5.1)	2.8 (2.3–3.4)	3.1 (2.9–3.3)	3.2 (2.5–3.9)	2.2 (1.7–2.6)	2.4 (2.2–2.5)
South	2.5 (1.4–3.5)	1.7 (1.3–2.0)	1.8 (1.7–2.0)	1.7 (1.3–2.1)	1.2 (0.9–1.4)	1.3 (1.2–1.4)	1.5 (1.1–1.8)	1.0 (0.8–1.2)	1.1 (1.0–1.2)
Southwest	2.9 (2.3–3.4)	2.0 (1.6–2.4)	2.2 (2.0–2.3)	2.4 (1.8–3.1)	1.7 (1.3–2.0)	1.8 (1.7–2.0)	1.6 (1.3–1.9)	1.1 (0.9–1.4)	1.2 (1.1–1.3)

* *P* indicates the prevalence of potentially inappropriate medication use among the Chinese population aged ≥30 years. Prevalence values were weighted to represent the overall national population.

† PAF =population attributable fraction; *CI*=confidence interval.

§ Subnational regions were classified as follows: East (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong); Central (Henan, Hubei, Hunan); Southwest (Sichuan, Guizhou, Yunnan, Chongqing, Xizang); North (Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia); South (Guangdong, Guangxi, Hainan); Northeast (Liaoning, Jilin, Heilongjiang); Northwest (Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang).

alongside persistent challenges in optimizing rational medication use for cardiovascular prevention across demographic and geographic subgroups. Despite a sustained decline in PIM use, approximately 2.3% of the primary prevention population in 2023 still received inappropriate medications, which represents a considerable burden given China's large population base.

Second, the parallel 50% reductions in mortality and morbidity PAFs indicate major progress in medication stewardship and CVD prevention. Morbidity PAFs remained higher than mortality PAFs, suggesting that PIM mainly contributes to new CVD events, while the narrowing gap reflects improved acute care and secondary prevention. By 2023, rural PAFs slightly exceeded urban values, highlighting uneven progress and the need to strengthen prescribing quality and follow-up in rural areas. Persistently higher mortality PAFs in men indicate greater fatal risk, calling for focused medication review, risk-factor control, and emergency preparedness. Marked age and north–south gradients further support targeted interventions for older adults and high-burden northern regions, reinforced by ongoing surveillance.

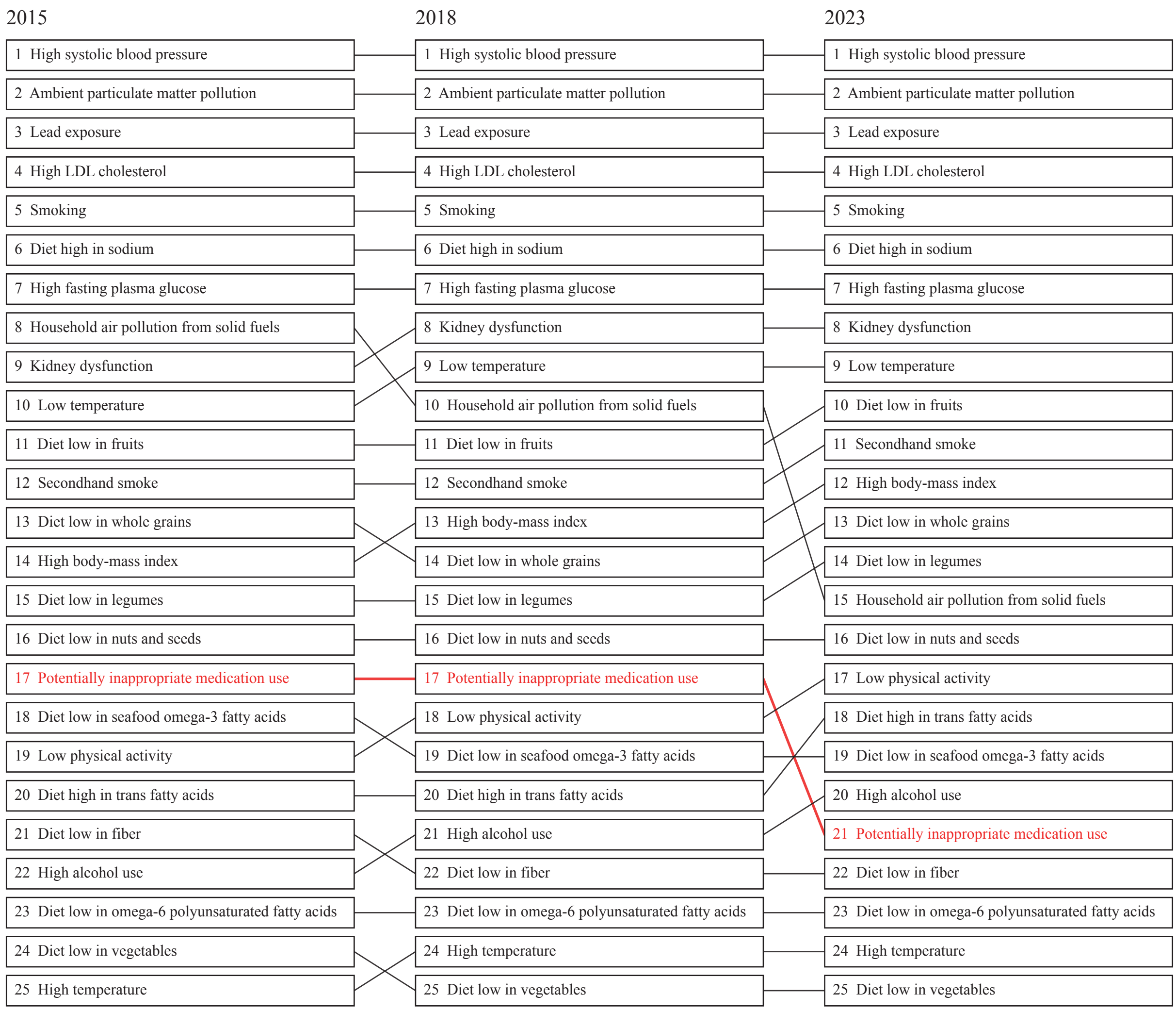

FIGURE 1. Ranking of the top 25 risk factors by attributable cardiovascular disease deaths in China, 2015, 2018, and 2023 (both sexes).

Note: Estimates for risk factors other than potentially inappropriate medication use were derived from the Global Burden of Disease 2023. The estimates of cardiovascular disease (CVD) deaths attributable to the potentially inappropriate medication use were derived from population attributable fractions and the death counts due to CVD estimates from the Global Burden of Disease 2023.

Third, the rank of PIM–attributable CVD deaths declined significantly from 17th to 21st after 2018 among all CVD risk factors, marking a pivotal turning point. Three major developments between 2017 and 2019 may explain this shift. First, three landmark clinical trials — ARRIVE, ASPREE, and ASCEND — fundamentally questioned the role of aspirin in primary prevention, leading to widespread revisions in international clinical guidelines (*5–6*). Second, China's centralized medicine procurement policy, launched in 2019, substantially improved the cost-effectiveness of pharmacotherapies for CVD prevention (*7*). Third, in 2018, China introduced explicit criteria for PIM use in older adults to enhance prescribing oversight and rational medication management (*8*). Collectively, these evidence- and policy-driven reforms may explain the downward trend in PIM-attributable CVD deaths observed after 2018.

Fourth, regional policy initiatives in Inner Mongolia (since 2019) and Tianjin (since 2020) likely contributed to the observed declines in PIM-attributable CVD deaths and incidence. In December 2019, Inner Mongolia issued a reform plan mandating stricter supervision of drug and consumable use (*9*). By March 2020, all medical institutions across the region were required to establish and publicly disclose key drug monitoring lists, followed by the implementation of a province-wide surveillance system integrating clinical monitoring with performance assessment. In 2020, the Tianjin government introduced digital

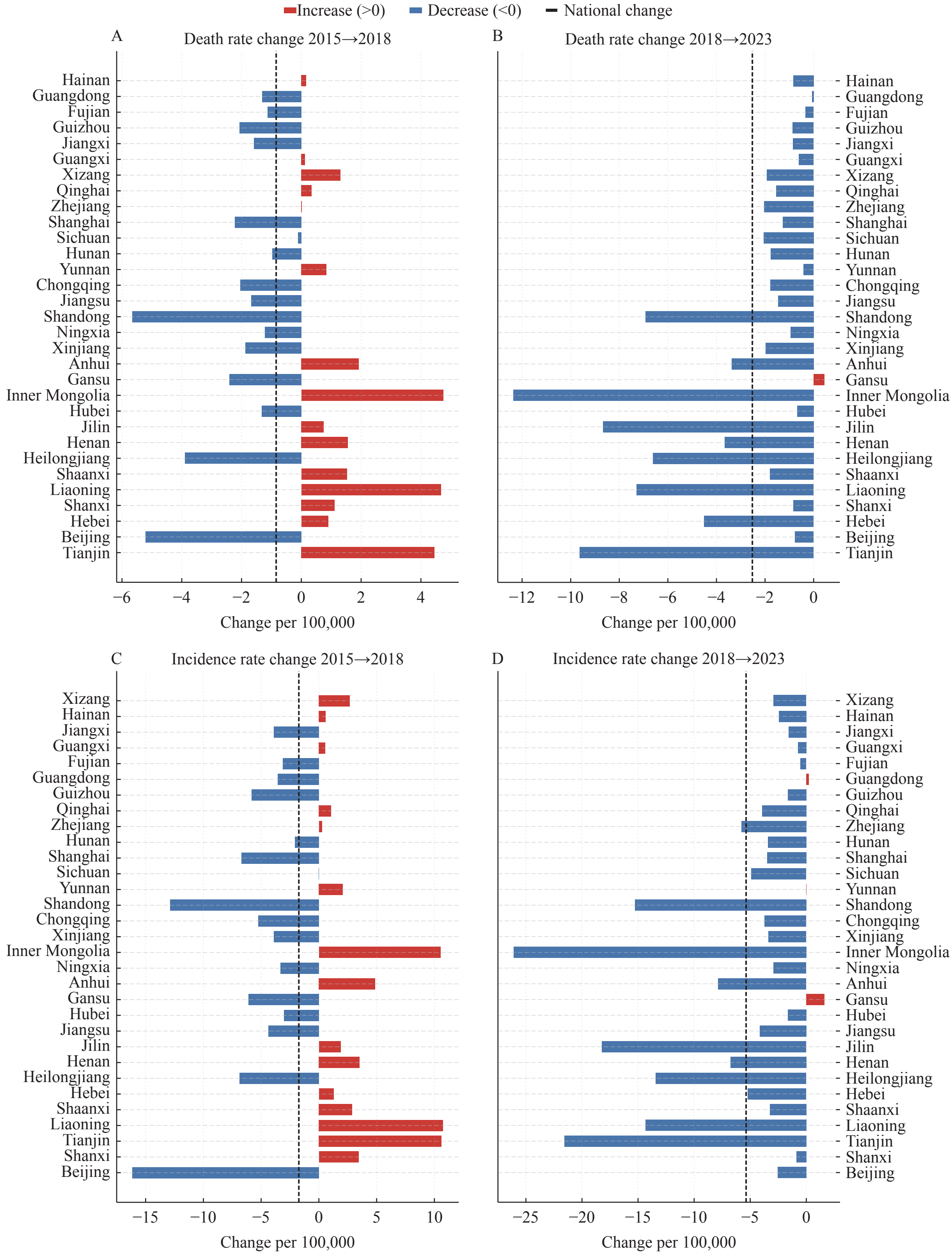

FIGURE 2. Province-level changes in CVD mortality and morbidity attributable to potentially inappropriate preventive medication use, China, 2015–2018 and 2018–2023. (A) Death rate change 2015−2018; (B) Death rate change 2018−2023; (C) Incidence rate change 2015−2018; (D) Incidence rate change 2018−2023.

Note: Estimates were derived from province-specific population attributable fractions applied to provincial mortality and morbidity data.

health community platforms at the primary care level across four districts — Hebei, Jinnan, Dongli, and Xiqing (*10*). PIM use was restricted through an online, AI-enabled prescription review system. These coordinated policy actions likely played a key role in reducing PIM-attributable CVD deaths and incidence after 2018.

Several limitations of this study should be acknowledged. First, untreated individuals who were unaware of having hypertension but met diagnostic thresholds, and those unaware of having diabetes despite elevated fasting blood glucose (≥7.0 mmol/L) or hemoglobin A1c (≥6.5%), were not classified as receiving PIM. Consequently, our estimates may underestimate the burden among individuals who should have received pharmacotherapy but did not. Second, we used International Classification of Diseases, 10th Revision (I00–I99) codes to identify CVDs in real-world settings; however, this approach may obscure differences among specific CVD subtypes. Third, we analyzed mortality and morbidity but not disability-adjusted life years. Fourth, causal inferences regarding policy interventions require further validation. Lastly, while sensitivity analyses were not conducted, the robustness of our findings is supported by the large sample size, high response rates, and consistent patterns across demographic strata and survey years.

In conclusion, although progress in rational medication use for CVD prevention is evident, gaps persist across regions and populations. Establishing population-based medication surveillance and integrating rational-use training and public education into basic public health services — particularly in northern and northeastern provinces — are essential for further reduce the CVD burden attributable to PIM.

Conflicts of interest: The authors declare no conflicts of interest.

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Preplanned Studies

Prevalence of Metabolic Dysfunction-Associated Steatotic Liver Disease with Clinically Significant Fibrosis in Obese Patients with Type 2 Diabetes Mellitus — China, 2017–2024

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Summary

What is already known about this topic?

Metabolic dysfunction-associated steatotic liver disease (MASLD) with clinically significant fibrosis substantially elevates the risk of liver-related complications and mortality. The American Diabetes Association consensus report specifically recommends systematic risk stratification for MASLD and hepatic fibrosis in patients with type 2 diabetes mellitus (T2DM), with particular emphasis on those presenting with obesity.

What is added by this report?

This multicenter study demonstrates that obese patients with T2DM exhibit a substantially elevated prevalence of MASLD with clinically significant fibrosis compared to their non-obese counterparts (26.7% *vs.* 8.4%). Furthermore, the prevalence escalates progressively with the accumulation of cardiometabolic risk factors, highlighting the synergistic impact of multiple metabolic abnormalities on hepatic fibrosis development.

What are the implications for public health practice?

Our findings underscore the critical need for routine screening and integrated management of MASLD with clinically significant fibrosis in patients with T2DM, particularly those presenting with obesity and multiple cardiometabolic risk factors.

ABSTRACT

Introduction: This study investigated the prevalence of metabolic dysfunction-associated steatotic liver disease (MASLD) with clinically significant fibrosis among obese patients with type 2 diabetes mellitus (T2DM).

Methods: This multicenter study enrolled T2DM patients from tertiary hospitals and primary care facilities across 21 cities in China between 2017 and 2024. Clinically significant fibrosis was defined as liver stiffness measurement (LSM) ≥8 kPa assessed by vibration-controlled transient elastography (VCTE) or biopsy-confirmed fibrosis stage ≥F2.

Results: Of the 10,281 patients included, 9,725 comprised the VCTE cohort (5,171 from clinics and 4,554 from primary care), while 556 comprised the biopsy cohort. Overall, 25.6% were obese. The prevalence of MASLD with clinically significant fibrosis reached 26.7% in obese patients, significantly exceeding that in non-obese patients (8.4%). This prevalence increased progressively with rising body mass index and demonstrated a strong association with the number of cardiometabolic risk factors. Furthermore, a non-invasive model incorporating age, waist circumference, alanine aminotransferase, total bilirubin, and triglycerides exhibited reliable performance in stratifying the risk of MASLD with clinically significant fibrosis among obese patients with T2DM [Area under the receiver operating characteristic curve (AUC): 0.799 (95% *CI*: 0.767–0.832)].

Conclusions: MASLD with clinically significant fibrosis is highly prevalent among obese patients with T2DM, emphasizing the necessity for systematic risk stratification and integrated management of these interconnected metabolic conditions.

Metabolic dysfunction-associated steatotic liver disease (MASLD) affects approximately 38% of the global adult population, with its prevalence rising in parallel with the growing burden of metabolic disorders (*1*). The progression to clinically significant fibrosis substantially elevates the risk of liver-related complications, including cirrhosis and hepatocellular carcinoma (*2*). Cardiometabolic risk factors (CMRFs), particularly type 2 diabetes mellitus (T2DM) and obesity, frequently coexist with MASLD and further accelerate disease progression (*3*). Recognizing this critical intersection, the recent American Diabetes Association (ADA) consensus report recommends systematic risk stratification for MASLD and liver fibrosis in adults with T2DM, especially those with obesity (*2*). Despite these recommendations, comprehensive prevalence data and risk factor analyses for MASLD with clinically significant fibrosis among patients with both obesity and T2DM in China remain scarce. To address this knowledge gap, we conducted a large-scale multicenter study to evaluate the prevalence of MASLD with clinically significant fibrosis in obese patients with T2DM and to identify associated risk factors. Additionally, we systematically examined how five CMRFs, individually and in combination, contribute to the development of clinically significant fibrosis in this high-risk population.

This prospective multicenter study enrolled adult patients with T2DM from tertiary hospitals and primary care facilities across 21 cities in China (Supplementary Table S1, available at https://weekly.chinacdc.cn/). The study comprised two cohorts: the vibration-controlled transient elastography (VCTE) cohort included patients who underwent VCTE examination between 2022 and 2024, while the liver biopsy cohort included patients with MASLD and T2DM who underwent liver biopsy between 2017 and 2024 (Supplementary Figure S1, available at https://weekly.chinacdc.cn/). All VCTE examinations were performed using the FibroScan® device (Echosens, Paris, France) according to standardized protocols. Clinically significant fibrosis was defined as liver stiffness measurement (LSM) ≥8 kPa in the VCTE cohort or histological fibrosis stage ≥F2 in the biopsy cohort, consistent with our previous study (*4*). Statistical analyses were conducted using SPSS (version 27.0.1, IBM SPSS Statistics, Armonk, NY, USA) and GraphPad Prism (version 10.0; GraphPad Software, San Diego, CA, USA). Additional methodological details, including exclusion criteria, VCTE reliability standards, histological assessment procedures, and statistical methods, are provided in the Supplementary Materials (available at https://weekly.chinacdc.cn/).

A total of 10,281 participants were enrolled from two cohorts. The VCTE cohort comprised 9,725 participants (50.0% male; 24.5% obese). Obese patients were younger than their non-obese counterparts [49.4 (14.34) *vs.* 56.6 (13.18) years] (Table 1). Of these, 5,171 patients were recruited from clinics and 4,554 from primary care settings. Patients in primary care were older [61.4 (10.39) *vs.* 49.0 (13.87) years] and had a lower obesity prevalence (16.6% *vs.* 31.5%) compared to those in clinics (Supplementary Table S2, available at https://weekly.chinacdc.cn/). The liver biopsy cohort included 556 biopsy-proven MASLD patients with T2DM (48.9% male; 44.1% obese) (Table 2).

In the VCTE cohort, the overall prevalence of MASLD, MASLD with clinically significant fibrosis, advanced fibrosis, and cirrhosis in T2DM patients was 59.7%, 13.0%, 6.8%, and 3.1%, respectively (Figure 1A). Obese patients with T2DM demonstrated significantly higher prevalence rates across all fibrosis stages compared to non-obese patients with T2DM, with MASLD with clinically significant fibrosis at 26.7% *vs.* 8.4% (P<0.001) (Figure 1B).

The prevalence of MASLD with cirrhosis in obese T2DM patients was higher in clinics than in primary care (Figure 1C). Non-obese T2DM patients in clinics exhibited lower prevalence rates of MASLD, clinically significant fibrosis, and advanced fibrosis compared to those in primary care (Figure 1D). Notably, MASLD and fibrosis prevalence increased progressively with body mass index (BMI), reaching the highest levels in obese patients compared to underweight, normal weight, and overweight groups (Supplementary Figure S2A, available at https://weekly.chinacdc.cn/). Moreover, among obese patients, applying different BMI cutoff values to define obesity classes revealed generally similar trends (Supplementary Figure S2B).

Sensitivity analyses using alternative definitions of central obesity yielded results consistent with those based on BMI-defined obesity, confirming higher MASLD and fibrosis prevalence in obese patients with T2DM in the VCTE cohort (Supplementary Figure S3A–I, available at https://weekly.chinacdc.cn/). However, no significant difference in the prevalence of MASLD with clinically significant fibrosis was observed between obese and non-obese patients in the liver biopsy cohort (Supplementary Figure S3J–M).

As the number of CMRFs increased, the prevalence of MASLD with clinically significant fibrosis also rose, reaching its peak among patients with five CMRFs (including T2DM) (Supplementary Figure S3N). The prevalence in T2DM patients with additional CMRFs was higher than that in those with

TABLE 1. Baseline characteristics of patients with type 2 diabetes mellitus stratified by obesity status in the VCTE cohort.

Characteristic	Overall (*N*=9,725)	Non-obese (*n*=7,338)	Obese (*n*=2,387)	*P*
Age, years	54.8 (13.82)	56.6 (13.18)	49.4 (14.34)	<0.001
Groups				<0.001
18 to 59 years	5,665 (58.3%)	3,932 (53.6%)	1,733 (72.6%)	
≥60 years	4,060 (41.7%)	3,406 (46.4%)	654 (27.4%)	
Sex, *n* (%)				<0.001
Male	4,865 (50.0%)	3,471 (47.3%)	1,394 (58.4%)	
Female	4,860 (50.0%)	3,867 (52.7%)	993 (41.6%)	
BMI, kg/m^2	25.8 (4.11)	24.0 (2.48)	31.2 (3.33)	<0.001
Waist circumference, cm (*n*=8,101)	89.9 (10.98)	86.5 (8.51)	101.7 (10.41)	<0.001
Hypertension (*n*=8,925)	5,745 (64.4%)	4,292 (62.6%)	1,453 (70.2%)	<0.001
Dyslipidemia (*n*=3,493)	2,374 (67.9%)	1,595 (63.3%)	779 (80.0%)	<0.001
Platelet count, ×10^9/L (*n*=3,492)	237.4 (69.82)	233.2 (68.54)	248.6 (72.05)	<0.001
GGT, IU/L (*n*=2,498)	51.3 (97.28)	48.0 (107.53)	58.3 (69.99)	0.005
ALT, IU/L (*n*=3,802)	38.7 (108.53)	35.1 (123.84)	48.3 (44.95)	<0.001
AST, IU/L (*n*=3,802)	30.2 (77.29)	29.2 (89.11)	32.8 (25.33)	0.054
ALB, g/L (*n*=3,753)	44.5 (4.17)	44.5 (4.23)	44.6 (3.98)	0.566
TBIL, μmol/L (*n*=3,791)	16.1 (12.05)	16.6 (13.42)	14.5 (6.83)	<0.001
Scr, μmol/L (*n*=3,553)	151.2 (1,252.23)	96.7 (700.65)	296.7 (2,101.16)	0.004
UA, μmol/L (*n*=3,545)	356.9 (103.00)	340.4 (95.74)	400.9 (108.60)	<0.001
HbA1c, % (*n*=3,004)	7.1 (1.80)	7.1 (1.80)	7.3 (1.78)	0.007
TC, mmol/L (*n*=3,494)	5.1 (1.27)	5.1 (1.31)	5.1 (1.17)	0.151
TG, mmol/L (*n*=3,494)	2.2 (2.42)	2.0 (2.34)	2.6 (2.55)	<0.001
HDL-C, mmol/L (*n*=3,492)	1.3 (0.33)	1.3 (0.35)	1.2 (0.27)	<0.001
LDL-C, mmol/L (*n*=3,494)	3.0 (3.69)	3.0 (4.32)	3.0 (0.87)	0.894
CAP, dB/m	260.9 (55.77)	250.5 (54.40)	293.1 (46.98)	<0.001
CAP ≥248 dB/m	5,807 (59.7%)	3,783 (51.6%)	2,024 (84.8%)	<0.001
CAP ≥268 dB/m	4,452 (45.8%)	2,736 (37.3%)	1,716 (71.9%)	<0.001
CAP ≥280 dB/m	3,687 (37.9%)	2,205 (30.0%)	1,482 (62.1%)	<0.001
LSM, kPa	6.9 (6.00)	6.5 (5.74)	8.0 (6.60)	<0.001
LSM ≥6.8 kPa	2,972 (30.6%)	1,865 (25.4%)	1,107 (46.4%)	<0.001
LSM ≥8.0 kPa	1,817 (18.7%)	1,096 (14.9%)	721 (30.2%)	<0.001
LSM ≥10.0 kPa	1,020 (10.5%)	613 (8.4%)	407 (17.1%)	<0.001
LSM ≥13.0 kPa	529 (5.4%)	329 (4.5%)	200 (8.4%)	<0.001

Note: Data are presented as mean (SD) or *n* (%).

Abbreviation: VCTE=vibration-controlled transient elastography; ALB=albumin; ALT=alanine aminotransferase; AST=aspartate aminotransferase; BMI=body mass index; CAP=controlled attenuation parameter; GGT=gamma-glutamyltransferase; HbA1c=hemoglobin A1c; HDL-C=high-density lipoprotein cholesterol; LDL-C=low-density lipoprotein cholesterol; LSM=liver stiffness measurement; Scr=serum creatinine; SD=standard deviation; TBIL=total bilirubin; TC=total cholesterol; TG=triglyceride; UA=uric acid.

T2DM alone. In the VCTE cohort, the risk of MASLD with clinically significant fibrosis increased progressively as the number of CMRFs accumulated (Table 3). Among all combinations of T2DM with other CMRFs, T2DM combined with overweight/obesity conferred the highest risk. This association remained statistically significant after adjusting for age and sex.

Multivariate logistic regression analysis identified five independent risk factors for MASLD with clinically significant fibrosis: age, waist circumference, alanine aminotransferase (ALT), total bilirubin (TBIL), and triglyceride (TG). Using these variables, we constructed a non-invasive predictive model for risk

TABLE 2. Baseline characteristics of patients with type 2 diabetes mellitus stratified by obesity status in the liver biopsy cohort.

Characteristic	Overall (*N*=556)	Non-obese (*n*=311)	Obese (*n*=245)	*P*
Age, years	46.6 (12.98)	49.8 (11.69)	42.5 (13.41)	<0.001
Groups				0.001
18 to 59 years	470 (84.5%)	249 (80.1%)	221 (90.2%)	
≥60 years	86 (15.5%)	62 (19.9%)	24 (9.8%)	
Sex, *n* (%)				<0.001
Male	272 (48.9%)	131 (42.1%)	141 (57.6%)	
Female	284 (51.1%)	180 (57.9%)	104 (42.4%)	
BMI, kg/m^2	27.7 (4.14)	24.8 (2.05)	31.4 (3.04)	<0.001
Waist circumference, cm (*n*=393)	95.2 (10.09	89.2 (6.91)	101.9 (8.77)	<0.001
Hypertension (*n*=249)	187 (75.1%)	103 (71.0%)	84 (80.8%)	0.080
Dyslipidemia (*n*=503)	405 (80.5%)	215 (75.7%)	190 (86.8%)	0.002
Platelet count, ×10^9/L	225.5 (65.26)	217.3 (59.69)	235.8 (70.47)	0.001
GGT, IU/L (*n*=387)	89.1 (104.75)	89.6 (112.37)	88.4 (92.40)	0.906
ALT, IU/L	75.4 (58.04)	67.0 (49.52)	86.1 (65.89)	<0.001
AST, IU/L	58.6 (60.39)	53.3 (38.44)	65.3 (79.60)	0.031
ALB, g/L (*n*=551)	43.7 (4.69)	43.5 (4.17)	43.9 (5.29)	0.322
TBIL, μmol/L (*n*=551)	13.3 (6.89)	13.1 (6.92)	13.6 (6.86)	0.337
Scr, μmol/L (*n*=416)	63.4 (15.31)	61.2 (14.97)	66.0 (15.33)	0.001
UA, μmol/L (*n*=414)	364.0 (93.67)	345.7 (92.32)	384.9 (90.99)	<0.001
HbA1c, % (*n*=303)	7.6 (1.80)	7.4 (1.70)	7.8 (1.91)	0.080
TC, mmol/L (*n*=499)	4.9 (1.27)	4.9 (1.25)	5.0 (1.29)	0.396
TG, mmol/L (*n*=499)	2.5 (2.54)	2.3 (2.21)	2.8 (2.88)	0.017
HDL-C, mmol/L (*n*=499)	1.4 (0.96)	1.5 (1.04)	1.3 (0.82)	<0.001
LDL-C, mmol/L (*n*=499)	2.5 (1.09)	2.4 (1.08)	2.7 (1.09)	0.006
CAP, dB/m (*n*=370)	302.7 (42.64)	295.2 (42.88)	313.8 (39.92)	<0.001
LSM, kPa (*n*=368)	10.2 (6.66)	9.7 (6.31)	11.0 (7.08)	0.067
Liver steatosis				0.073
S0	20 (3.6%)	15 (4.8%)	5 (2.0%)	
S1	175 (31.5%)	107 (34.5%)	68 (27.8%)	
S2	235 (42.3%)	124 (40.0%)	111 (45.3%)	
S3	125 (22.5%)	64 (20.6%)	61 (24.9%)	
Liver fibrosis				0.394
F0-F1	297 (53.4%)	173 (55.6%)	124 (50.6%)	
F2	133 (23.9%)	66 (21.2%)	67 (27.3%)	
F3	89 (16.0%)	50 (16.1%)	39 (15.9%)	
F4	37 (6.7%)	22 (7.1%)	15 (6.1%)	

Note: Data are presented as mean (SD) or *n* (%).

Abbreviation: ALB=albumin; ALT=alanine aminotransferase; AST=aspartate aminotransferase; BMI=body mass index; CAP=controlled attenuation parameter; GGT=gamma-glutamyltransferase; HbA1c=hemoglobin A1c; HDL-C=high-density lipoprotein cholesterol; LDL-C=low-density lipoprotein cholesterol; LSM=liver stiffness measurement; Scr=serum creatinine; SD=standard deviation; TBIL=total bilirubin; TC=total cholesterol; TG=triglyceride; UA=uric acid.

stratification of MASLD with clinically significant fibrosis in obese patients with T2DM, expressed by the following formula:

Model = −10.983 + 0.025 × Age (years) + 0.074 ×

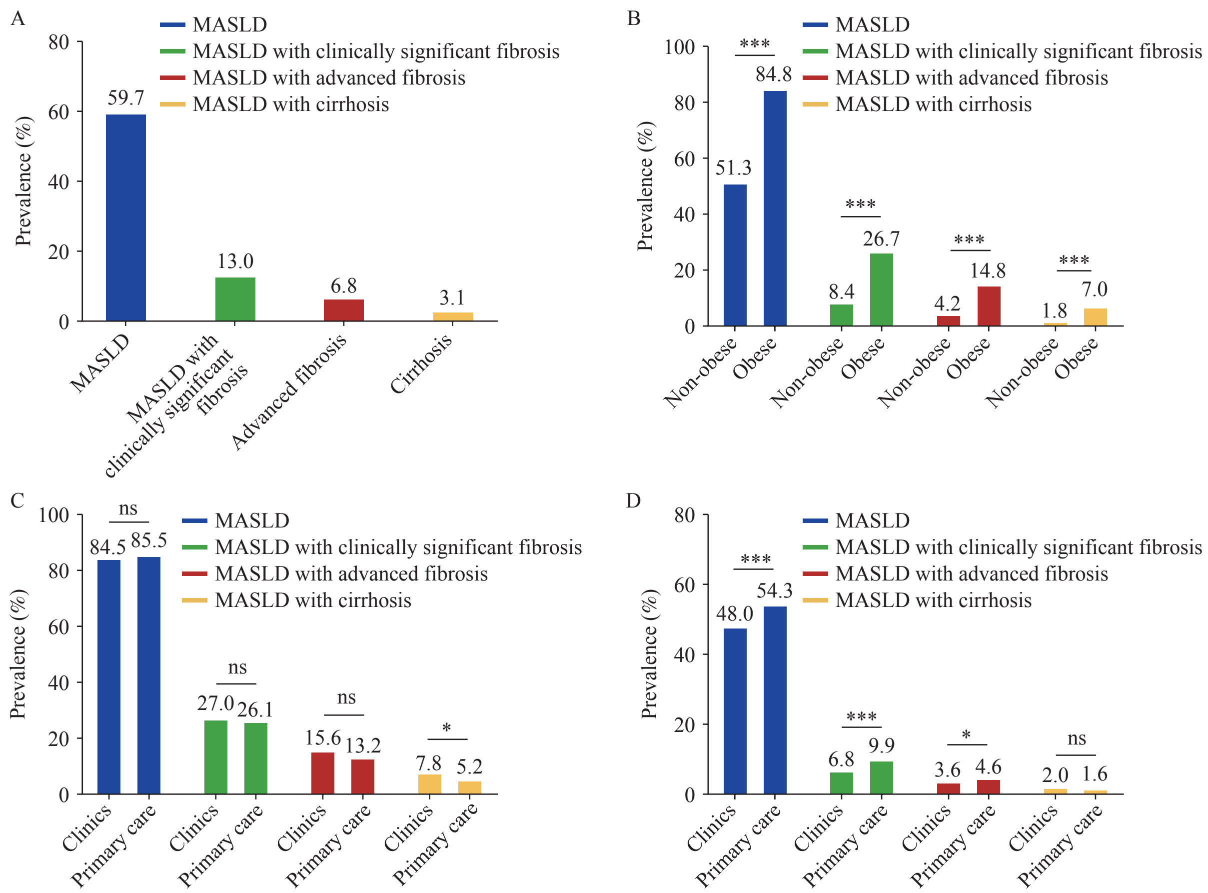

FIGURE 1. Prevalence of MASLD and liver fibrosis stages among patients with type 2 diabetes mellitus. (A) Overall prevalence across all patients; (B) Comparison between obese and non-obese patient groups; (C) Comparison within obese patients: clinic-based versus primary care settings; (D) Comparison within non-obese patients: clinic-based versus primary care settings.
* *P*<0.05; *** *P*<0.001; ns, not significant.
Abbreviation: MASLD=metabolic dysfunction-associated steatotic liver disease.

waist circumference (cm) + 0.015 × ALT (IU/L) − 0.076 × TBIL (μmol/L) + 0.223 × TG (mmol/L)

The model demonstrated robust discriminatory performance, with an area under the receiver operating characteristic curve of 0.799 (95% *CI*: 0.767–0.832). A cutoff value of −2.197 achieved ≥95% sensitivity for excluding clinically significant fibrosis, whereas a cutoff of 0.405 achieved ≥95% specificity for confirming clinically significant fibrosis.

DISCUSSION

This large-scale, multicenter prospective study represents the first comprehensive assessment of MASLD with clinically significant fibrosis prevalence and associated risk factors among patients with T2DM in China. Our findings revealed that 59.7% of T2DM patients had MASLD, and 13.0% had clinically significant fibrosis, with the prevalence increasing progressively with rising BMI. Notably, obese patients with T2DM exhibited a substantially higher prevalence of MASLD with clinically significant fibrosis compared to their non-obese counterparts (26.7% *vs.* 8.4%, *P*<0.001). Furthermore, the prevalence escalated with accumulating CMRFs, with the combination of T2DM and overweight/obesity conferring the greatest risk. Additionally, our non-invasive predictive model incorporating age, waist circumference, ALT, TBIL, and TG demonstrated robust diagnostic performance for identifying clinically significant fibrosis.

Our previous research characterized the bidirectional relationship between T2DM and MASLD (*5*). Younossi et al. (*6*) reported pooled all-cause and liver-specific mortality rates of 16.79 and 2.15 per 1,000 person-years, respectively, among MASLD patients with T2DM. In comparison, our study identified a MASLD prevalence of 59.7% in T2DM patients,

TABLE 3. Logistic regression analyses evaluating associations between cardiometabolic risk factors and MASLD with clinically significant fibrosis in the VCTE and liver biopsy cohorts.

Characteristic	VCTE cohort			Liver biopsy cohort		
	OR	95% *CI*	*P*	*OR*	95% *CI*	*P*
Number of CMRF(s) (unadjusted)						
1 CMRF (only T2DM)	Reference					
T2DM + Any 1 CMRF	1.87	1.15–3.05	0.012	3.54	1.49–8.44	0.004
T2DM + Any 2 CMRFs	2.46	1.54–3.93	<0.001	2.77	1.18–6.54	0.020
T2DM + Any 3 CMRFs	3.35	2.10–5.34	<0.001	2.67	1.14–6.24	0.023
T2DM + 4 CMRFs	4.19	2.52–6.96	<0.001	2.13	0.85–5.35	0.108
Number of CMRF(s) (age- and sex-adjusted)						
1 CMRF (only T2DM)	Reference					
T2DM + Any 1 CMRF	1.87	1.15–3.05	0.012	3.52	1.46–8.46	0.005
T2DM + Any 2 CMRFs	2.44	1.53–3.90	<0.001	2.78	1.17–6.63	0.021
T2DM + Any 3 CMRFs	3.31	2.07–5.27	<0.001	2.77	1.17–6.54	0.020
T2DM + 4 CMRFs	4.09	2.46–6.82	<0.001	2.22	0.87–5.69	0.095

Abbreviation: *CI*=confidence interval; CMRF=cardiometabolic risk factor; MASLD=metabolic dysfunction-associated steatotic liver disease; *OR*=odds ratio; T2DM=type 2 diabetes mellitus; VCTE=vibration-controlled transient elastography.

slightly lower than the 65.04% reported by a recent meta-analysis (*7*). These discrepancies likely reflect variations in diagnostic methodologies, population demographics, and study inclusion criteria. Specifically, differences in imaging modalities (ultrasound versus VCTE), ethnic composition, and metabolic disease severity across cohorts may contribute to the observed variations. Nevertheless, the prevalence remains substantial, underscoring the critical need for systematic liver disease screening in this high-risk population.

MASLD with clinically significant fibrosis represents a pivotal disease stage associated with elevated risks of cirrhosis, hepatocellular carcinoma, and liver-related mortality (*2*). The recent ADA consensus report recommended routine assessment for MASLD and liver fibrosis in T2DM patients with obesity (*2*). In our cohort, the prevalence of MASLD with clinically significant fibrosis was 13.0% among all T2DM patients and 26.7% among those with obesity, highlighting the strong association between adiposity and hepatic fibrosis progression. By comparison, Cho et al. (*7*) reported a higher prevalence of 35.54%. This discrepancy likely reflects the more severe disease spectrum in meta-analyses that predominantly included patients referred for specialist evaluation rather than population-based cohorts. Our findings emphasize that obesity, regardless of the anthropometric measurement used, substantially increases the burden of clinically significant fibrosis in T2DM patients.

Obesity serves as a critical driver of liver disease progression in patients with T2DM and MASLD (*8*). Our sensitivity analyses employing multiple obesity definitions, including BMI, waist circumference, waist-hip ratio, and waist-height ratio, revealed varying prevalence estimates of MASLD with clinically significant fibrosis, ranging from 14.4% to 26.7% in the VCTE cohort and from 29.6% to 49.4% in the liver biopsy cohort. These findings underscore the substantial liver disease burden associated with excess adiposity, regardless of the anthropometric measurement used. Moreover, they suggest that simple anthropometric indices beyond BMI may offer additional insights into metabolic risk and fibrosis burden in patients with T2DM and obesity (*9*).

CMRFs, such as hypertension, dyslipidemia, and obesity, demonstrated strong associations with MASLD with clinically significant fibrosis (*3*,*10*). The prevalence of clinically significant fibrosis increased progressively with the accumulation of CMRFs, even after adjusting for age and sex, suggesting additive or potentially synergistic effects. Notably, the combination of T2DM with overweight or obesity conferred the highest risk among all CMRF combinations, emphasizing the interconnected pathophysiology of metabolic dysfunction and liver disease. Furthermore, sex, waist circumference, AST, ALB, TBIL, and HbA1c emerged as independent risk factors for clinically significant fibrosis, with restricted cubic spline analyses revealing non-linear associations with liver fibrosis risk.

This study demonstrates several notable strengths. First, it represents one of the largest multicenter prospective investigations assessing the prevalence of MASLD with clinically significant fibrosis in Chinese patients with T2DM, thereby providing robust and generalizable estimates. Second, we employed both VCTE, a widely validated non-invasive assessment tool, and liver biopsy, the gold standard for fibrosis diagnosis, thereby minimizing diagnostic misclassification. Third, we conducted comprehensive sensitivity analyses using multiple obesity definitions to validate the consistency of our findings across different anthropometric measures. Finally, we developed a novel non-invasive model that may facilitate risk stratification for clinically significant fibrosis in this high-risk population.

However, several limitations warrant consideration. First, blood sample data were incomplete for some patients, and information on medication use (e.g., antidiabetic, lipid-lowering, or hepatoprotective agents) was unavailable, potentially introducing residual confounding. Additionally, incomplete laboratory data may have modestly reduced the accuracy and generalizability of our prediction model. Future studies incorporating more comprehensive data collection are needed to validate our findings. Second, VCTE accuracy may be compromised in patients with severe obesity, potentially introducing measurement bias in LSM values. Nevertheless, our subgroup analysis stratified by BMI demonstrated generally consistent results across obesity categories. Finally, the cross-sectional design precludes causal inference regarding the observed associations between metabolic variables and liver fibrosis. Longitudinal studies are warranted to establish temporal relationships and validate the proposed risk stratification model.

In conclusion, our study demonstrates a high prevalence of MASLD with clinically significant fibrosis among T2DM patients, particularly those with obesity and multiple CMRFs. These findings underscore the critical importance of routine liver fibrosis screening and integrated management of metabolic risk factors to mitigate liver-related complications in this high-risk population.

Conflicts of interest: No conflicts of interest.

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Ethical statement: Conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The Ethics Committee of Zhongda Hospital, Medical School, Southeast University, approved the study protocol (approval number: 2024ZDSYLL398-P01). All participants provided written informed consent prior to enrollment.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Distribution of the data.

No.	City	Sample size	
		VCTE cohort (*n*=9,725)	Biopsy cohort (*n*=556)
01	Baotou	222	−
02	Bozhou	543	−
03	Hangzhou	−	53
04	Huozhou	1,198	−
05	Jinhua	736	−
06	Lishui	57	−
07	Nanjing	1,242	−
08	Ningxia	166	−
09	Ningbo	−	51
10	Qiqihar	279	−
11	Qingdao	173	2
12	Shanghai	39	167
13	Shenyang	1,164	87
14	Shiyan	210	−
15	Shunde	1,359	−
16	Suining	94	−
17	Wenzhou	−	194
18	Wuwei	10	−
19	Xingtai	989	−
20	Zhengzhou	765	2
21	Zhuhai	479	−

Note: "−" means data was not available.
Abbreviation: VCTE=vibration-controlled transient elastography.

Exclusion Criteria

Patients were excluded if they met any of the following criteria: 1) type 1 diabetes mellitus (DM); 2) gestational DM; 3) other specific types of DM; 4) missing body mass index (BMI) data; 5) alcohol consumption exceeding 20 g/day (females) or 30 g/day (males); 6) inability to undergo vibration-controlled transient elastography (VCTE) or liver biopsy; 7) an interval exceeding one month between VCTE or liver biopsy and blood sample collection.

Vibration-controlled Transient Elastography and Liver Biopsy Assessment

Trained operators, blinded to participants' clinical and laboratory data, performed VCTE using FibroScan with M and XL probes following standardized protocols (*1*). Examinations were deemed reliable when ≥10 valid measurements were obtained with an interquartile range/median ratio <30%. Histological slides were evaluated at each participating center according to standard procedures (*2*) by pathologists who remained blinded to all clinical information.

Logistic Regression Analyses

We employed logistic regression analyses to evaluate associations between cardiometabolic risk factors (CMRFs) and metabolic dysfunction-associated steatotic liver disease (MASLD) with clinically significant fibrosis, as well as to identify independent risk factors for this condition. Variables demonstrating P values <0.05 in univariate analyses were subsequently entered into multivariate models. Missing data were handled through multiple imputation, generating five datasets with a seed value of 1,234.

SUPPLEMENTARY TABLE S2. Baseline characteristics of patients with type 2 diabetes mellitus stratified by clinical setting.

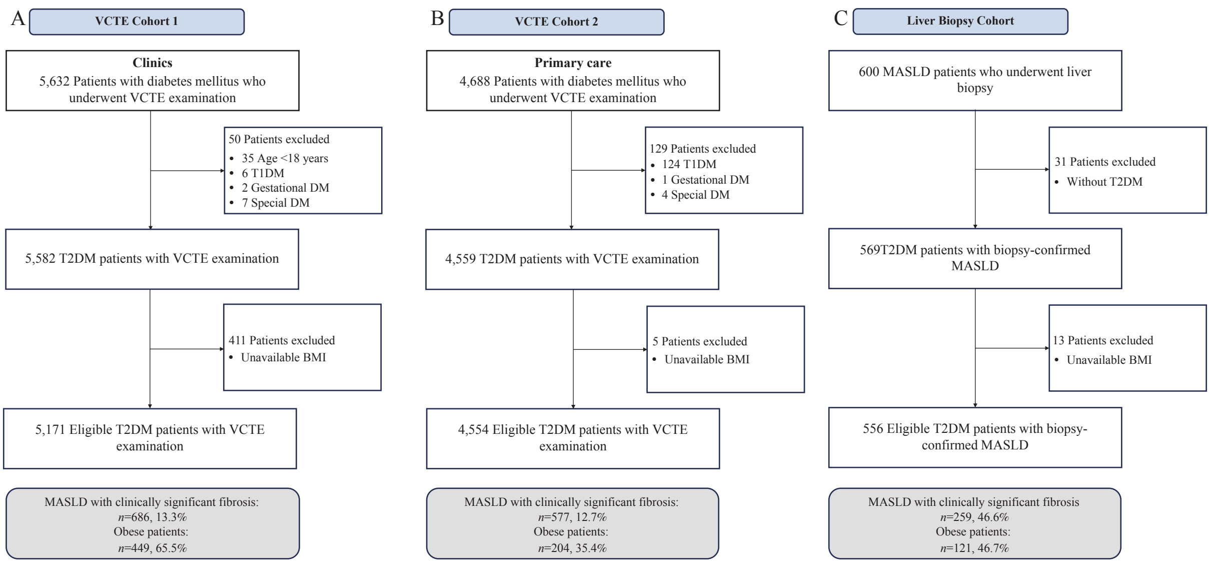
Characteristic	Clinics (*n*=5,171)	Primary care (*n*=4,554)	*P*
Age, years	49.0 (13.87)	61.4 (10.39)	<0.001
Groups			<0.001
18 to 59 years	3,867 (74.8%)	1,798 (39.5%)	
≥60 years	1,304 (25.2%)	2,756 (60.5%)	
Sex, *n* (%)			<0.001
Male	3,180 (61.5%)	1,685 (37.0%)	
Female	1,991 (38.5%)	2,869 (63.0%)	
BMI, kg/m^2	26.5 (14.53)	25.0 (13.38)	<0.001
Groups			<0.001
≥28.0 kg/m²	1,629 (31.5%)	758 (16.6%)	
<28.0 kg/m²	3,542 (68.5%)	3,796 (83.4%)	
Waist circumference, cm (*n*=8,101)	92.6 (11.94)	87.9 (9.66)	<0.001
Hypertension (*n*=8,925)	2,240 (51.0%)	3,505 (77.4%)	<0.001
Dyslipidemia (*n*=3,494)	1,569 (71.3%)	805 (62.3%)	<0.001
Platelet count, ×10^9/L (*n*=3,492)	226.2 (68.73)	256.4 (67.56)	<0.001
GGT, IU/L (*n*=2,498)	51.3 (97.28)	−	−
ALT, IU/L (*n*=3,802)	43.7 (132.56)	28.9 (19.93)	<0.001
AST, IU/L (*n*=3,802)	32.8 (94.71)	25.1 (11.14)	<0.001
ALB, g/L (*n*=3,753)	43.7 (4.59)	46.2 (2.48)	<0.001
TBIL, μmol/L (*n*=3,791)	16.2 (14.15)	15.8 (6.22)	0.205
Scr, μmol/L (*n*=3,553)	195.7 (1,568.39)	73.4 (23.14)	<0.001
UA, μmol/L (*n*=3,545)	352.5 (100.64)	364.7 (106.59)	<0.001
HbA1c, % (*n*=3,004)	7.4 (2.03)	6.7 (1.32)	<0.001
TC, mmol/L (*n*=3,494)	4.9 (1.27)	5.5 (1.17)	<0.001
TG, mmol/L (*n*=3,494)	2.2 (2.53)	2.1 (2.21)	0.099
HDL-C, mmol/L (*n*=3,492)	1.2 (0.32)	1.4 (0.33)	<0.001
LDL-C, mmol/L (*n*=3,494)	2.9 (4.61)	3.1 (0.80)	0.101
CAP, dB/m	260.7 (55.27)	261.2 (56.35)	0.647
CAP ≥248 dB/m	3,088 (59.7%)	2,719 (59.7%)	0.990
CAP ≥268 dB/m	2,377 (46.0%)	2,075 (45.6%)	0.690
CAP ≥280 dB/m	1,977 (38.2%)	1,710 (37.5%)	0.488
LSM, kPa	7.4 (7.59)	6.3 (3.29)	<0.001
LSM ≥6.8 kPa	1,602 (31.0%)	1,370 (30.1%)	0.338
LSM ≥8.0 kPa	1,051 (20.3%)	766 (16.8%)	<0.001
LSM ≥10.0 kPa	666 (12.9%)	354 (7.8%)	<0.001
LSM ≥13.0 kPa	399 (7.7%)	130 (2.9%)	*P*<0.001

Note: Data are presented as mean (SD) or *n* (%).

Abbreviation: ALB=albumin; ALT=alanine aminotransferase; AST=aspartate aminotransferase; BMI=body mass index; CAP=controlled attenuation parameter; GGT=gamma-glutamyltransferase; HbA1c=hemoglobin A1c; HDL-C=high-density lipoprotein cholesterol; LDL-C=low-density lipoprotein cholesterol; LSM=liver stiffness measurement; Scr=serum creatinine; SD=standard deviation; TBIL=total bilirubin; TC=total cholesterol; TG=triglyceride; UA=uric acid.

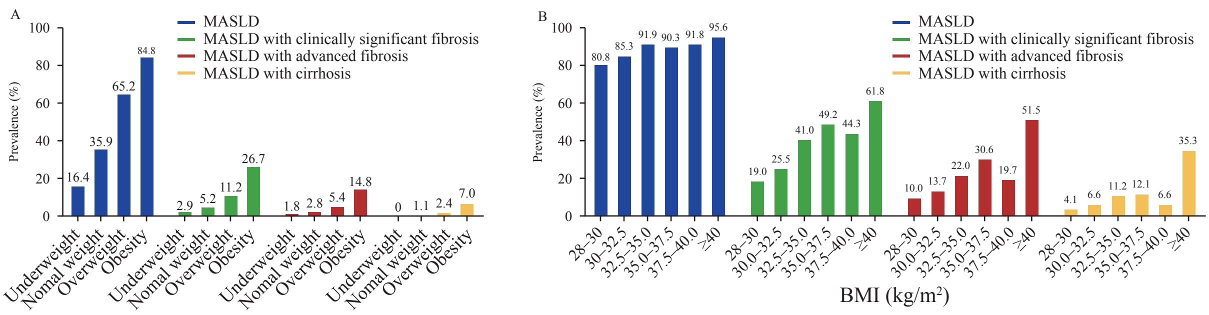
Sensitivity Analyses

To validate the robustness of our findings, we conducted sensitivity analyses using alternative obesity definitions: waist circumference, waist-to-hip ratio (WHR), and waist-to-height ratio (WHTR). These analyses confirmed the



SUPPLEMENTARY FIGURE S1. Study flow diagram.

Abbreviation: MASLD=metabolic dysfunction-associated steatotic liver disease; T2DM=type 2 diabetes mellitus; VCTE=vibration-controlled transient elastography.



SUPPLEMENTARY FIGURE S2. Prevalence of MASLD with clinically significant fibrosis among patients with type 2 diabetes mellitus in the VCTE cohort. (A) Prevalence in patients with T2DM stratified by BMI categories; (B) Prevalence in obese patients with T2DM according to different BMI cutoff values.

Abbreviation: BMI=body mass index; MASLD=metabolic dysfunction-associated steatotic liver disease; T2DM=type 2 diabetes mellitus; VCTE=vibration-controlled transient elastography.

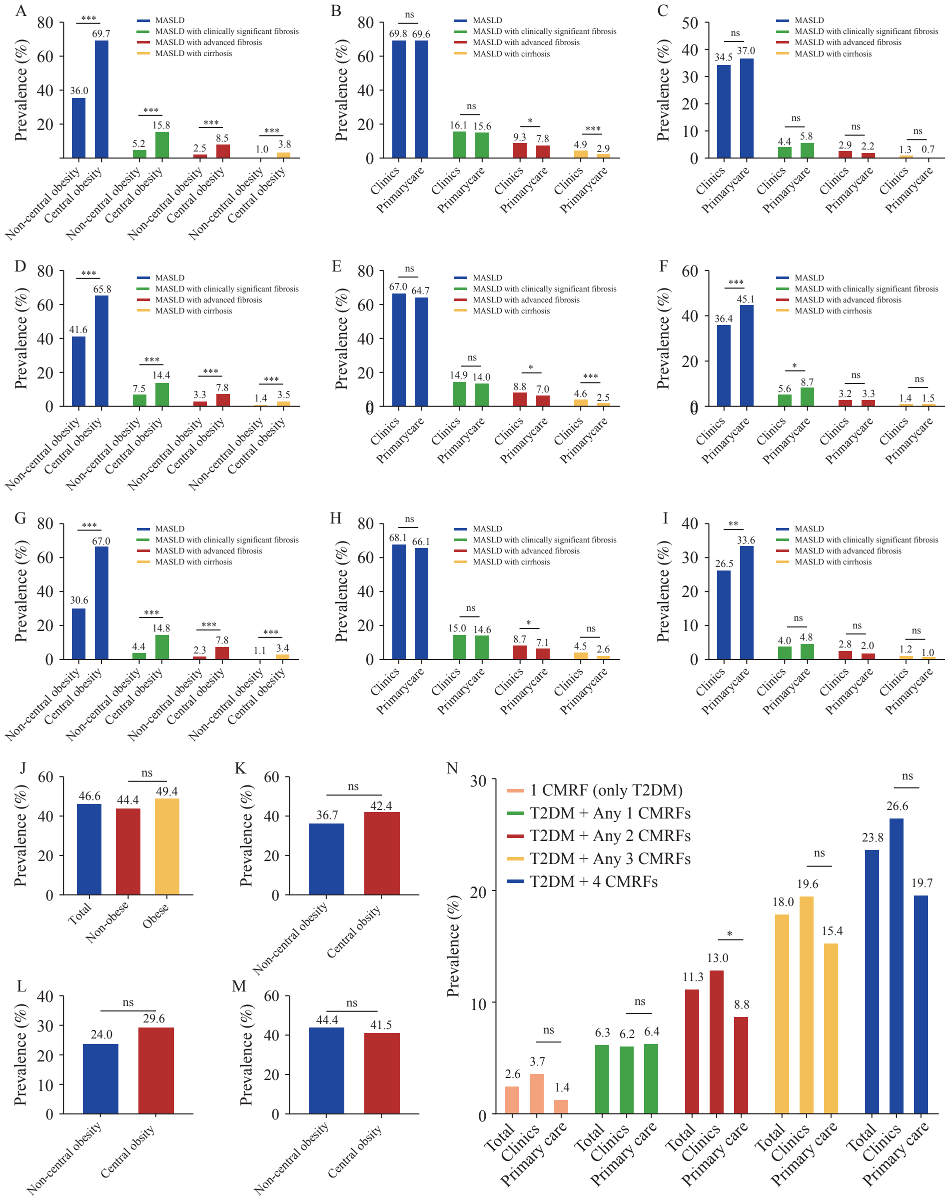
consistently elevated prevalence of MASLD with clinically significant fibrosis among patients with type 2 diabetes mellitus (T2DM). Additionally, we stratified prevalence estimates across different obesity classes using established cutoff values (*3*).

Statistical Analyses

Continuous variables are expressed as mean (SD), and categorical variables as n (%). Group differences were assessed using the chi-square test or Fisher's exact test for categorical variables, and Student's *t*-test or Mann-Whitney *U* test for continuous variables. A two-tailed $P<0.05$ was considered statistically significant.

Definitions

In the VCTE cohort, advanced fibrosis was defined as liver stiffness measurement (LSM) ≥10 kPa, and cirrhosis as LSM ≥13 kPa (*4*). Liver steatosis was identified as controlled attenuation parameter (CAP) ≥248 dB/m (*5*). Body mass index (BMI) categories were defined as follows: underweight <18.5 kg/m^2, normal weight 18.5–23.9 kg/m^2, overweight 24.0–27.9 kg/m^2, and obesity ≥28 kg/m^2 (*6*). Central obesity was identified as waist circumference ≥90 cm (males) or ≥80 cm (females)(*5*), waist-to-hip ratio (WHR) >0.9 (males) or >0.85 (females) (*7*), or waist-to-



SUPPLEMENTARY FIGURE S3. Prevalence of MASLD with clinically significant fibrosis among patients with type 2 diabetes mellitus. (A) Central obesity versus non-central obesity defined by waist circumference in the VCTE cohort; (B) Central obesity defined by waist circumference in the VCTE cohort: clinic-based versus primary care settings; (C) Non-central obesity defined by waist circumference in the VCTE cohort: clinic-based versus primary care settings; (D) Central obesity versus non-central obesity defined by waist-to-hip ratio in the VCTE cohort; (E) Central obesity defined by waist-to-hip ratio in the VCTE cohort: clinic-based versus primary care settings; (F) Non-central obesity defined by waist-to-hip ratio in the VCTE cohort: clinic-based versus primary care settings; (G) Central obesity versus non-central obesity defined by waist-to-height ratio in the VCTE cohort; (H) Central obesity defined by waist-to-height ratio in the VCTE cohort: clinic-based versus primary care settings; (I) Non-central obesity defined by waist-to-height ratio in the VCTE cohort: clinic-based versus primary care settings; (J) Obesity versus non-obesity defined by body mass index in the liver biopsy cohort; (K) Central obesity versus non-central obesity defined by waist circumference in the liver biopsy cohort; (L) Central obesity versus non-central obesity defined by waist-to-hip ratio in the liver biopsy cohort; (M) Central obesity versus non-central obesity defined by waist-to-height ratio in the liver biopsy cohort; (N) Prevalence stratified by the cumulative number of cardiometabolic risk factors.

Note: ns, no significance.

Abbreviations: BMI=body mass index; CMRFs=cardiometabolic risk factors; MASLD=metabolic dysfunction-associated steatotic liver disease; VCTE=vibration-controlled transient elastography; WC=waist circumference; WHR=waist-to-hip ratio; WHTR=waist-to-height ratio.

* *P*<0.05; ** *P*<0.01 *** *P*<0.001.

height ratio (WHTR) ≥0.5 (*8*).

Hypertension was defined as blood pressure ≥130/80 mmHg (*9*). Elevated alanine aminotransferase (ALT) or aspartate aminotransferase (AST) levels were defined as >40 IU/L (*10*). Dyslipidemia was diagnosed based on the following criteria: total cholesterol ≥6.22 mmol/L, triglycerides ≥1.70 mmol/L, high-density lipoprotein cholesterol <1.04 mmol/L for males or <1.30 mmol/L for females, or low-density lipoprotein cholesterol ≥4.14 mmol/L (*11*). Cardiometabolic risk factors included overweight or obesity, dysglycemia or T2DM, elevated triglycerides, reduced high-density lipoprotein cholesterol, and elevated blood pressure (*5*).

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Preplanned Studies

Effectiveness and Acceptability of A Community-Based Comprehensive Smoking Cessation Intervention Incorporating Traditional Chinese Medicine Therapy — Qingdao City, Shandong Province, China, December 2023–December 2024

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Summary

What is already known about this topic?

Traditional Chinese Medicine (TCM) acupuncture represents a feasible, low-risk smoking cessation intervention, yet evidence supporting its integration into community-based programs in China remains limited.

What is added by this report?

The intervention group demonstrated substantially higher self-reported sustained abstinence rates compared to the control group at each follow-up assessment (23.85% *vs.* 7.60%, 19.25% *vs.* 4.40%, and 17.57% *vs.* 4.00%; $P<0.05$). Participants receiving the intervention were 2.44 times more likely to achieve sustained smoking cessation at 6 months compared to controls [adjusted odds ratio (*aOR*)=2.44, 95% confidence interval (*CI*): 1.08, 5.50].

What are the implications for public health practice?

This study establishes a precedent for integrating comprehensive TCM approaches into existing community smoking cessation services. Our findings provide innovative perspectives and empirical evidence to advance the development of smoking cessation intervention models.

ABSTRACT

Introduction: Traditional Chinese Medicine (TCM) provides a practical and safe approach to smoking cessation. However, research examining its integration into community-based smoking cessation programs in Chinese mainland remains limited.

Methods: This cluster randomized controlled trial selected 20 matched communities in Qingdao and randomly assigned them in a 1∶1 ratio to intervention or control groups, with 10 communities per group. Community health centers recruited voluntary smokers seeking cessation as study participants. The final sample comprised 239 participants in the intervention group and 250 in the control group, totaling 489 participants. The intervention group received a comprehensive TCM-based community intervention incorporating acupuncture and auricular acupressure, while the control group received standard self-help smoking cessation materials. Follow-up assessments were conducted at one, three, and six months post-enrollment. Logistic regression models were employed to evaluate the intervention's impact on smoking cessation outcomes.

Results: Logistic regression analysis adjusted for covariates demonstrated that the intervention group achieved significantly superior smoking cessation outcomes at all follow-up time points compared to the control group. At 6 months, participants in the intervention group showed significantly higher probabilities of achieving sustained cessation [adjusted odds ratio (*aOR*)=2.44, 95% confidence interval (*CI*): 1.08, 5.50], attempting cessation (*aOR*=5.01, 95% *CI*: 3.14, 7.99), reducing smoking consumption (*aOR*=2.99, 95% *CI*: 2.00, 4.45), and maintaining 7-day point prevalence abstinence (*aOR*=3.76, 95% *CI*: 2.04, 6.90).

Conclusions: These findings provide compelling evidence supporting the integration of TCM smoking cessation therapies into community-based cessation services. The results offer innovative perspectives and empirical evidence for advancing smoking intervention models in public health practice.

Smoking cessation represents the most effective strategy for reducing population-level smoking prevalence. However, unassisted attempts to quit achieve success rates of only 3.00%–5.00% (*1*). While evidence-based research in modern medicine has established Traditional Chinese Medicine (TCM) acupuncture as a feasible, effective, and low-risk therapeutic approach for smoking cessation (*2*), a significant research gap persists regarding the effectiveness of community-based acupuncture interventions for smoking cessation. This community-based trial conducted in Qingdao, China, from December 2023 to December 2024, evaluated the effectiveness of an integrated TCM smoking cessation intervention. The study enrolled 489 eligible participants, with 239 assigned to the TCM intervention group and 250 to the control group. At each follow-up assessment, the intervention group demonstrated significantly higher rates of continuous abstinence, seven-day point prevalence of abstinence, smoking reduction, and quit attempts compared to the control group. Adjusted logistic regression analysis revealed that relative to controls, the intervention group had 2.44 times higher odds of achieving continuous abstinence [95% confidence interval (*CI*): 1.08, 5.50], 5.01 times greater likelihood of attempting smoking cessation (95% *CI*: 3.14, 7.99), 2.99 times increased probability of smoking reduction (95% *CI*: 2.00, 4.45), and 3.76 times elevated odds of seven-day abstinence (95% *CI*: 2.04, 6.90) at six-month follow-up.

Based on the sample size formula for cluster randomized controlled trials, each group required a minimum of 72 participants. To ensure adequate statistical power, we recruited additional participants beyond this threshold. We selected 20 matched communities in Qingdao and randomly assigned them in a 1∶1 ratio to either intervention or control groups. Community health service centers recruited approximately 25 participants per community from voluntary quitters who had at least one year of smoking history and had smoked daily in the previous month. The control group received standard self-help smoking cessation materials distributed by community health workers (Figure 1). Given the distinctive nature of TCM treatment protocols, blinding participants to group assignment was not feasible. The intervention group participated in a comprehensive TCM smoking cessation program comprising two key components:

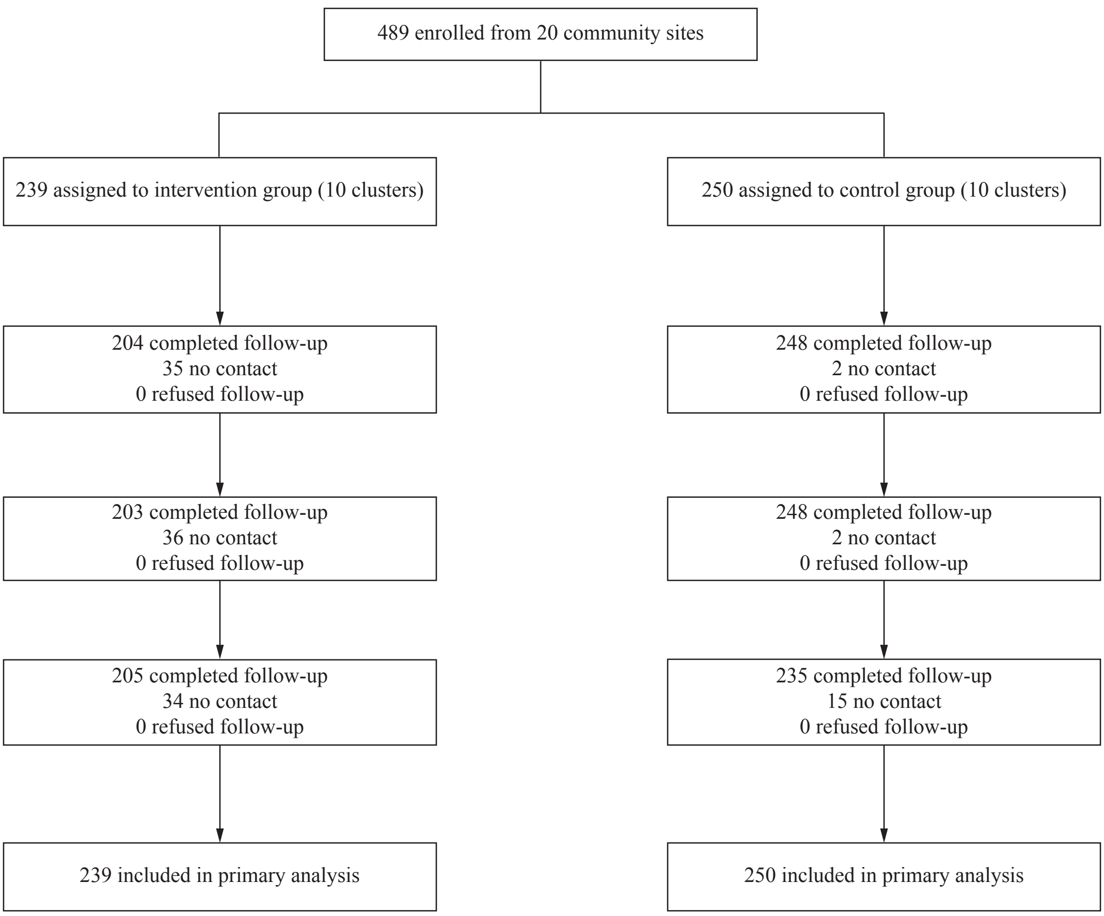

FIGURE 1. Flowchart of participant recruitment and progression throughout the study — Qingdao City, China, 2023.

TCM therapeutic services in the form of body acupuncture administered 2 to 3 times weekly for eight weeks, combined with auricular acupressure involving seed replacement every 2 to 3 days for eight weeks. Trained community physicians performed all acupuncture and auricular point pressing procedures following standardized protocols developed by the China Academy of Chinese Medical Sciences (CACMS). To ensure treatment consistency across all sites, these physicians completed two intensive training sessions provided by CACMS, focusing on precise point location, needling techniques, and auricular pressing methods (*3*). Supportive environmental interventions encompass comprehensive public education on tobacco-related health risks, disseminated through multiple channels, including timed releases of risk information via community WeChat groups and offline materials such as posters and bulletin boards. The program featured six educational lectures at community health centers covering topics including smoking health risks, cessation benefits, and firsthand quit-smoking experiences, with each lecture reaching at least 50 community residents. Additional activities included smoking cessation competitions, smoke-free family initiatives, smoke-free community programs, and complimentary TCM medical consultations after each lecture. Community workers implemented supportive activities to create an environment conducive to smoking cessation.

Participants underwent follow-up assessments at one, three, and six months post-intervention. The primary outcome was continuous abstinence rate (CAR), while secondary outcomes included seven-day point prevalence of abstinence rate (PPAR), smoking reduction rate, and quit attempt rate at each follow-up timepoint. We applied the following standardized definitions: a quit attempt was defined as self-reported abstinence lasting ≥24 hours; seven-day PPAR required self-reported continuous abstinence for ≥7 days preceding the follow-up assessment; CAR indicated sustained self-reported abstinence maintained since enrollment; and smoking reduction was defined as a ≥ 50% decrease in daily cigarette consumption compared to baseline levels (excluding participants who reported complete abstinence). All analyses adhered to intention-to-treat (ITT) principles, with participants lost to follow-up conservatively classified as current smokers. Participants who missed all three follow-up assessments were considered lost to follow-up while remaining included in ITT analysis.

Data analysis was performed using SPSS (version 25, IBM Corporation, Armonk, US) and R software (version 4.4.3, R Foundation for Statistical Computing, Vienna, Austria). Continuous variables following normal distributions were presented as mean ± standard deviation (SD), while non-normally distributed variables were summarized as median (interquartile range, IQR). Categorical variables were described using frequencies and percentages. We conducted logistic regression analysis to identify factors associated with six-month smoking cessation outcomes, with results reported as odds ratio (*OR*) and 95% *CI*. All statistical tests were two-tailed, with $P<0.05$ considered statistically significant.

This study enrolled 489 smokers, with participants distributed by 239 in the intervention group and 250 in the control group. The study population was predominantly male (98.57%) with a mean age of 47.75 years. The majority of participants were married (87.53%) and employed (66.05%), while 40.69% had achieved college-level education or higher. Participants consumed an average of 14.13±8.12 cigarettes per day at baseline (Table 1).

At each follow-up time point, the intervention group consistently demonstrated significantly superior rates across all smoking cessation outcomes compared to the control group. Specifically, the intervention group achieved higher quit attempt rates, seven-day PPAR, CAR, and smoking reduction rates at 1-month (43.51% *vs.* 14.00%, 26.36% *vs.* 8.80%, 23.85% *vs.* 7.60%, and 37.24% *vs.* 22.40%; $P<0.05$), 3-month (54.81% *vs.* 19.20%, 29.71% *vs.* 6.80%, 19.25% *vs.* 4.40%, and 43.10% *vs.* 30.40%; $P<0.05$), and 6-month follow-ups (61.09% *vs.* 22.40%, 30.96% *vs.* 8.00%, 17.57% *vs.* 4.00%, and 46.03% *vs.* 22.80%; $P<0.05$).

Logistic regression analysis was performed to identify predictors of six-month CAR, incorporating all aforementioned variables. The results revealed that participants in the intervention group demonstrated 2.44 times greater likelihood of achieving sustained smoking cessation at six months compared to the control group [adjusted *OR* (*aOR*)=2.44, 95% *CI*: 1.08, 5.50]. Additionally, higher educational attainment (*aOR*=2.37, 95% *CI*: 1.44, 3.89) and poorer perceived health status (*aOR*=2.16, 95% *CI*: 1.03, 4.54) significantly enhanced the probability of successful cessation. Conversely, higher daily cigarette consumption substantially reduced cessation success (*aOR*=0.93, 95% *CI*: 0.89, 0.97). The comprehensive results are presented in Table 2.

Identical logistic regression models were employed

TABLE 1. Baseline characteristics of participants — Qingdao City, China, December 2023 – December 2024 [*N* (%)].

Characteristic	Total	Control group	Intervention group	t/χ^2	*P*
Total	489 (100.00)	250 (100.00)	239 (100.00)		
Gender*				3.86	0.06
Male	482 (98.57)	249 (99.60)	233 (97.49)		
Female	7 (1.43)	1 (0.40)	6 (2.51)		
Age (M±SD)	47.75±14.52	53.39±13.95	41.86±12.67	9.55	<0.001
Marital status				22.14	<0.01
Married	428 (87.53)	236 (94.40)	192 (80.33)		
Unmarried/divorced/widowed	61 (12.47)	14 (5.60)	47 (19.67)		
Education level				129.43	<0.01
Primary or lower	47 (9.61)	37 (14.80)	10 (4.18)		
Secondary school	127 (25.97)	97 (38.80)	30 (12.55)		
High school/secondary specialized school	116 (23.72)	75 (30.00)	41 (17.15)		
Specialized school or higher	199 (40.69)	41 (16.40)	158 (66.11)		
Employment status				0.03	0.87
Employed	323 (66.05)	166 (66.40)	157 (65.69)		
Unemployed	166 (33.95)	84 (33.60)	82 (34.31)		
Perceived health status at the first visit				8.54	0.01
Very good/good	404 (82.62)	218 (87.20)	186 (77.82)		
Fair	80 (16.36)	29 (11.60)	51 (21.34)		
Very poor/poor	5 (1.02)	3 (1.20)	2 (0.84)		
Chronic non-communicable diseases				24.39	<0.01
Yes	194 (39.67)	136 (54.40)	58 (24.27)		
No	295 (60.33)	114 (45.60)	181 (75.73)		
Daily cigarette consumption (M±SD)	14.13±8.12	14.33±8.76	13.93±7.47	−0.54	0.59
Fagerström test for nicotine dependence				6.53	0.04
Low (0–3)	277 (56.65)	149 (59.60)	128 (53.56)		
Moderate (4–5)	92 (18.81)	36 (14.40)	56 (23.43)		
Severe (6–10)	120 (24.54)	65 (26.00)	55 (23.01)		

Abbreviation: M=mean; SD=standard deviation.

* Fisher's exact test was employed to examine the chi-square value.

to examine intervention effects on six-month quit attempt rates, seven-day PPAR, and smoking reduction rates. The analysis demonstrated that participants in the intervention group exhibited 5.01 times higher odds of making quit attempts (*aOR*=5.01, 95% *CI*: 3.14, 7.99), 2.99 times greater odds of achieving smoking reduction (*aOR*=2.99, 95% *CI*: 2.00, 4.45), and 3.76 times elevated odds of attaining seven-day PPAR (*aOR*=3.76, 95% *CI*: 2.04, 6.90) compared to the control group, with all differences reaching statistical significance (Table 3).

To address potential confounding from baseline differences, we conducted comprehensive sensitivity analyses. The results confirmed that the intervention's beneficial effects on all outcome variables maintained statistical significance (P<0.05) across all model specifications, with consistent positive effect directions (β>0), demonstrating the robustness of our primary findings (Table 4).

DISCUSSION

This study represents the first comprehensive community-based TCM smoking cessation intervention implemented in China, pioneering the integration of evidence-based TCM approaches into existing community cessation services. The intervention demonstrated high fidelity, with most

TABLE 2. Logistic regression analysis of influencing factors of the six-month CAR — Qingdao City, China, December 2023 – December 2024 (n=489).

Characteristic	B	SE	Wald χ^2	P	aOR (95% CI)
Education level	0.86	0.25	11.62	<0.01	2.37 (1.44, 3.89)
Daily cigarette consumption	−0.07	0.02	9.82	<0.01	0.93 (0.89, 0.97)
Perceived health status at the first visit	0.77	0.38	4.16	0.04	2.16 (1.03, 4.54)
Intervention	−0.89	0.41	4.63	0.03	2.44 (1.08, 5.50)

Note: *aOR*, adjusted for characteristic factors.
Abbreviation: CAR=continuous abstinence rate; *SE*=standard error; *aOR*=adjusted odds ratio; *CI*=confidence interval.

TABLE 3. Comparison of cessation outcomes between the intervention and control groups at a six-month follow-up — Qingdao City, China, December 2023 – December 2024.

Six-month follow-up	Intervention group (n, %)	Control group (n, %)	aOR	95% CI	P
Quit attempt rate	146 (61.09)	56 (22.40)	5.01	(3.14, 7.99)	<0.01
Smoking reduction rate	110 (46.03)	57 (22.80)	2.99	(2.00, 4.45)	<0.01
Seven-day PPAR	74 (30.96)	20 (8.00)	3.76	(2.04, 6.90)	<0.01
CAR	42 (17.57)	10 (4.00)	2.44	(1.08, 5.50)	0.03

Note: *aOR*, adjusted for characteristics factors.
Abbreviation: *CI*=confidence interval; PPAR=point prevalence of abstinence rate; CAR=continuous abstinence rate; *aOR*=adjusted odds ratio.

TABLE 4. Sensitivity analysis of the impact of intervention effects on various outcome variables at the 6-month follow-up.

Elements	Model 1 (unadjusted)		Model 2 (adjusted)*		Model 3 (adjusted)†	
	β (95% CI)	P	β (95% CI)	P	β (95% CI)	P
Quit attempt rate	5.44 (3.66, 8.07)	<0.01	4.27 (2.73, 6.68)	<0.01	5.01 (3.14, 7.99)	<0.01
Smoking reduction rate	2.89 (1.96, 4.26)	<0.01	2.89 (1.96, 4.26)	<0.01	2.99 (2.00, 4.45)	<0.01
Seven-day PPAR	5.16 (3.03, 8.79)	<0.01	3.43 (1.88, 6.26)	<0.01	3.76 (2.04, 6.90)	<0.01
CAR	5.12 (2.50, 10.46)	<0.01	2.49 (1.13, 5.48)	0.02	2.44 (1.08, 5.50)	0.03

Abbreviation: *CI*=confidence interval; PPAR=point prevalence of abstinence rate; CAR=continuous abstinence rate.
* Covariates in model 2 included age, marital status, education, health status, chronic non-communicable diseases, Fagerström test for nicotine dependence.
† Covariates in model 3 included all baseline characteristics.

planned activities successfully delivered according to protocol records, confirming the feasibility of incorporating TCM therapies into community smoking cessation programs.

The study achieved a 17.57% six-month continuous abstinence rate for the intervention group, revealing distinct characteristics compared to pharmacological approaches. While this rate falls below the 25.50% continuous abstinence rate reported for varenicline in clinical randomized controlled trials, it closely approximates the efficacy of nicotine patches (18.50%) and bupropion (18.80%) (*4*). The TCM protocol achieved comparable long-term cessation rates to conventional nicotine replacement therapy (NRT) without creating pharmacological dependency, offering a non-medication alternative for community interventions.

Consistent with previous research findings (*5–6*), multivariable analysis identified higher educational attainment and poorer self-rated health status as significant positive predictors of six-month continuous abstinence. Conversely, heavier daily cigarette consumption negatively correlated with successful cessation. These associations likely reflect several key factors: 1) populations with lower education levels require targeted strategies to enhance accessibility and acceptability of TCM smoking cessation services; 2) illness attribution effects can motivate health-compromised smokers by highlighting smoking-related symptoms; and 3) heavy smokers require intensive, tailored interventions to overcome high nicotine dependence and withdrawal symptoms while improving cessation efficacy.

The observed six-month quit attempt rate (61.09%) notably exceeded the 47.00% rate reported in the mobile platform-based community intervention conducted in Hong Kong by Guo et al. (*7*). Additionally, 46.03% of participants in the intervention group who did not achieve complete cessation reduced their daily cigarette consumption by more than 50% from baseline levels at six months, significantly exceeding those documented in comparable studies (*8–9*). The sustained effects of acupuncture may result from acupoint stimulation that regulates mesolimbic dopamine release, thereby suppressing nicotine withdrawal symptoms and cravings while promoting lasting behavioral modifications (*10*). These findings demonstrate that this comprehensive TCM-based intervention approach more effectively promotes long-term cessation attempts compared to conventional community services.

The six-month seven-day point prevalence abstinence rate (30.96%) substantially exceeded outcomes from comparable interventions: the 16.80% rate observed in Hong Kong's community acupuncture program (*3*) and the 16.00% rate reported by Jayakrishnan et al. (*9*) for health education-based interventions in rural India. These results indicate that integrating TCM acupuncture with community health education produces superior cessation outcomes compared to implementing either approach independently.

There are several limitations to be acknowledged. Firstly, the primary limitation involves our inability to definitively determine whether smoking cessation effects resulted from the TCM interventions themselves or from the supportive cessation environment created. Future research should incorporate comparable control groups to address this methodological concern. Secondly, while we implemented activities to maintain participant adherence, we did not quantify adherence assessment. Thirdly, relying on self-reported abstinence without biochemical verification may introduce reporting bias. Fourthly, due to the inherent limitations of community-based trials, selection bias during participant recruitment may have led to baseline characteristic imbalances between groups, potentially causing inaccurate intervention effect estimation. Finally, implementation challenges arose from limited domestic precedents for TCM acupuncture smoking cessation protocols, necessitating strict adherence to research specifications established by the China Academy of Chinese Medical Sciences.

In conclusion, this study demonstrates the feasibility of implementing TCM-based smoking cessation services within community settings. TCM cessation approaches, which have demonstrated satisfactory acceptability, smoking abstinence rates, and operational feasibility, are well-suited for integration into community tobacco control programs. Efforts should be intensified to promote TCM acupuncture for smoking cessation, integrate to these approaches into public health services, and enhance to training and policy support for community healthcare providers.

Conflicts of interest: No conflicts of interest.

Ethical statement: The Ethics Review Committee of China CDC approved the study protocol (Approval No. 202314), and the trial was registered with the Chinese Clinical Trial Registry (Registration No. ChiCTR2400080614).

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Notifiable Infectious Diseases Reports

Reported Cases and Deaths of National Notifiable Infectious Diseases — China, August 2025*

Diseases	Cases	Deaths
Plague	0	0
Cholera	5	0
SARS-CoV	0	0
Acquired immune deficiency syndrome†	3,754	1,402
Hepatitis	130,104	227
Hepatitis A	1,311	0
Hepatitis B	109,355	37
Hepatitis C	16,138	189
Hepatitis D	13	0
Hepatitis E	2,712	1
Other hepatitis	575	0
Poliomyelitis	0	0
Human infection with H5N1 virus	0	0
Measles	94	0
Epidemic hemorrhagic fever	122	0
Rabies	32	27
Japanese encephalitis	36	3
Dengue	1,702	0
Anthrax	106	1
Dysentery	3,686	0
Tuberculosis	54,614	246
Typhoid fever and paratyphoid fever	647	0
Meningococcal meningitis	8	0
Pertussis	1,774	0
Diphtheria	0	0
Neonatal tetanus	0	0
Scarlet fever	1,884	0
Brucellosis	6,137	1
Gonorrhea	10,477	0
Syphilis	54,387	4
Leptospirosis	156	0
Schistosomiasis	2	0
Malaria	420	1
Human infection with H7N9 virus	0	0
COVID-19	164,625	7
Monkey pox§	81	0
Influenza	85,606	0

Continued

Diseases	Cases	Deaths
Mumps	6,009	0
Rubella	51	0
Acute hemorrhagic conjunctivitis	2,044	0
Leprosy	23	0
Typhus	145	0
Kala azar	33	0
Echinococcosis	370	0
Filariasis	0	0
Infectious diarrhea¶	144,550	2
Hand, foot and mouth disease	103,195	0
Total	776,879	1,921

* 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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Erratum

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In the article entitled *National Survey on Nutrition Knowledge Assessment Among Junior High School Students — 31 PLADs, China, 2023–2024* [2025, 7(38): 1214–1219. doi: 10.46234/ccdcw2025.204], the funding information should be added as follow: "Supported by the Public Health Emergency Project Nutrition Health and Healthy Diet Campaign (No. 102393220020070000012)".

Vol. 7 No. 41

In the article entitled *The Cluster of Mpox (Clade Ib) Infections — Yiwu City, Zhejiang Province, China, July–August 2025* [2025, 7 (41): 1308–1313. doi: 10.46234/ccdcw2025.221], the last author (one of the corresponding authors) "Jiming Sun" was mistakenly listed and should be the following: "Jimin Sun".

Indexed by Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), PubMed Central (PMC), Scopus, Chinese Scientific and Technical Papers and Citations, and Chinese Science Citation Database (CSCD)

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