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Perspectives

Obesity Control and Cancer Prevention in China: Insights from the Weight Management Year

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ABSTRACT

Obesity has emerged as a critical public health challenge worldwide and in China, substantially contributing to the burden of chronic diseases, including cancer. In response, China launched the "Weight Management Year" initiative in 2024, representing a strategic shift toward upstream interventions in chronic disease control. This perspective examines the essential role of obesity control in cancer prevention across the complete prevention continuum — primordial (zero-level), primary, secondary, and tertiary prevention. The initiative presents a unique opportunity to integrate weight management strategies into health promotion, early risk identification, screening programs, and post-diagnosis rehabilitation. It emphasizes incorporating obesity-related cancer prevention into routine healthcare through digital platforms, multidisciplinary collaboration, and population-wide education campaigns. However, significant challenges persist, including limited public awareness of obesity's carcinogenic risks, insufficient integration between clinical and public health systems, and inadequate multi-sectoral cooperation. Moving forward, cancer prevention in China must transition from a reactive, screening-focused model to a proactive, life-course approach centered on behavioral and lifestyle interventions. Strengthening risk communication, institutionalizing weight management across all prevention levels, and fostering cross-sectoral collaboration are essential for building a sustainable, population-wide cancer prevention framework.

In recent years, obesity has emerged as an increasingly prominent global public health challenge. Currently, approximately one-third of the global population is overweight or obese. Since 1990, the global prevalence of obesity has increased by 155.1% among men and 104.9% among women (*1*). Adult BMI and obesity in China increased significantly between 2004 and 2018, with obesity prevalence rising from approximately 3.1% to 8.1%. An estimated 85 million adults were obese in 2018 — roughly three times the number in 2004 (*2*). At the same time, the prevalence of overweight and obesity among children and adolescents is also rising rapidly (*3*). Obesity serves as a major driver of other chronic diseases such as hypertension, type 2 diabetes, and fatty liver disease, underscoring the broader significance of weight management in chronic disease prevention. Moreover, it has become a key factor affecting life expectancy and healthy life years. This trend poses a serious challenge to achieving national population health strategies, such as the Healthy China Initiative.

The continuous rise in global obesity prevalence has underscored its role as a major risk factor for cancer. Projections suggest that obesity may surpass smoking to become the leading preventable cause of cancer in the near future (*4*). In 2016, the International Agency for Research on Cancer (IARC) confirmed a causal relationship between excess body fat and at least 13 types of cancer, including endometrial cancer, esophageal adenocarcinoma, kidney cancer, liver cancer, gastric cardia cancer, and colorectal cancer. IARC has classified excess body fat as a Group 1 carcinogen (*5*). A meta-analysis covering more than ten countries worldwide indicated that for every 5 kg/m^2 increase in body mass index (BMI), the risk of developing certain cancers rises significantly. These include esophageal adenocarcinoma, thyroid cancer, colon cancer, and kidney cancer in men, and endometrial cancer, gallbladder cancer, esophageal adenocarcinoma, kidney cancer, and postmenopausal breast cancer in women (*6*). In China, the burden of obesity-related cancers is becoming increasingly severe. In 2021, approximately 48.47% of cancer cases were associated with obesity, with the incidence of these cancers increasing at an annual rate of 3.6% — substantially higher than that of non-obesity-related cancers (*7*). For example, obesity can increase the risk of thyroid cancer and endometrial cancer through chronic inflammation and hormonal dysregulation (*8*). This trend not only intensifies the public health burden of preventable cancers but also poses a significant threat to healthy life expectancy across the population.

The Significance of Obesity Control for Cancer Prevention Under the "Weight Management Year" Initiative

In 2024, China's National Health Commission launched the "Weight Management Year" initiative (*9*), a comprehensive three-year public health campaign that represents a fundamental shift in the country's chronic disease prevention strategy. This initiative marks a transition from reactive, treatment-focused approaches toward proactive, upstream interventions that address root causes of disease. Weight management has thus evolved beyond individual health recommendations to become a cornerstone of national health policy. Pilot provinces have implemented digital monitoring platforms, while local governments have established collaborative networks linking schools, workplaces, and healthcare institutions. According to the *Notice on the Establishment and Management of Healthy Weight Management Clinics* issued by the National Health Commission and National Administration of Traditional Chinese Medicine (2025), healthy weight management clinics must be fully operational in all tertiary general hospitals, children's hospitals, and traditional Chinese medicine hospitals by June 2025 (*10*). This systematic approach enables a paradigm shift from screening-based secondary prevention toward comprehensive, multi-sectoral primary prevention through institutionalized weight management frameworks. Cancer prevention efforts should capitalize on this opportunity by promoting integrated strategies that simultaneously target cancer and other metabolic diseases, enhance clinical-public health synergy, and foster interdepartmental collaboration on weight-related interventions. This transformation supports the evolution from passive disease detection to proactive prevention and control.

The "Weight Management Year" initiative employs a systematic, life-course approach characterized by population-wide, multi-setting interventions. These structural advantages position the initiative as an ideal platform for integration across all levels of cancer prevention, facilitating the strategic transition from a "detection-treatment" paradigm to a proactive "identification-intervention-prevention" model.

Zero-Level Cancer Prevention: A Coordinated Pathway Centered on Weight Management

Zero-level prevention encompasses preemptive interventions implemented before disease onset, distinguishing itself from primary prevention by emphasizing environmental and behavioral risk factor control before these factors become established (*11*). Primary prevention, in contrast, focuses on managing existing risk factors. Within cancer prevention, weight management-centered coordinated pathways for zero-level prevention can be developed through three strategic approaches: 1) Establishing cancer prevention-friendly social health environments by incorporating "active and exercise-friendly cities" concepts and competitive mechanisms into urban culture, promoting weight management-supportive indoor environments, and advancing healthy kitchen initiatives; 2) Strengthening public understanding of the relationship between abnormal weight and cancer risk through dedicated "obesity and cancer" educational materials, integrating weight management into cancer screening promotion programs, and disseminating scientific evidence of obesity's carcinogenic effects via multimedia platforms; 3) Coordinating resources across multiple sectors — education, sports, human resources, and medical insurance — to establish cross-system, multi-population, multi-channel collaborations that develop weight intervention guidelines for high-risk cancer populations and explore viable incentive models for healthy behaviors. The "Weight Management Year" initiative should therefore be leveraged as a crucial opportunity and institutional framework for advancing cancer prevention concepts. Through environmental optimization and multi-sectoral collaboration, a comprehensive, life-course cancer prevention ecosystem covering the entire population can be progressively established.

Primary Cancer Prevention: Risk Control Strategies Anchored in Weight Management

Primary prevention aims to reduce initial cancer risk by controlling carcinogenic factors and promoting healthier lifestyles. Intentional weight loss effectively lowers the risk of several cancer types (*12–13*), establishing obesity prevention and control as a cornerstone intervention in primary cancer prevention. The systematic framework promoted by the "Weight Management Year" initiative enables coordinated pathways for primary cancer prevention through three strategic approaches: 1) Weight management should be integrated into primary cancer prevention risk assessment tools. This integration involves incorporating parameters such as BMI, waist circumference, and metabolic indicators to develop a comprehensive "metabolic–oncologic risk" assessment and intervention model suitable for health examination centers, wellness management institutions, and primary care settings; 2) Digital platforms and integrated clinical–public health service systems developed under the "Weight Management Year" initiative should target high-risk cancer populations with abnormal weight, metabolic disorders, or comorbid chronic diseases. Standardized intervention packages for abnormal weight should be implemented across health examination centers, wellness management institutions, and primary healthcare facilities; 3) Multiple disciplines, including nutrition, physical activity, psychology, and oncology, should collaborate to develop weight loss guidelines and intervention pathways for primary cancer prevention. Additionally, primary cancer prevention objectives should be embedded within the weight management framework of essential public health service programs. In China, schools serve as critical settings for obesity prevention. Multiple intervention strategies targeting children and adolescents have been implemented, including promoting healthy diets, increasing physical activity, and encouraging self-monitoring of obesity-related behaviors. Early-life obesity interventions provide significant protective effects against adult cancer risk (*14*). The "Weight Management Year" provides a crucial opportunity to establish a new primary cancer prevention model — one that uses weight management as the entry point and lifestyle intervention as the core strategy. This model can accelerate the transition from isolated screening-based approaches toward comprehensive, multi-sectoral, and system-level interventions.

Secondary Cancer Prevention: An Integrated Screening and Early Detection Framework Enhanced by Weight Management

Secondary prevention focuses on early cancer detection, diagnosis, and treatment — identifying disease during latent or early stages to reduce progression and mortality. The "Weight Management Year" initiative offers systematic advantages in identifying high-risk populations, managing follow-up care, and integrating intervention resources, thereby strengthening secondary cancer prevention efforts: 1) Cancer screening and follow-up protocols for precancerous lesions should systematically incorporate weight intervention measures for individuals with obesity. For those who screen positive but remain undiagnosed — particularly individuals with precancerous conditions — structured weight control and metabolic regulation should be implemented using outpatient resources, intervention tools, and nutrition and exercise prescriptions promoted through the "Weight Management Year" initiative, with the objective of delaying or preventing disease progression; 2) Digital platforms should facilitate the establishment of an integrated "screening–management–feedback" follow-up system. In China, digital health platforms are increasingly integrated into cancer screening programs, with screening results incorporated into electronic health records to enable systematic follow-up of high-risk individuals. Internet-based tools, including mobile applications and WeChat reminders, support weight monitoring, lifestyle interventions, and re-examinations, thereby strengthening the integration of weight management into secondary cancer prevention. The "Weight Management Year" initiative should therefore serve as a critical support platform for optimizing secondary cancer prevention systems, promoting the development of an integrated model where cancer screening and weight management are unified and actionable post-screening interventions enable early cancer diagnosis and treatment.

Tertiary Prevention: Rehabilitation Management Pathways Based on Weight Management

Tertiary prevention focuses on improving quality of life after cancer diagnosis while reducing risks of recurrence, metastasis, and treatment-related complications. Obesity significantly correlates with elevated recurrence rates and compromised treatment responses across multiple cancer types, including prostate, colorectal, breast, and esophageal cancers (*15*–*18*). The comprehensive management strategies and multidisciplinary intervention frameworks established through the "Weight Management Year" initiative provide robust infrastructure for enhancing tertiary cancer prevention. Key implementation pathways include: 1) Systematically integrating weight management protocols into cancer rehabilitation and surveillance programs — particularly for high-recurrence-risk cancers such as breast and colorectal malignancies — to optimize hormonal and metabolic profiles through targeted weight reduction, thereby diminishing recurrence probability; 2) Leveraging specialized weight management clinics and comprehensive nutrition–exercise–psychological support services to deliver personalized rehabilitation interventions for cancer patients, enhancing both quality of life and functional recovery outcomes. Currently, leading cancer institutions in China (including the National Cancer Center and select provincial cancer hospitals) have established dedicated weight management and rehabilitation clinics that provide integrated nutritional, exercise, and psychological interventions; 3) Implementing digital surveillance platforms to monitor postoperative weight fluctuations and track behavioral intervention adherence, enabling early detection of recurrence risk factors and establishing closed-loop management systems. The "Weight Management Year" initiative establishes a comprehensive institutional framework for multidisciplinary integration and sustained support in tertiary cancer prevention, facilitating the healthcare system's evolution toward comprehensive life-course management approaches.

Current Challenges and Future Directions

While the "Weight Management Year" initiative provides a valuable policy framework and intervention platform for cancer prevention, several implementation challenges persist. First, public awareness of the connection between abnormal weight and cancer risk remains inadequate. The carcinogenic potential of obesity has not been fully recognized by the general population, resulting in limited motivation for active weight management and difficulty sustaining weight loss behaviors (*19*). Second, the integration of clinical and public health approaches to weight management and cancer prevention lacks systematic support at both policy and service delivery levels. A coordinated service mechanism and comprehensive multi-disease prevention framework spanning intervention, screening, and rehabilitation have yet to be established. Third, multi-sectoral collaboration mechanisms remain underdeveloped. Weight management initiatives are still largely confined within health and disease control systems, with insufficient engagement and resource coordination from critical sectors such as education, medical insurance, and social services. This limitation significantly hinders the widespread adoption and long-term sustainability of intervention measures (*20*).

Moving forward, cancer prevention must leverage the opportunity presented by the "Weight Management Year" initiative to drive a strategic transformation from secondary prevention measures, such as screening, toward zero-level and primary prevention strategies emphasizing health education, health promotion, and behavioral interventions. This shift will advance the prevention frontier (*21*). Policy measures should be tailored to specific populations: for adolescents, school-based interactive health education programs should be strengthened; for middle-aged and elderly populations, customized lifestyle intervention programs should be promoted through community healthcare centers. Public science communication and risk awareness education must be enhanced, incorporating the message that "obesity represents a preventable and controllable cancer risk factor" (*22*) as a central theme in health promotion to improve overall societal health literacy. Additionally, an integrated reconstruction of the prevention and control service system should be promoted, systematically embedding weight management mechanisms into screening, intervention, rehabilitation, and follow-up processes to establish standardized collaborative pathways linking cancer prevention and weight management. Furthermore, multi-sectoral coordination must be strengthened to institutionalize the connection between weight management policies and cancer prevention strategies, ultimately building a comprehensive cancer prevention and control system covering the entire population across the life course.

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Preplanned Studies

Evaluation of the Long-Term Benefits and Cost-Effectiveness of Colorectal Cancer Screening for Populations with Excess Weight — China, 2023

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Summary

What is already known on this topic?

China has the world's largest population of individuals who are overweight or obese, contributing to the growing burden of colorectal cancer (CRC). Screening is an effective strategy for reducing CRC mortality and incidence.

What is added by this report?

Using a simulation model, we found that CRC screening reduces incidence and mortality across all body mass index groups (normal, overweight, and obese) in China, with greater quality-adjusted life-year gains and 6%–14% higher colonoscopy efficiency in individuals who are overweight or obese. Screening proved to be more cost-effective for these groups, despite high lifetime healthcare expenditures.

What are the implications for public health practice?

CRC screening in China can prioritize populations with excess weight and incorporate weight management to improve health outcomes and control long-term healthcare costs.

ABSTRACT

Introduction: Individuals with excess body weight have elevated colorectal cancer (CRC) risk. This study aimed to evaluate the long-term efficacy and cost-effectiveness of CRC screening strategies in populations with excess weight.

Methods: A multistate Markov model was used to evaluate the efficacy and cost-effectiveness of CRC screening. Three hypothetical cohorts were simulated based on body mass index (BMI) subgroups: normal, overweight, and obese. Screening strategies included colonoscopy (every 10 years) or an annual fecal immunochemical test, initiated at ages 45 and 50. Key outcomes included CRC cases, deaths, quality-adjusted life-year (QALY), lifetime costs, endoscopic resource use, and incremental cost-effectiveness ratios.

Results: QALY gains increased from 0.097 [95% confidence interval (*CI*): 0.091–0.102] in individuals with normal weight to 0.104 (0.101–0.107) in those who were overweight and 0.108 (0.105–0.111) in those who were obese. Individuals who were overweight or obese demonstrated 6%–14% greater colonoscopy efficiency compared with those of normal weight. All screening strategies were cost-effective (incremental cost-effectiveness ratio=USD 671–USD 949 per QALY gained), with a marginal decrease in cost per QALY gained observed at higher BMI. Despite improved cost-effectiveness, lifetime healthcare expenditures were higher in individuals who were overweight ($845.19–$955.00) and obese ($1,358.00–$1,467.37) than in those with normal weight ($119.62–$229.20).

Conclusion: CRC screening in China demonstrated effectiveness and cost-effectiveness across BMI groups, with populations with excess weight showing high colonoscopy resource efficiency. Amid rising lifetime healthcare costs attributable to high BMI, integrating weight management with CRC screening is critical for optimizing health and economic benefits.

Colorectal cancer (CRC) is the second most common cancer and the fourth leading cause of cancer-related deaths in China (*1*). Screening is an effective strategy for reducing both mortality and disease burden (*2*). Current screening guidelines primarily use age and family history of CRC as eligibility criteria, overlooking modifiable risk factors, such as being overweight or obese. This limitation may compromise the efficiency of CRC screening programs.

China is experiencing a sharp increase in obesity, with a relative increase of 144.2% from 1990 to 2021

(*3*), driven by rapid socioeconomic development and lifestyle changes. The country currently has the world's largest population of individuals who are overweight or obese, and this trend is projected to impose an economic burden of CNY 418 billion by 2030 (*3*). As established independent risk factors for CRC, overweight and obesity contribute to 7.4% of the national CRC burden and represent the most financially burdensome among body mass index (BMI)-associated cancers (*4*). These findings highlight the urgent need for tailored CRC screening and management in individuals with excess weight.

Colonoscopy and fecal immunochemical testing (FIT) are the most widely used CRC screening modalities and are cost-effective in average-risk populations. While individuals with excess weight have a higher risk of CRC, they also face increased competing health risks and high medical costs, which may reduce the overall clinical and economic benefits of screening. Therefore, the long-term health outcomes and cost-effectiveness of CRC screening, specifically in populations with excess weight in China, remain unclear.

To address these gaps, we constructed a multistate Markov model to simulate the long-term health outcomes and cost-effectiveness of CRC screening strategies in populations with weight excess. This study provides policymakers with evidence to optimize screening programs and mitigate the rising burden of obesity-associated CRC.

Our validated CRC simulation model (CRC-SIM) reproduces the natural history, screening interventions, and clinical management of CRC. Nine health states were included: normal epithelium, non-advanced adenoma, advanced adenoma, CRC stages I–IV, and terminal states (CRC-related and other deaths), as detailed in Supplementary Figure S1 (available at https://weekly.chinacdc.cn/). The model incorporated BMI-specific modifications for CRC risk, all-cause mortality, and obesity-associated costs.

We simulated three hypothetical population cohorts (*N*=100,000 per cohort), based on BMI strata: normal weight (18.5–23.9 kg/m^2) and excess-weight populations (≥24 kg/m^2). The excess-weight group was further divided into overweight (24–27.9 kg/m^2) and obese (≥28 kg/m^2) subgroups according to China's BMI standards (*5*). All individuals entered the model at age 40 and were followed until age 79 or death, whichever occurred first. We modeled screening using colonoscopy (every 10 years) or annual FIT, initiated at ages 45 or 50.

A complete list of the variables and data sources used in our simulation model is provided in Supplementary Table S1 (available at https://weekly.chinacdc.cn/). Transitional probabilities for natural history were derived from systematic reviews and calibrated to age-specific CRC incidence and mortality using the Global Burden of Disease data (https://ghdx.healthdata.org/). Health utilities were obtained from a cross-sectional study of 300 newly diagnosed patients with CRC in China, with utilities of 0.768, 0.655, 0.562, and 0.495 for CRC stages I through IV, respectively (*6*). Cost parameters included screening, clinical management, travel expenses, and productivity losses. The BMI-specific CRC risk was derived from a population-based CRC screening program in China (*7*). The association between BMI and overall mortality was derived from a large population-based cohort study of 3.6 million individuals (*8*). All risks were adjusted by the prevalence of overweight and obesity reported in the *Report on the Nutrition and Chronic Diseases Status of Chinese Residents 2020,* with relative risks for CRC incidence of 1.04 (overweight) and 1.12 (obesity) and for all-cause mortality of 1.05 (overweight) and 1.22 (obesity) (*9*). Additional healthcare costs associated with overweight and obesity were derived from a longitudinal study on individual healthcare expenditures, which estimated annual costs of $44.02 for overweight and $75.79 for obese individuals (*10*). All parameters were incorporated into our Markov models, in which individuals transitioned annually between exclusive health states. Health utilities and costs were assigned to each state to calculate QALYs and lifetime costs.

We estimated CRC cases, deaths, QALYs, lifetime costs, endoscopic resources, and incremental cost-effectiveness ratios per person, comparing each strategy with no screening. Cost-effectiveness was assessed against a willingness-to-pay threshold of US$18,364/QALY. All costs were discounted by 5% annually according to the China Guidelines for Pharmacoeconomic Evaluations, with application of a half-cycle correction. Analyses were performed using R software (version 3.6.0; R Foundation for Statistical Computing, Vienna, Austria) and TreeAge Pro 2022 (TreeAge Software Inc., Williamstown, MA, USA).

Table 1 reveals distinct patterns in clinical outcomes across BMI categories (normal weight, overweight, and obese). In the absence of screening, CRC-specific mortality was higher among individuals who were overweight (2,420 deaths per 100,000) and obese

TABLE 1. Lifetime clinical outcomes of colorectal cancer screening strategies *vs*. no screening by body mass index group in 100,000 Chinese individuals (aged 40–79 years).

Indicators	No screening	50–74 years of age		45–74 years of age	
		Colonoscopy	FIT	Colonoscopy	FIT
Normal					
CRC cases (per 100,000)	4,013 (4,013, 4,013)	1,022 (1,020, 1,024)	1,566 (1,562, 1,570)	872 (870, 875)	1,334 (1,329, 1,338)
Cases prevented (per 100,000)	ref	2,991 (2,989, 2,993)	2,447 (2,443, 2,451)	3,141 (3,138, 3,143)	2,679 (2,675, 2,684)
Cases prevented (%)	ref	74.53	60.97	78.27	66.76
CRC deaths (per 100,000)	2,264 (2,264, 2,264)	565 (564, 566)	662 (661, 663)	416 (415,417)	514 (513, 515)
Deaths prevented (per 100,000)	ref	1,699 (1,698, 1,700)	1,602 (1,601, 1,603)	1,848 (1,847, 1,849)	1,750 (1,749, 1,751)
Deaths prevented (%)	ref	75.05	70.76	81.63	77.21
QALYs (per person)	16.18 (16.176, 16.182)	16.28 (16.273, 16.278)	16.26 (16.252, 16.258)	16.30 (16.292, 16.297)	16.27 (16.267, 16.273)
Additional QALY gain	ref	0.097 (0.091, 0.102)	0.076 (0.070, 0.082)	0.116 (0.110, 0.121)	0.091 (0.085, 0.097)
Overweight					
CRC cases (per 100,000)	4,281 (4,281, 4,281)	1,121 (1,119, 1,123)	1,698 (1,694, 1,702)	950 (947, 952)	1,442 (1,438, 1,446)
Cases prevented (per 100,000)	ref	3,160 (3,158, 3,162)	2,583 (2,579, 2,587)	3,331 (3,329, 3,334)	2,839 (2,835, 2,843)
Cases prevented (%)	ref	73.81	60.33	77.81	66.22
CRC deaths (per 100,000)	2,420 (2,420, 2,420)	617 (616, 618)	720 (719, 721)	453 (452,454)	558 (556, 559)
Deaths prevented (per 100,000)	ref	1,803 (1,802, 1,804)	1,700 (1,699, 1,701)	1,967 (1,966, 1,968)	1,862 (1,861, 1,864)
Deaths prevented (%)	ref	74.50	70.25	81.28	77.04
QALYs (per person)	16.016 (16.013, 16.019)	16.120 (16.117, 16.123)	16.098 (16.110, 16.101)	16.141 (16.138, 16.144)	16.114 (16.111, 16.117)
Additional QALY gain	ref	0.104 (0.101, 0.107)	0.081 (0.079, 0.084)	0.125 (0.122, 0.127)	0.098 (0.095, 0.101)
Obese					
CRC cases (per 100,000)	4,502 (4,502, 4,502)	1,213 (1,211, 1,215)	1,828 (1,824, 1,833)	1,020 (1,018, 1,022)	1,550 (1,545, 1,554)
Cases prevented (per 100,000)	ref	3,289 (3,287, 3,291)	2,674 (2,669, 2,680)	3,482 (3,480, 3,484)	2,952 (2,948, 2,957)
Cases prevented (%)	ref	73.06	59.40	77.34	65.57
CRC deaths (per 100,000)	2,550 (2,550, 2,550)	665 (664, 666)	775 (773, 776)	487 (486,488)	599 (598, 600)
Deaths prevented (per 100,000)	ref	1,885 (1,884, 1,886)	1,775 (1,774, 1,777)	2,063 (2,062, 2,064)	1,951 (1,950, 1,952)
Deaths prevented (%)	ref	74.08	69.59	80.90	76.51
QALYs (per person)	15.844 (15.841, 15.847)	15.952 (15.949, 15.955)	15.929 (15.926, 15.932)	15.974 (15.972, 15.977)	15.946 (15.944, 15.949)
Additional QALY gain	ref	0.108 (0.105, 0.111)	0.084 (0.082, 0.087)	0.130 (0.127, 0.133)	0.102 (0.099, 0.105)

Note: Three hypothetical population cohorts (*N*=100,000 per cohort) based on body mass index strata were considered in our study: normal weight (18.5–23.9 kg/m^2), overweight (24–27.9 kg/m^2), and obese (≥28 kg/m^2), according to China's body mass index standards. All individuals entered the model at age 40 and were followed until age 79 or death, whichever occurred first. Screening strategies included colonoscopy (every 10 years) or annual FIT, initiated at ages 45 or 50.

Abbreviation: FIT=fecal immunochemical test; CRC=colorectal cancer; QALY=quality-adjusted life-year; Ref=reference.

(2,550 per 100,000) than among those with normal weight (2,264 per 100,000). Regarding health utility, individuals with obesity had the lowest overall QALYs [15.844, 95% confidence interval (*CI*): 15.841–15.847], followed by those who were overweight (16.016, 95% *CI*: 16.013–16.019) and those with normal weight (16.179, 95% *CI*: 16.176–16.182).

Screening significantly reduced CRC cases (59.40%–78.27%) and deaths (69.59%–81.63%) and increased QALYs gained (0.076–0.130) relative to no screening. The number of prevented CRC cases and deaths was comparable across BMI categories. Specifically, among individuals initiating colonoscopy at age 50, CRC case prevention rates were 74.53% for those with normal weight, 73.81% for those who were overweight, and 73.06% for those who were obese, with corresponding mortality reductions of 75.05%, 74.50%, and 74.08%, respectively. Concurrently, QALY gains increased from 0.0967 (95% *CI*: 0.091–0.102) in individuals with normal weight to 0.104 (0.101–0.107) in those who were overweight and 0.108 (0.105–0.111) in those who were obese. The disparity in QALY gains between higher-BMI and normal-weight groups widened when screening was initiated earlier (Table 1).

A high BMI was associated with improved colonoscopy efficiency. Compared with individuals with normal weight, those who were overweight and obese required fewer colonoscopies per case prevented (6%–8% and 10%–14%, respectively) and per death prevented (6%–8% and 10%–13%, respectively). This trend remained consistent across screening strategies and initiation ages (Table 2).

Both colonoscopy and FIT strategies were cost-effective (incremental cost-effectiveness ratio

TABLE 2. Lifetime economic burden and endoscopic resource use for colorectal cancer screening strategies *vs*. no screening by body mass index group in 100,000 Chinese individuals (aged 40–79 years).

Indicators	No screening	50–75 years of age		45–75 years of age	
		Colonoscopy	FIT	Colonoscopy	FIT
Normal					
Cost per person (USD)	119.62 (119.54, 119.71)	194.03 (193.63, 194.44)	171.85 (171.62, 172.07)	229.20 (228.64, 229.76)	183.85 (183.58, 184.13)
Colonoscopies per person	Not applicable	2.71 (2.71, 2.71)	1.25 (1.24, 1.25)	3.53 (3.53, 3.53)	1.45 (1.45, 1.45)
No. of colonoscopies per case prevented		160	78	191	83
No. of colonoscopies per death prevented		91	51	112	54
Overweight					
Cost per person (USD)	845.19 (845.10, 845.29)	920.50 (920.09, 920.91)	899.87 (899.64, 900.11)	955.00 (954.43, 955.58)	911.62 (911.33, 911.91)
Colonoscopies per person	Not applicable	2.67 (2.67, 2.67)	1.24 (1.24, 1.24)	3.46 (3.46, 3.46)	1.44 (1.44, 1.45)
No. of colonoscopies per case prevented		148	73	176	78
No. of colonoscopies per death prevented		84	48	104	51
Prevented cases compared to normal weight individual (%)		7	6	8	6
Prevented deaths compared to normal weight individual (%)		7	6	8	6
Obese					
Cost per person (USD)	1,358.00 (1,357.90, 1,358.10)	1,433.79 (1,433.38, 1,434.20)	1,414.98 (1,414.73,1,415.22)	1,467.37 (1,466.80, 1,467.94)	1,426.42 (1,426.12, 1,426.71)
Colonoscopies per person	Not applicable	2.62 (2.62, 2.62)	1.23 (1.23, 1.23)	3.38 (3.38, 3.38)	1.43 (1.43, 1.44)
No. of colonoscopies per case prevented		139	69	164	74
No. of colonoscopies per death prevented		80	46	97	49
Prevented cases compared to normal weight individual (%)		13	11	14	11
Prevented deaths compared to normal weight individual (%)		12	10	13	10

Note: Three hypothetical population cohorts (*N*=100,000 per cohort) based on body mass index strata were considered in our study: normal weight (18.5–23.9 kg/m^2), overweight (24–27.9 kg/m^2), and obese (≥28 kg/m^2), according to China's body mass index standards. All individuals entered the model at age 40 and were followed until age 79 or death, whichever occurred first. Screening strategies included colonoscopy (every 10 years) or annual FIT, initiated at ages 45 or 50.

Abbreviation: USD=United States dollar; FIT=fecal immunochemical test.

TABLE 3. Incremental cost-effectiveness for each screening strategy compared with no screening by body mass index in 100,000 Chinese individuals (aged 40–79 years).

Strategies	ICER (USD/QALYs)		
	Normal	Overweight	Obesity
Colonoscopy *vs*. no screening, 50 years of age	769	725	703
Annul FIT *vs*. no screening, 50 years of age	686	671	675
Colonoscopy *vs*. no screening, 45 years of age	949	882	840
Annul FIT *vs*. no screening, 45 years of age	706	679	671

Note: Incremental QALYs and costs were compared with no screening. Three hypothetical population cohorts (*N*=100,000 per cohort) based on body mass index strata were considered in our study: normal weight (18.5–23.9 kg/m^2), overweight (24–27.9 kg/m^2), and obese (≥ 28 kg/m^2), according to China's body mass index standards. All individuals entered the model at age 40 and were followed until age 79 or death, whichever occurred first. Screening strategies included colonoscopy (every 10 years) or annual FIT, initiated at ages 45 or 50.
Abbreviation: QALYs=quality-adjusted life-years; USD=United States dollar; ICERs=incremental cost-effectiveness ratios; FIT=fecal immunochemical test.

<$18,364/QALY) across all BMI categories compared with no screening (Table 3). Most screening modalities showed progressively decreasing costs per QALY gained with increasing BMI ($769, $725, and $703 per QALY gained for individuals with normal weight, overweight, and obesity, respectively, when initiated at age 50). Despite improved cost-effectiveness of screening, lifetime healthcare expenditures were higher in those who were overweight ($845.19–$955.00) and obese ($1,358.00–$1,467.37) than in those with normal weight ($119.62–$229.20) (Table 2).

DISCUSSION

We constructed a multistate Markov model to simulate the long-term health outcomes and cost-effectiveness of CRC screening in populations with excess weight. Our study demonstrates that CRC screening reduces both incidence and mortality across all BMI groups (normal weight, overweight, and obese) in China. Individuals who are overweight or obese derive greater QALY gains and resource efficiency (6%–13% fewer colonoscopies per CRC case and death prevented) than those with normal weight. Notably, most screening strategies proved to be cost-effective, with a marginal decrease in cost per QALY gained as BMI increased.

Few modeling studies have evaluated the cost-effectiveness of CRC screening across BMI groups. Our findings show that targeting populations with overweight or obesity yields greater QALY gains and improved cost-effectiveness compared with targeting populations with normal weight, consistent with results from a prior German modeling study (*11*). This enhanced benefit is likely owing to the high prevalence and faster progression of adenomas in individuals with a high BMI, which increases the yield of CRC screening. Our analysis further revealed that screening these populations also improves colonoscopy efficiency, requiring fewer procedures for CRC death prevention. These findings provide compelling evidence for prioritizing individuals with overweight or obesity in CRC screening programs in resource-limited settings.

A national screening study revealed significantly lower adherence to CRC screening among individuals with obesity (38.7% *vs*. 55.8% among those with normal weight) (*12*). This reduced uptake persisted despite free colonoscopic access [odds ratio (*OR*)=2.16] (*13*). Insufficient risk awareness may have contributed to this disparity. Additionally, individuals with a high BMI incur substantially higher lifetime healthcare expenditures than those with normal weight, primarily because of obesity-related comorbidity management. These results underscore the critical need to integrate BMI management into the CRC screening continuum to optimize health and economic benefits.

The strengths of our study include: (*1*) a comprehensive evaluation incorporating CRC risk, competing comorbidities, and obesity-attributable costs; (*2*) assessment of multiple screening initiation ages to address the rising burden of early-onset CRC; and (*3*) estimation of resource demand and costs, providing essential evidence for resource-limited regions. Importantly, our model was specifically adapted to reflect the distinct epidemiological patterns of CRC and obesity in China, thereby generating tailored, policy-relevant evidence.

This study has at least three limitations. First, it primarily relied on the adenoma–carcinoma sequence (70%–90% of CRC cases) because of insufficient Chinese data on serrated pathways. Second, we did not consider emerging screening technologies (including mt-sDNA) owing to the lack of population-based evidence in China. Future evaluations should include novel technologies when Chinese-specific data become available. Finally, more effective obesity markers (including central adiposity metrics) should be incorporated to optimize obesity-specific risk stratification.

Our study highlights that CRC screening in China is cost-effective across BMI groups, with individuals who are overweight or obese showing high colonoscopy resource efficiency. Based on these results, we recommend that screening programs in China prioritize populations with a high BMI, particularly under resource constraints. Furthermore, amid rising healthcare costs caused by obesity and related comorbidities, integrating weight management into CRC screening is essential for optimizing screening efficacy and long-term cost containment.

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SUPPLEMENTARY MATERIALS

OVERVIEW OF THE MODEL

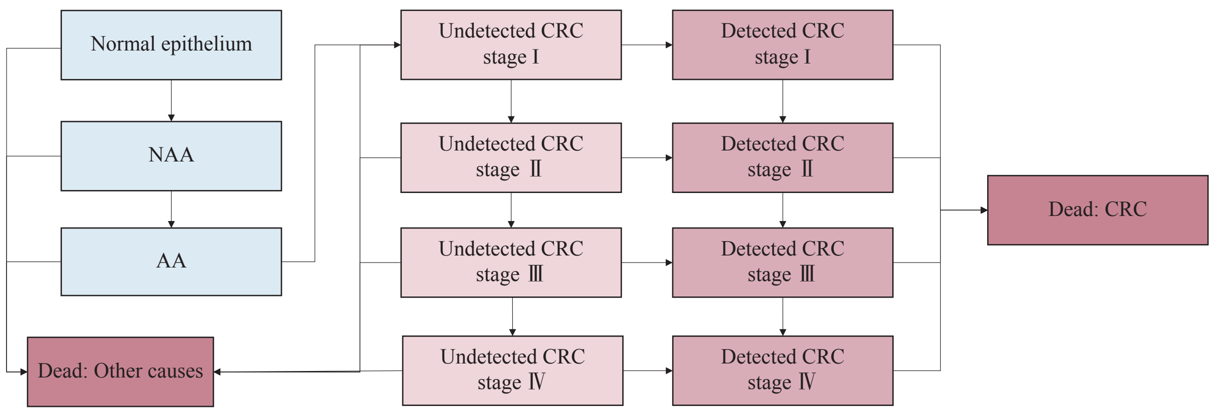
The Colorectal Cancer (CRC) Screening Simulation model was constructed using TreeAge Pro 2022 to simulate the natural history, screening, and treatment of CRC in a hypothetical population. The model incorporates nine mutually exclusive health states: normal epithelium; non-advanced adenoma; advanced adenoma; CRC stages I–IV; CRC death; and death from other causes (Supplementary Figure S1). Guided by the clinical characteristics of the Chinese population and large-scale cancer screening program implementations, non-advanced adenoma and advanced adenoma states were included to model the progression of colorectal precancerous lesions. The model assumes that all CRC arises via the adenoma–carcinoma sequence, accounting for approximately 80% of all CRC cases. Diagnosed CRC is represented as a mutually exclusive state; once an individual is diagnosed, CRC progression halts, and they transition to the corresponding management pathways. The model features two absorbing states: death from other causes and CRC-related death.

The natural history transition probabilities were derived from a systematic review. Without screening, individuals may still be diagnosed with CRC through symptomatic presentations or incidental findings during the investigation of other health conditions. A model calibration approach was employed to ascertain these parameter values. The methods and results are presented in Supplementary Table S1. Age-specific all-cause, CRC, and non-CRC mortality rates in China were derived from the China Statistical Yearbook. Other-cause mortality was calculated as follows: $\mathrm{Oth}_{\mathrm{Cause}_{\mathrm{Mort}}(\mathrm{age})} = \mathrm{All\_Cause\_Mort}\,(\mathrm{age}) \times (1 - (\mathrm{N\_CRC}_{\mathrm{Deaths}}\,(\mathrm{age}) \,/\, \mathrm{N\_All\_Deaths}\,(\mathrm{age})\,))$.

CRC Risk and Mortality by Body Mass Index (BMI) and Risk Modification

CRC risks by BMI strata were derived from a population-based CRC screening program in China that included 182,927 participants (*1*), with detailed estimates provided in Supplementary Table S1. Mortality by BMI strata was derived from an international multicenter cohort study, and the estimated relative risk was obtained from the Chinese subgroup (*2*).

Model implementation required calculating CRC risk by BMI stratum relative to the population-average risk (i.e., relative to the model's original calibration), not relative to the normal-weight group. To derive these estimates, we accounted for the proportional distribution of each BMI stratum in the population during the calibration period, ensuring that aggregating stratum-specific relative risks yielded the population-average CRC risk. We used prevalence data on overweight and obesity from the *Report on the Nutrition and Chronic Diseases Status of Chinese Residents 2020* (*3*), which were consistent with findings from consecutive nationally representative surveys (*4*) and a large cross-sectional study in China (*5*). Based on these data, we generated BMI-stratified CRC relative risks compared with population-average risks (*6*). The modified relative risks are provided in Supplementary Table S1.



SUPPLEMENTARY FIGURE S1. Schematic of the colorectal cancer screening simulation model.
Abbreviation: NAA=non-advanced adenoma; AA=advanced adenoma; CRC=colorectal cancer.

TABLE S1. Parameters of the Colorectal Cancer Screening Simulation model.

Parameters	Base case value	Reference
Nature history		
Normal to NAA	Age-dependent, range from 0.0004 to 0.0345	Calibration
NAA to AA	0.020	(*12–13*)
AA to preclinical CRC	0.044	(*12*)
CRC I-II	0.300	
CRC II- III	0.450	(*14*)
CRC III- IV	0.500	
Preclinical CRC I-II to diagnosis	0.190	
Preclinical CRC III to diagnosis	0.430	(*15*)
Preclinical CRC IV to diagnosis	0.720	
CRC I to death	0.032	
CRC II to death	0.041	Estimated though systematic review (*16*)
CRC III to death	0.106	
CRC IV to death	0.214	
Heath utility		
No colorectal lesion & false positive	1.000	
NAA	0.955	
AA	0.955	
CRC		
CRC stage 1	0.768	(*17–18*)
CRC stage 2	0.656	
CRC stage 3	0.562	
CRC stage 4	0.495	
Death	0	
Screening cost		
FIT[1]	2.17	(*19*)
Colonoscopy	72.47	
Time lost from FIT	2.22	
Travel cost from FIT	0.07	
Pathology	19.43	(*17*)
Travel cost from clinical screening	0.76	
Time lost from clinical screening	7.6	
Treatment for complications	154.57	
Direct medical and non-medical cost of treatment (USD)[1]		
NAA	189.29	
AA		
Surgery	2657.3	
Endoscopic mucosal resection	424.12	
Precent of AA receiving surgery	0.027	(*17*)
CRC Stage I	9944.76	
CRC Stage II	10627.79	
CRC Stage III	11928.97	
CRC Stage IV	14665.51	

Continued

Parameters	Base case value	Reference
Indirect cost of treatment (USD)		
AA - surgery	520.59	(*17*)
AA - endoscopic mucosal resection	83.09	
Stage I	1895.56	
Stage II	1927.94	
Stage III	2441.06	
Stage IV	3158.44	
Screening performance		
Colonoscopy		
Sensitivity for NAA	85%	(*20*)
Sensitivity for AA	95%	(*20*)
Sensitivity for preclinical CRC & CRC	95%	(*20*)
Specificity of colonoscopy	86%	(*20*)
FIT		
Sensitivity for NAA	8.7%	(*21*)
Sensitivity for AA	20.3%	(*21*)
Sensitivity for preclinical CRC & CRC	78.9%	(*21*)
Specificity of FIT	95%	(*22*)
CRC Risk and Mortality by BMI		
Modified incidence RR for normal	0.93	(*1*)
Modified incidence RR for overweight	1.04	(*1*)
Modified incidence RR for obesity	1.12	(*1*)
Modified all-cause mortality RR for normal	0.90	(*23*)
Modified all-cause mortality RR for overweight	1.05	(*23*)
Modified all-cause mortality RR for obesity	1.22	(*23*)

Abbreviations: AA=advanced adenoma; CRC=colorectal cancer; NAA=non-advanced adenoma; FIT=fecal immunochemical test.

Colonoscopy Complications in Individuals with Overweight and Obesity

We incorporated findings from a published systematic review investigating the association between overweight/obesity and colonoscopy complications (*7*). The review reported that the only well-studied colonoscopy outcome related to obesity was poorer bowel preparation in individuals with overweight or obesity (*8*). No high-quality evidence was found regarding risks associated with moderate sedation or colonoscopy specifically in these populations (*9*). Published studies have not shown significantly increased rates of acute coronary syndrome or cerebrovascular accident associated with major cardiac or colorectal surgery in individuals with overweight or obesity (*10*).

Medical Costs of Overweight and Obesity

Additional per capita healthcare costs associated with overweight and obesity were derived from a longitudinal study of individual-level healthcare expenditures. The study reported annual additional costs of $44.02 for individuals with overweight and $75.79 for those with obesity (*11*).

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Preplanned Studies

Longitudinal Trajectories of Adiposity Indicators and Cancer Risk Over 14 Years: Evidence from Repeated Health Check-Ups of 10 Times or More — China, 2010–2023

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Summary

What is already known about this topic?

Central obesity is a recognized risk factor for several types of cancers. However, most supporting evidence originates from Western populations and relies on single adiposity measurements, with limited longitudinal data available from China.

What is added by this report?

Drawing on data from more than 25,000 Chinese adults who each underwent 10 or more health check-ups over 14 years, this study demonstrated that waist-related indicators — particularly Body Mass Index - adjusted waist circumference (WCadjBMI) and waist-to-hip ratio (WHRadjBMI) — and their inverted U-shaped trajectories are more strongly associated with cancer risk than BMI alone, especially in men and adults aged 50 years and above.

What are the implications for public health practice?

Tracking changes in waist-related fat measures over time may help identify cancer risk earlier than BMI monitoring alone. Integrating central obesity measures into routine screening could improve targeted cancer prevention, particularly for the older and male populations, and advance the goals of Healthy China 2030.

ABSTRACT

Introduction: Obesity, particularly central adiposity, has been associated with elevated cancer risk. However, longitudinal data on adiposity trajectories and cancer incidence in Chinese populations remain limited.

Methods: We analyzed data from 25,653 adults with ≥10 health check-ups in the West China Hospital Alliance Longitudinal Epidemiology Wellness (WHALE) Study (2010–2023). Five adiposity indicators — body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), BMI-adjusted WC (WCadjBMI), and BMI-adjusted WHR (WHRadjBMI) — were evaluated using Poisson regression and generalized linear mixed-effects models. Latent class mixed modeling identified long-term adiposity trajectories. Analyses were stratified by sex and age (≥50 years).

Results: Over 14 years, 393 participants developed cancer. Higher BMI [risk ratio (*RR*)=0.873, *P*=0.019] was associated with lower cancer risk, whereas central adiposity indicators (e.g., WCadjBMI, *RR*=1.175, *P*=0.001) showed positive associations, particularly among men and those aged ≥50 years. WCadjBMI was significantly associated with lung cancer (*RR*=1.246, *P*=0.009), with similar trends for breast and liver cancers. Inverted U-shaped trajectories of BMI-adjusted waist measures were linked to elevated cancer risk, highlighting the relevance of long-term fat distribution.

Conclusions: Central adiposity and its trajectories are associated with cancer risk in Chinese adults, supporting dynamic obesity monitoring and targeted prevention in older adults and men.

Obesity is now recognized as a major modifiable cancer risk factor. Globally, an estimated 4%–8% of all cancer cases are attributable to elevated body mass index (BMI), with higher proportions in high-income countries. Prospective cohorts in Europe and North America have shown that obesity increases the risk of colorectal, breast, kidney, and liver cancers by 1.5 to 2 times (*1*). Beyond energy storage, adipose tissue acts as an endocrine organ that can promote carcinogenesis through chronic inflammation, insulin resistance, hormonal imbalances, and altered adipokine secretion (*2*). However, most studies rely on a single baseline adiposity measure, which does not reflect long-term exposure or changing fat distribution.

In China, both obesity and cancer burdens have increased sharply in recent decades. National survey data show that adult obesity has surpassed 16% (*3*), while cancer incidence reached 341.75 per 100,000 in 2022 (*4*). Rapid increases have been noted in cancers such as lung, colorectal, and thyroid, with accumulating evidence linking them to central obesity (*5*). Nevertheless, most research on adiposity and cancer is based on Western cohorts and may not fully represent the metabolic profiles or fat distribution patterns of Chinese adults. Furthermore, limited Chinese studies have leveraged repeated health checkup data to assess how long-term changes in adiposity influence cancer risk.

To address this evidence gap and support the "Healthy China 2030" strategy, which emphasizes proactive health management, this study used data from the West China Hospital Alliance Longitudinal Epidemiology Wellness (WHALE) Study. The study integrates routine health check-up records from multiple centers. By analyzing more than 25,000 adults with at least 10 check-ups, we investigated how general and central adiposity indicators and their long-term trajectories relate to cancer incidence. This study offers novel evidence on the predictive value of dynamic fat distribution, which may improve early risk detection and inform population-based cancer prevention strategies in China.

Data were obtained from the WHALE Study (2010–2023), which is based on periodic health check-ups conducted at the Health Management Center of West China Hospital and its four affiliated subcenters (*6*). After excluding individuals with fewer than 10 visits, missing BMI data, or insufficient pre-diagnosis records, 25,653 adults were included in the analysis. Cancer cases were identified through hospital-confirmed diagnoses during follow-up visits. Obesity-related indicators included BMI, waist circumference (WC), and waist-to-hip ratio (WHR), measured using standardized protocols. Residualized variables [BMI-adjusted waist circumference (WCadjBMI) and BMI-adjusted waist-to-hip ratio (WHRadjBMI)] were constructed to minimize collinearity. Repeated measures were handled using an Andersen-Gill structure, and Poisson regression was used to estimate risk ratio (RR) for incident cancer. Generalized linear mixed models with random intercepts accounted for within-individual correlation. Analyses were stratified by sex and baseline age. Latent class mixed modeling was applied to identify long-term obesity trajectories, which were then incorporated into regression models (Figure 1). All statistical analyses were conducted using R (version 4.2.3, R Foundation for Statistical Computing, Vienna, Austria). Detailed analytic procedures are provided in the Supplementary Materials (available at https://weekly.chinacdc.cn/).

A total of 25,653 adults with at least 10 health check-up records were included in the final sample. The median age was 40 years, and 53.0% were male. During follow-up, 393 participants (1.5%) were diagnosed with malignant tumors. Compared with cancer-free participants, those who developed cancer were older (median age: 46 *vs*. 40 years, $P<0.001$) and had higher rates of hypertension (27.5% *vs*. 19.5%, $P<0.001$) and diabetes (10.9% *vs*. 6.6%, $P=0.001$) (Table 1). The distribution of cancer types is presented in Supplementary Table S1 (available at https://weekly.chinacdc.cn/).

Poisson regression analysis showed distinct differences in how adiposity indicators were associated with cancer risk (Figure 2A and Supplementary Table S2, available at https://weekly.chinacdc.cn/). In the overall sample, higher BMI was consistently linked to lower cancer risk, even after full adjustment for demographic, behavioral, and metabolic factors [risk ratio (*RR*)=0.873; 95% confidence interval (*CI*): 0.778, 0.977; $P=0.019$]. By contrast, WCadjBMI was positively associated with cancer risk (*RR*=1.175; 95% *CI*: 1.071, 1.289; $P=0.001$), suggesting an independent contribution of central adiposity to cancer development.

In sex-stratified analyses, both WCadjBMI and WC remained significantly associated with increased cancer risk in men (WCadjBMI *RR*=1.353; 95% *CI*: 1.194, 1.531; $P<0.001$; and WC *RR*=1.182, 95% *CI*: 1.031, 1.352, $P=0.016$), while BMI showed no significant association. Among women, WHR displayed a significant negative association with cancer risk (*RR*=0.830; 95% *CI*: 0.704, 0.975; $P=0.025$), while no other indicators were significant.

Age-stratified analyses showed that in participants aged ≥50 years, WHRadjBMI (*RR*=1.193; 95% *CI*: 1.016, 1.395; $P=0.030$) and WCadjBMI (*RR*=1.392; 95% *CI*: 1.189, 1.626; $P<0.001$) were both associated with higher cancer risk. For those aged <50 years, WHR remained the only significant indicator (*RR*=0.837; 95% *CI*: 0.705, 0.992; $P=0.042$), showing an inverse association. Findings were consistent across mixed-effects models, supporting the robustness of these results (Supplementary Table S2).

WCadjBMI was significantly associated with increased lung cancer risk and showed positive trends for other cancer types, in contrast to the inverse

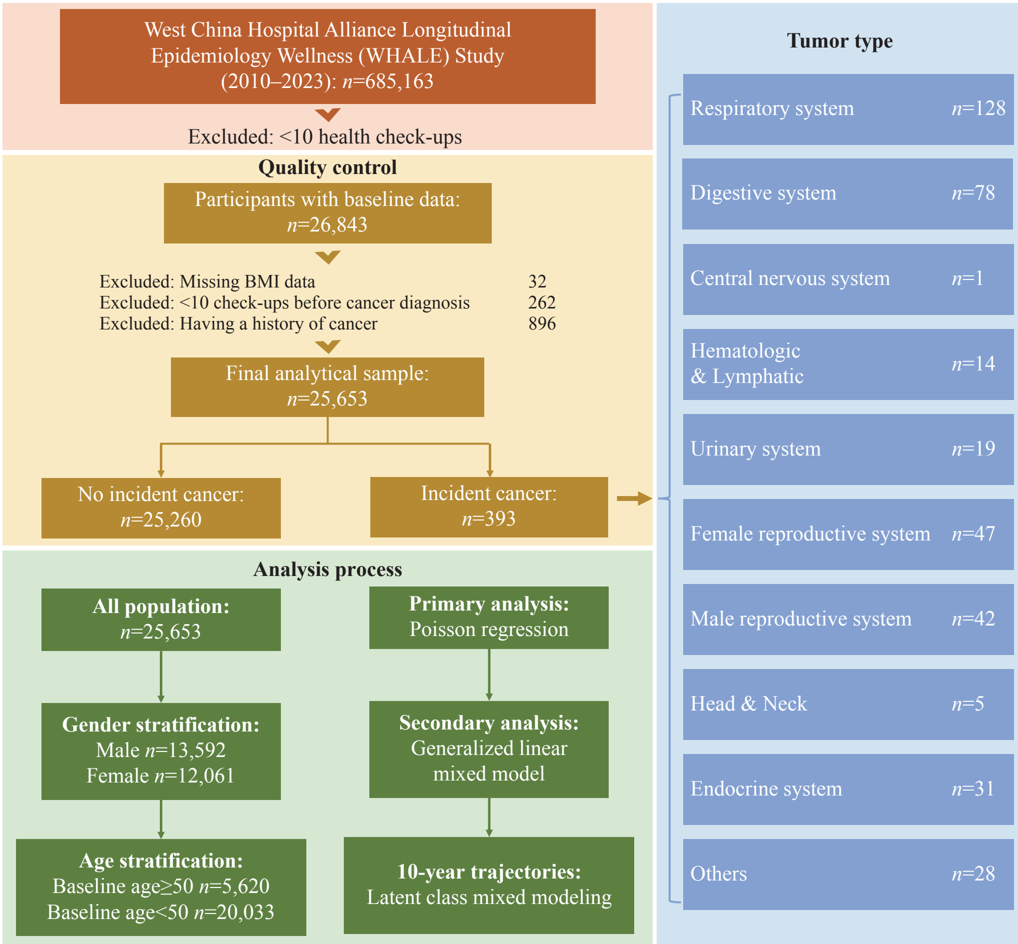

FIGURE 1. Flowchart of study population selection from the WHALE Study, 2010–2023.

Note: A stepwise illustration of participant inclusion and exclusion criteria is used to derive the final analytic sample (*n*=25,653) from the original WHALE Study (*n*=685,163), based on repeated health check-up data and cancer diagnosis status.

Abbreviation: BMI=body mass index; WHALE=West China Hospital Alliance Longitudinal Epidemiology Wellness.

relationship observed for BMI (Supplementary Table S3, available at https://weekly.chinacdc.cn/).

Trajectory analysis revealed that an inverted U-shaped pattern of WHRadjBMI was significantly associated with greater cancer risk in the overall population (unadjusted *RR*=1.448; 95% *CI*: 1.058, 1.937; *P*=0.016) and in men (unadjusted *RR*=1.862, 95% *CI*: 1.066, 3.066; *P*=0.020). Among individuals aged ≥50 years, an inverted U-shaped WCadjBMI trajectory remained significantly associated with higher cancer risk after full adjustment (*RR*=1.776; 95% *CI*: 0.973, 2.991; *P*=0.043) (Figure 2B and Supplementary Table S4, available at https://weekly.chinacdc.cn/).

DISCUSSION

This longitudinal cohort study of more than 25,000 Chinese adults with at least 10 repeated check-ups over 14 years provides robust evidence that central adiposity indicators, particularly WC and WCadjBMI, are independently associated with higher cancer risk. Stratified analyses showed stronger predictive value of central adiposity measures among men and individuals aged ≥50 years. Most notably, trajectory modeling revealed that participants following an inverted U-shaped trajectory of WHRadjBMI or WCadjBMI had significantly greater cancer risk, suggesting that long-term adiposity dynamics may provide an early opportunity for cancer risk detection. The inverse BMI–cancer association may partly reflect reverse causation from pre-diagnostic weight loss (*7*). These findings have direct practical public health implications, supporting routine monitoring of central adiposity (thereby outperforming BMI in cancer prediction) as part of chronic disease prevention strategies in China.

TABLE 1. Baseline characteristics of 25,653 adults in the WHALE Study (2010–2023), by cancer status.

Baseline characteristics	Cancer status			
	Overall	Cancer	Non cancer	*P*
N	25,653	393	25,260	
Age [(median IQR)]	40.00 [32.00, 48.00]	46.00 [38.00, 55.00]	40.00 [32.00, 48.00]	<0.001
BMI [(median IQR)]	22.98 [20.83, 25.32]	23.38 [21.08, 25.46]	22.96 [20.83, 25.32]	0.126
WHR [(median IQR)]	0.84 [0.78, 0.89]	0.84 [0.79, 0.90]	0.84 [0.78, 0.89]	0.186
Age group, years (%)				
<50	20,033 (78.1)	249 (63.4)	19,784 (78.3)	<0.001
≥50	5,620 (21.9)	144 (36.6)	5,476 (21.7)	
Sex (%)				
Male	13,592 (53.0)	212 (53.9)	13,380 (53.0)	0.739
Female	12,061 (47.0)	181 (46.1)	11,880 (47.0)	
Smoke status (%)				0.377
Current smoker	6,666 (26.0)	112 (28.5)	6,554 (25.9)	
Former smoker	77 (0.3)	2 (0.5)	75 (0.3)	
Non smoker	18,910 (73.7)	279 (71.0)	18,631 (73.8)	
Drink status (%)				0.493
Current drinker	10,186 (39.7)	151 (38.4)	10,035 (39.7)	
Former drinker	62 (0.2)	2 (0.5)	60 (0.2)	
Non drinker	15,405 (60.1)	240 (61.1)	15,165 (60.0)	
Hypertension (%)				
Hypertension	5,039 (19.6)	108 (27.5)	4,931 (19.5)	<0.001
Non hypertension	20,614 (80.4)	285 (72.5)	20,329 (80.5)	
Diabetes (%)				
Diabetes	1,721 (6.7)	43 (10.9)	1,678 (6.6)	0.001
Non diabetes	23,932 (93.3)	350 (89.1)	23,582 (93.4)	

Note: Continuous variables are expressed as median (IQR); categorical variables are expressed as percentages (%). The analytic sample includes 25,653 participants with ≥10 health check-up records from the West China Hospital Alliance Longitudinal Epidemiology Wellness (WHALE) Study, 2010–2023.

Abbreviation: BMI=body mass index; WHR=waist-to-hip ratio; WHALE=West China Hospital Alliance Longitudinal Epidemiology Wellness; IQR=interquartile range.

Our results are consistent with both international and domestic studies which highlight the role of central adiposity in cancer development. A large UK Biobank analysis reported that waist-based indicators were more strongly associated with obesity-related cancers than BMI, with notable sex-specific differences (*8*). Similar findings have been observed in Chinese cohorts, including the MJ Health and Guangzhou Biobank studies, where waist-based measures outperformed BMI in predicting cancer risk, especially among women and for colorectal cancer (*9*–*10*). The present study reinforces these findings and emphasizes the relevance of fat distribution indicators, especially for men and older adults. The stronger link between central adiposity and cancer is likely mediated by visceral fat–driven inflammation and hormonal disruption (*8*,*11*). Additionally, the inverted U-shaped trajectories of WHRadjBMI and WCadjBMI may indicate early subclinical processes such as cachexia or systemic inflammation preceding a cancer diagnosis (*12*).

This study has several strengths, including its large and well-characterized sample, repeated anthropometric measurements over a long follow-up period, and the combined use of trajectory modeling and traditional regression approaches to better capture cancer risk dynamics. The use of residualized adiposity indicators allowed clearer differentiation between general and central adiposity effects.

The findings in this report are subject to four main

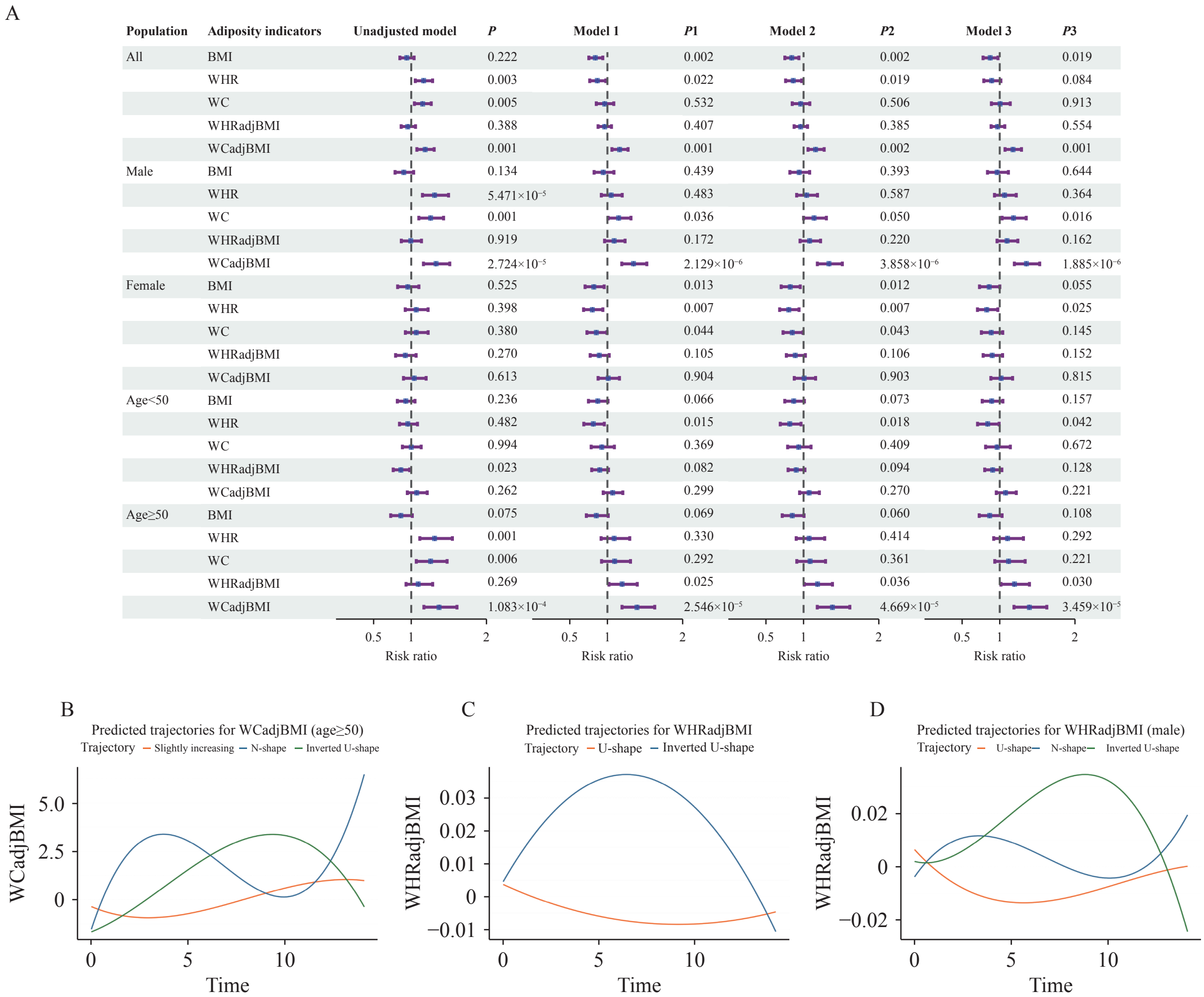

FIGURE 2. Longitudinal trajectories of adiposity indicators and their associations with cancer risk in the WHALE Study (2010–2023). (A) Forest plot of *RR*s and 95% *CI*s for the associations between adiposity indicators and cancer risk across the total population and subgroups (by sex and age group); (B) Trajectories of adiposity indicators over time prior to cancer diagnosis, estimated by latent class mixed modeling: (B) WCadjBMI in participants aged ≥50 years; (C) WHRadjBMI in the overall population; (D) WHRadjBMI in males.

Note: (A), Model 1: adjusted for baseline age and sex (sex not adjusted in sex-stratified models); Model 2: additionally adjusted for smoking status and drinking habits; Model 3: additionally adjusted for hypertension and diabetes. (B), in participants aged ≥50 years, an inverted U-shaped WCadjBMI trajectory remained significantly associated with elevated cancer risk in the fully adjusted model (Model 3: *RR*=1.776, 95% *CI*: 0.973, 2.991, *P*=0.043). In the overall population, an inverted U-shaped WHRadjBMI trajectory was significantly associated with increased cancer risk in the unadjusted model (*RR*=1.448, 95% *CI*: 1.058, 1.937, *P*=0.016). Among males, the same trajectory showed a similar association (*RR*=1.862, 95% *CI*: 1.066, 3.066, *P*=0.020). No significant associations were observed for BMI trajectories in any subgroup. Detailed trajectory class distributions, model fit indices, and regression estimates are presented in Supplementary Tables S4–S5 and Supplementary Figure S1 (available at https://weekly.chinacdc.cn/).

Abbreviation: *CI*=confidence interval; *RR*s=risk ratios; BMI=body mass index; WCadjBMI=Waist circumference adjusted for age, sex, and BMI; WHRadjBMI=Waist-to-hip ratio adjusted for age, sex, and BMI; WHALE=West China Hospital Alliance Longitudinal Epidemiology Wellness.

limitations. First, the relatively small number of cancer cases may have limited statistical power, particularly in subgroup and trajectory analyses. Second, excluding individuals with fewer than 10 follow-up visits or pre-existing cancer may have introduced survivorship bias, potentially underestimating cancer incidence in higher-risk individuals who were lost to follow-up or died earlier. Third, residual confounding influences from unmeasured lifestyle factors, such as diet and physical activity, cannot be ruled out. Finally, cancer type-specific analyses were constrained by sample size and should be addressed in future large-scale studies.

Given China's ongoing implementation of the "Healthy China 2030" initiative (*6*), which prioritizes personalized and proactive chronic disease prevention, these findings provide timely and actionable evidence to support targeted cancer screening and interventions addressing abdominal obesity. Future research should aim to incorporate more comprehensive lifestyle data, extend follow-up duration, and expand sample sizes to enhance subgroup analyses and clarify site-specific cancer associations, further strengthening the evidence base for targeted public health interventions in China.

Conflicts of interest: No conflicts of interest.

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SUPPLEMENTARY MATERIALS

Study Population and Data Source

Data were derived from the West China Hospital Alliance Longitudinal Epidemiology Wellness (WHALE) Study, a large-scale hospital-based study anchored at West China Hospital (WCH) of Sichuan University — the largest tertiary medical center in western China. WCH serves a referral population exceeding 80 million across Sichuan and neighboring provinces (*1*). Among 685,163 participants initially enrolled (2010–2023), we excluded individuals with fewer than 10 total check-up visits, missing baseline body mass index (BMI), or fewer than 10 visits prior to cancer diagnosis. A total of 25,653 adults were included in the final analytic sample.

Outcome Ascertainment

Cancer incidence was identified through clinically confirmed diagnoses in hospital-based electronic medical records. Participants were categorized as either developing incident malignant tumors (*n*=393) or remaining cancer-free during follow-up (*n*=25,260). Based on clinical plausibility experience. We further look into the top 5 most incident cancer and liver, stomach cancer in our database, using the same analysis.

SUPPLEMENTARY TABLE S1. Tumor prevalence and incidence in individuals undergoing ≥10 check-ups (total population: 26,843).

Cancer system	Cancer type	Label	Cases detected	New cases	Total population	Prevalence (%)	Incidence rate (per 10^5)
Respiratory System	Lung Cancer	1	315	181	26,843	1.173	674.291
Digestive System	Liver Cancer	2	54	24	26,843	0.201	89.409
	Stomach Cancer	3	52	20	26,843	0.194	74.507
	Colorectal Cancer	4	123	57	26,843	0.458	212.346
	Esophageal Cancer	5	13	11	26,843	0.048	40.979
	Pancreatic Cancer	6	17	10	26,843	0.063	37.254
	Gallbladder Cancer	7	40	3	26,843	0.149	11.176
Central Nervous System	Brain and CNS Tumors	8	10	4	26,843	0.037	14.901
Hematologic & Lymphatic	Leukemia	9	27	16	26,843	0.101	59.606
	Lymphoma	10	39	20	26,843	0.145	74.507
Urinary System	Bladder Cancer	11	41	23	26,843	0.153	85.683
	Kidney Cancer	12	66	21	26,843	0.246	78.233
Female Reproductive System	Cervical Cancer	13	25	1	26,843	0.093	3.725
	Uterine Cancer	14	43	2	26,843	0.160	7.451
	Ovarian Cancer	15	19	2	26,843	0.071	7.451
	Breast Cancer	16	162	53	26,843	0.604	197.444
Male Reproductive System	Testicular Cancer	17	3	2	26,843	0.011	7.451
	Prostate Cancer	18	117	63	26,843	0.436	234.698
Head & Neck	Lip, Oral Cavity, and Pharyngeal Cancer	20	10	1	26,843	0.037	3.725
	Laryngeal Cancer	21	6	3	26,843	0.022	11.176
	Nasopharyngeal Cancer	22	25	5	26,843	0.093	18.627
Endocrine System	Thyroid Cancer	23	251	69	26,843	0.935	257.050
Others	Others	24	93	64	26,843	0.346	238.423

Note: This table summarizes tumor data from individuals who underwent ≥10 check-ups.The total number of tumor cases is 1,551. “Cases Detected” refers to the cumulative number of individuals found to have tumors in any of the 10 rounds; “New cases” refers to individuals who were newly diagnosed with tumors during the current round. “Prevalence (%)” is the proportion of all detected cases relative to the total population; “Incidence rate (per 100,000)” represents the rate of newly diagnosed cases per 100,000 individuals.

Exposure Assessment

Obesity-related indicators included BMI (kg/m^2), waist circumference (WC), and waist-to-hip ratio (WHR), measured using standardized anthropometric procedures during each visit. To reduce multicollinearity and capture independent associations, residualized indicators were computed via linear regression: WC adjusted for age, sex, and BMI (WCadjBMI), and WHR adjusted for age, sex, and BMI (WHRadjBMI).

Statistical Analysis

To account for time-varying covariates and repeated measures, data were structured using the Andersen-Gill formulation, with one risk record per visit until censoring (*2*). Poisson regression was used to estimate relative risks

SUPPLEMENTARY TABLE S2. Associations between adiposity indicators and cancer risk: results from Poisson regression and generalized linear mixed-effects models (GLMMs).

Method	Subgroup	Indicator	Unadjusted		Model 1		Model 2		Model 3	
			RR*, 95% *CI	***P***	***RR*, 95% *CI***	***P***	***RR*, 95% *CI***	***P***	***RR*, 95% *CI***	***P***
POISSON	All	BMI	0.939 (0.849, 1.038)	0.222	0.841 (0.753, 0.939)	0.002	0.840 (0.751, 0.938)	0.002	0.873 (0.778, 0.977)	0.019
		WHR	1.164 (1.054, 1.284)	0.003	0.866 (0.765, 0.979)	0.022	0.862 (0.761, 0.975)	0.019	0.895 (0.788, 1.015)	0.084
		WHRadjBMI	0.957 (0.866, 1.057)	0.388	0.962 (0.876, 1.054)	0.407	0.960 (0.874, 1.053)	0.385	0.972 (0.885, 1.067)	0.554
		WCadjBMI	1.185 (1.075, 1.305)	<0.001	1.163 (1.060, 1.275)	0.001	1.162 (1.059, 1.274)	0.002	1.175 (1.070, 1.289)	<0.001
		WC	1.149 (1.042, 1.266)	0.005	0.962 (0.852, 1.085)	0.532	0.960 (0.849, 1.083)	0.506	1.007 (0.889, 1.140)	0.913
	Male	BMI	0.901 (0.785, 1.032)	0.134	0.946 (0.823, 1.087)	0.439	0.941 (0.818, 1.081)	0.393	0.967 (0.837, 1.115)	0.644
		WHR	1.313 (1.149, 1.496)	<0.001	1.049 (0.919, 1.197)	0.483	1.038 (0.908, 1.185)	0.587	1.065 (0.930, 1.220)	0.364
		WHRadjBMI	0.993 (0.868, 1.136)	0.919	1.091 (0.962, 1.235)	0.172	1.082 (0.953, 1.226)	0.220	1.095 (0.964, 1.241)	0.162
		WCadjBMI	1.327 (1.162, 1.512)	<0.001	1.348 (1.191, 1.524)	<0.001	1.340 (1.183, 1.515)	<0.001	1.353 (1.194, 1.531)	<0.001
		WC	1.256 (1.101, 1.430)	<0.001	1.151 (1.009, 1.313)	0.036	1.142 (1.000, 1.303)	0.050	1.182 (1.031, 1.352)	0.016
	Female	BMI	0.953 (0.819, 1.102)	0.525	0.822 (0.703, 0.957)	0.013	0.821 (0.702, 0.956)	0.012	0.857 (0.731, 1.001)	0.055
		WHR	1.064 (0.920, 1.224)	0.398	0.802 (0.683, 0.940)	0.007	0.802 (0.682, 0.940)	0.007	0.830 (0.704, 0.975)	0.025
		WHRadjBMI	0.920 (0.792, 1.065)	0.270	0.889 (0.771, 1.024)	0.105	0.890 (0.771, 1.024)	0.106	0.900 (0.779, 1.038)	0.152
		WCadjBMI	1.038 (0.897, 1.198)	0.613	1.009 (0.876, 1.160)	0.904	1.009 (0.876, 1.160)	0.903	1.017 (0.882, 1.171)	0.815
		WC	1.066 (0.922, 1.225)	0.380	0.852 (0.728, 0.994)	0.044	0.851 (0.727, 0.993)	0.043	0.888 (0.756, 1.040)	0.145
	Age<50 years	BMI	0.926 (0.815, 1.050)	0.236	0.870 (0.748, 1.008)	0.066	0.872 (0.750, 1.011)	0.073	0.895 (0.767, 1.042)	0.157
		WHR	0.956 (0.844, 1.083)	0.482	0.812 (0.686, 0.959)	0.015	0.817 (0.690, 0.966)	0.018	0.837 (0.705, 0.992)	0.042
		WHRadjBMI	0.863 (0.760, 0.979)	0.023	0.896 (0.791, 1.014)	0.082	0.899 (0.794, 1.018)	0.094	0.907 (0.800, 1.028)	0.128
		WCadjBMI	1.073 (0.948, 1.213)	0.262	1.067 (0.944, 1.205)	0.299	1.071 (0.947, 1.210)	0.270	1.08 (0.954, 1.220)	0.221
		WC	1.001 (0.883, 1.132)	0.994	0.927 (0.784, 1.093)	0.369	0.932 (0.788, 1.099)	0.409	0.964 (0.812, 1.141)	0.672
	Age≥50 years	BMI	0.860 (0.727, 1.014)	0.075	0.854 (0.720, 1.011)	0.069	0.850 (0.716, 1.006)	0.060	0.866 (0.727, 1.031)	0.108
		WHR	1.313 (1.114, 1.547)	0.001	1.090 (0.916, 1.297)	0.330	1.076 (0.902, 1.281)	0.414	1.101 (0.920, 1.315)	0.292
		WHRadjBMI	1.095 (0.931, 1.285)	0.269	1.196 (1.021, 1.397)	0.025	1.184 (1.009, 1.384)	0.036	1.193 (1.016, 1.395)	0.030
		WCadjBMI	1.371 (1.168, 1.608)	<0.001	1.396 (1.194, 1.629)	<0.001	1.383 (1.182, 1.615)	<0.001	1.392 (1.189, 1.626)	<0.001
		WC	1.256 (1.067, 1.477)	0.006	1.098 (0.922, 1.307)	0.292	1.085 (0.910, 1.292)	0.361	1.119 (0.934, 1.338)	0.221

Continued

Method	Subgroup	Indicator	Unadjusted		Model 1		Model 2		Model 3	
			RR, 95% *CI*	*P*	*RR*, 95% *CI*	*P*	*RR*, 95% *CI*	*P*	*RR*, 95% *CI*	*P*
GLMM	All	BMI	0.937 (0.847, 1.036)	0.202	0.842 (0.754, 0.941)	0.002	0.840 (0.752, 0.939)	0.002	0.872 (0.778, 0.977)	0.018
		WHR	1.158 (1.049, 1.278)	0.004	0.864 (0.763, 0.977)	0.020	0.858 (0.758, 0.972)	0.016	0.890 (0.784, 1.010)	0.071
		WHRadjBMI	0.956 (0.865, 1.056)	0.376	0.959 (0.874, 1.052)	0.378	0.956 (0.871, 1.049)	0.343	0.968 (0.881, 1.063)	0.496
		WCadjBMI	1.178 (1.069, 1.298)	0.001	1.158 (1.056, 1.27)	0.002	1.156 (1.054, 1.269)	0.002	1.169 (1.065, 1.284)	0.001
		WC	1.142 (1.036, 1.259)	0.008	0.960 (0.850, 1.083)	0.507	0.957 (0.847, 1.081)	0.476	1.003 (0.885, 1.136)	0.966
	Male	BMI	0.900 (0.785, 1.032)	0.132	0.946 (0.822, 1.088)	0.437	0.941 (0.818, 1.083)	0.398	0.966 (0.837, 1.116)	0.642
		WHR	1.310 (1.148, 1.495)	0.000	1.046 (0.916, 1.195)	0.505	1.035 (0.906, 1.183)	0.609	1.062 (0.927, 1.217)	0.388
		WHRadjBMI	0.993 (0.868, 1.136)	0.919	1.088 (0.960, 1.234)	0.186	1.079 (0.951, 1.224)	0.238	1.091 (0.961, 1.239)	0.179
		WCadjBMI	1.322 (1.158, 1.509)	0.000	1.345 (1.188, 1.522)	0.000	1.337 (1.181, 1.514)	0.000	1.350 (1.192, 1.529)	0.000
		WC	1.253 (1.099, 1.429)	0.001	1.150 (1.007, 1.312)	0.039	1.141 (1.000, 1.303)	0.051	1.180 (1.031, 1.352)	0.017
	Female	BMI	0.951 (0.819, 1.103)	0.504	0.824 (0.705, 0.961)	0.014	0.823 (0.705, 0.960)	0.013	0.858 (0.733, 1.005)	0.057
		WHR	1.057 (0.916, 1.219)	0.450	0.802 (0.683, 0.941)	0.007	0.801 (0.683, 0.940)	0.007	0.828 (0.704, 0.975)	0.024
		WHRadjBMI	0.918 (0.791, 1.065)	0.257	0.887 (0.770, 1.023)	0.099	0.887 (0.770, 1.023)	0.099	0.898 (0.778, 1.037)	0.143
		WCadjBMI	1.028 (0.889, 1.189)	0.710	1.001 (0.869, 1.153)	0.988	1.001 (0.869, 1.153)	0.988	1.010 (0.876, 1.164)	0.896
		WC	1.056 (0.916, 1.218)	0.454	0.849 (0.727, 0.993)	0.041	0.849 (0.726, 0.992)	0.039	0.885 (0.754, 1.037)	0.131
	Age<50 years	BMI	0.922 (0.812, 1.047)	0.211	0.869 (0.749, 1.009)	0.066	0.872 (0.751, 1.013)	0.073	0.895 (0.768, 1.043)	0.157
		WHR	0.951 (0.839, 1.077)	0.425	0.811 (0.686, 0.960)	0.015	0.816 (0.690, 0.966)	0.018	0.835 (0.704, 0.992)	0.040
		WHRadjBMI	0.863 (0.761, 0.980)	0.023	0.895 (0.791, 1.014)	0.082	0.898 (0.793, 1.017)	0.092	0.906 (0.800, 1.027)	0.124
		WCadjBMI	1.066 (0.942, 1.206)	0.311	1.060 (0.938, 1.198)	0.349	1.065 (0.942, 1.204)	0.316	1.073 (0.949, 1.213)	0.263
		WC	0.992 (0.876, 1.124)	0.901	0.922 (0.780, 1.089)	0.339	0.928 (0.785, 1.097)	0.380	0.959 (0.808, 1.138)	0.628
	Age≥50 years	BMI	0.863 (0.730, 1.019)	0.082	0.855 (0.721, 1.013)	0.071	0.850 (0.717, 1.008)	0.062	0.867 (0.728, 1.033)	0.110
		WHR	1.307 (1.109, 1.541)	0.001	1.086 (0.912, 1.294)	0.353	1.072 (0.899, 1.277)	0.440	1.095 (0.915, 1.309)	0.321
		WHRadjBMI	1.090 (0.928, 1.281)	0.294	1.191 (1.018, 1.395)	0.029	1.178 (1.006, 1.380)	0.042	1.186 (1.011, 1.391)	0.036
		WCadjBMI	1.364 (1.162, 1.601)	0.000	1.392 (1.192, 1.627)	0.000	1.380 (1.180, 1.613)	0.000	1.389 (1.187, 1.625)	0.000
		WC	1.254 (1.066, 1.475)	0.006	1.098 (0.921, 1.308)	0.297	1.085 (0.911, 1.293)	0.361	1.118 (0.934, 1.338)	0.224

Note: Model 1: adjusted for baseline age and sex (sex was not adjusted in sex-stratified models); Model 2: further adjusted for smoking status and drinking habits; Model 3: further adjusted for hypertension and diabetes.

Abbreviation: BMI=body mass index; WHR=waist-to-hip ratio; WC=waist circumference; WHRadjBMI=WHR adjusted for age, sex and BMI; WCadjBMI=WC adjusted for age, sex and BMI; *RR*=risk ratio; *CI*=confidence interval.

(RRs) for cancer incidence. And we applied a generalized linear mixed-effects model (GLMM) with participant-level random intercepts to account for intra-individual correlation.

Four sequential models were constructed:

- Model 0: unadjusted
- Model 1: adjusted for age and sex
- Model 2: additionally adjusted for smoking status and alcohol consumption
- Model 3: further adjusted for comorbid hypertension and diabetes

SUPPLEMENTARY TABLE S3. Site-specific associations between adiposity indicators and cancer risk based on Poisson regression models.

Cancer type	Indicator	Unadjusted		Model 1		Model 2		Model 3	
		RR*, 95% *CI	***P***	***RR*, 95% *CI***	***P***	***RR*, 95% *CI***	***P***	***RR*, 95% *CI***	***P***
Lung Cancer	BMI	0.806 (0.670, 0.964)	0.020	0.760 (0.622, 0.925)	0.007	0.760 (0.622, 0.926)	0.007		
	WHR	1.068 (0.898, 1.269)	0.455	0.939 (0.755, 1.165)	0.572	0.933 (0.749, 1.159)	0.531	0.977 (0.781, 1.218)	0.835
	WHRadjBMI	1.110 (0.935, 1.311)	0.228	1.085 (0.923, 1.269)	0.318				
	WCadjBMI	1.268 (1.070, 1.497)	0.006	1.237 (1.050, 1.453)	0.010	1.23 (1.044, 1.446)	0.013	1.246 (1.057, 1.467)	0.009
	WC	0.993 (0.834, 1.180)	0.940	0.925 (0.743, 1.146)	0.478				
Colorectal Cancer	BMI	1.151 (0.851, 1.534)	0.350	0.970 (0.693, 1.342)	0.859	0.952 (0.679, 1.320)	0.771	NA	NA
	WHR	1.604 (1.185, 2.131)	0.002	0.996 (0.687, 1.437)	0.982	0.971 (0.667, 1.406)	0.879	NA	NA
	WHRadjBMI	0.977 (0.716, 1.320)	0.883	1.013 (0.763, 1.333)	0.930	1.001 (0.753, 1.320)	0.996	NA	NA
	WCadjBMI	1.065 (0.784, 1.438)	0.685	1.072 (0.808, 1.415)	0.629	NA	NA	NA	NA
	WC	1.437 (1.068, 1.922)	0.016	1.025 (0.711, 1.467)	0.895	NA	NA	NA	NA
Breast Cancer	BMI	0.645 (0.461, 0.888)	0.009	NA	NA	NA	NA	NA	NA
	WHR	0.451 (0.322, 0.623)	0.000	0.600 (0.398, 0.893)	0.013	NA	NA	NA	NA
	WHRadjBMI	0.680 (0.504, 0.922)	0.013	0.697 (0.525, 0.924)	0.013	NA	NA	NA	NA
	WCadjBMI	1.092 (0.810, 1.462)	0.562	1.061 (0.791, 1.412)	0.689	NA	NA	NA	NA
	WC	0.574 (0.409, 0.791)	0.001	NA	NA	NA	NA	NA	NA
Prostate Cancer	BMI	1.188 (0.877, 1.585)	0.254	0.884 (0.624, 1.248)	0.488	0.878 (0.617, 1.243)	0.467	0.930 (0.647, 1.328)	0.692
	WHR	1.893 (1.413, 2.415)	0.000	0.834 (0.570, 1.222)	0.351	0.833 (0.566, 1.225)	0.354	0.889 (0.599, 1.319)	0.562
	WHRadjBMI	0.741 (0.541, 1.016)	0.063	0.899 (0.667, 1.208)	0.482	0.901 (0.666, 1.215)	0.499	0.932 (0.687, 1.260)	0.652
	WCadjBMI	1.049 (0.769, 1.422)	0.762	1.124 (0.850, 1.483)	0.411	1.123 (0.848, 1.481)	0.415	1.154 (0.870, 1.522)	0.318
	WC	1.804 (1.346, 2.399)	0.000	0.991 (0.688, 1.422)	0.959	0.985 (0.682, 1.418)	0.938	1.057 (0.724, 1.535)	0.772
Thyroid Cancer	BMI	1.230 (0.873, 1.698)	0.224	1.373 (0.953, 1.907)	0.075	NA	NA	NA	NA
	WHR	1.035 (0.727, 1.470)	0.848	1.222 (0.775, 1.868)	0.379	NA	NA	NA	NA
	WHRadjBMI	0.987 (0.690, 1.390)	0.941	0.986 (0.694, 1.378)	0.934	NA	NA	NA	NA
	WCadjBMI	1.159 (0.816, 1.627)	0.405	1.156 (0.816, 1.618)	0.410	NA	NA	NA	NA
	WC	1.184 (0.835, 1.664)	0.338	1.504 (0.982, 2.227)	0.052	NA	NA	NA	NA
Liver Cancer	BMI	1.456 (0.888, 2.259)	0.117	1.154 (0.647, 1.991)	0.619	NA	NA	NA	NA
	WHR	2.196 (1.403, 2.905)	0.000	1.385 (0.721, 2.454)	0.320	NA	NA	NA	NA
	WHRadjBMI	1.154 (0.683, 1.744)	0.581	1.248 (0.756, 1.826)	0.368	NA	NA	NA	NA
	WCadjBMI	1.703 (1.045, 2.463)	0.022	1.676 (1.058, 2.345)	0.018	NA	NA	NA	NA
	WC	2.344 (1.451, 3.639)	0.000	1.663 (0.904, 2.944)	0.094	NA	NA	NA	NA
Stomach Cancer	BMI	0.858 (0.439, 1.578)	0.639	0.664 (0.324, 1.319)	0.256	NA	NA	NA	NA
	WHR	1.320 (0.710, 2.364)	0.378	0.761 (0.353, 1.625)	0.485	NA	NA	NA	NA
	WHRadjBMI	0.923 (0.492, 1.649)	0.801	0.961 (0.535, 1.661)	0.894	NA	NA	NA	NA
	WCadjBMI	1.027 (0.555, 1.866)	0.933	1.040 (0.584, 1.824)	0.894	NA	NA	NA	NA
	WC	1.149 (0.615, 2.085)	0.654	0.730 (0.341, 1.535)	0.414	NA	NA	NA	NA

Note: Model 1: adjusted for baseline age and sex (sex was not adjusted in sex-stratified models); Model 2: further adjusted for smoking status and drinking habits; Model 3: further adjusted for hypertension and diabetes.
Abbreviation: BMI=Body mass index; WHR=waist-to-hip ratio; WC=waist circumference; WHRadjBMI=WHR adjusted for age, sex and BMI; WCadjBMI=WC adjusted for age, sex and BMI; *RR*=risk ratio; *CI*=confidence interval.

SUPPLEMENTARY TABLE S4. Associations between trajectories of adiposity indicators and cancer risk based on poisson regression.

Indicator	Subgroup	*N*	Cancer (%)	Trajectories	Unadjusted		Model 1		Model 2		Model 3	
					RR 95% *CI*	*P*	*RR* 95% *CI*	*P*	*RR* 95% *CI*	*P*	*RR* 95% *CI*	*P*
BMI	All	25,653	1.53	Inverted U-shape (ref.)								
				Slightly increasing	1.181 (0.901, 1.576)	0.243	1.136 (0.867, 1.516)	0.369	1.139 (0.869, 1.520)	0.361	1.113 (0.849, 1.486)	0.452
WCadjBMI				U-shape (ref.)								
				Inverted U-shape	1.146 (0.723, 1.717)	0.536	0.882 (0.556, 1.325)	0.569	0.882 (0.556, 1.325)	0.569	0.911 (0.574, 1.369)	0.672
WHRadjBMI				U-shape (ref.)								
				Inverted U-shape	1.448 (1.058, 1.937)	0.016	0.971 (0.706, 1.307)	0.853	0.968 (0.704, 1.304)	0.838	1.012 (0.734, 1.365)	0.940
BMI	Male	13,592	1.56	Inverted U-shape (ref.)								
				Stable	1.179 (0.701, 2.177)	0.565	1.047 (0.622, 1.932)	0.874	1.049 (0.623, 1.937)	0.867	1.028 (0.610, 1.901)	0.922
				U-shape	0.996 (0.425, 2.263)	0.992	0.847 (0.362, 1.926)	0.693	0.848 (0.362, 1.927)	0.694	0.836 (0.356, 1.901)	0.670
WCadjBMI				U-shape (ref.)								
				Inverted U-shape	1.528 (0.650, 3.001)	0.270	0.976 (0.415, 1.925)	0.950	0.977 (0.415, 1.927)	0.952	1.002 (0.425, 1.979)	0.995
WHRadjBMI				U-shape (ref.)								
				N-shape	1.062 (0.799, 1.419)	0.681	1.083 (0.815, 1.447)	0.585	1.080 (0.813, 1.444)	0.597	1.081 (0.813, 1.445)	0.594
				Inverted U-shape	1.862 (1.066, 3.066)	0.020	1.255 (0.717, 2.072)	0.397	1.230 (0.702, 2.031)	0.443	1.271 (0.724, 2.103)	0.375
BMI	Female	12,061	1.50	Inverted U-shape (ref.)								
				Slightly increasing	1.326 (0.810, 2.348)	0.295	1.384 (0.845, 2.451)	0.229	1.382 (0.844, 2.449)	0.230	1.320 (0.804, 2.341)	0.306
WCadjBMI				Inverted N-shape (ref.)								
				Slightly increasing	1.547 (0.589, 6.260)	0.453	1.691 (0.643, 6.846)	0.367	1.691 (0.643, 6.847)	0.367	1.660 (0.631, 6.722)	0.384
WHRadjBMI				Slightly decreasing (ref.)								
				Inverted U-shape	1.443 (0.908, 2.186)	0.100	0.982 (0.610, 1.511)	0.938	0.983 (0.611, 1.513)	0.941	1.038 (0.642, 1.604)	0.874
BMI	<50 years	20,033	1.24	Inverted U-shape (ref.)								
				Slightly increasing	1.375 (0.975, 1.998)	0.081	1.248 (0.886, 1.814)	0.224	1.246 (0.884, 1.812)	0.227	1.229 (0.871, 1.788)	0.259
WCadjBMI				Slightly increasing (ref.)								
				N-shape	0.611 (0.241, 1.254)	0.234	0.580 (0.228, 1.192)	0.188	0.578 (0.228, 1.189)	0.186	0.583 (0.230, 1.198)	0.192
WHRadjBMI				U-shape (ref.)								
				Slightly decreasing	1.442 (0.703, 3.656)	0.376	1.149 (0.559, 2.915)	0.738	1.153 (0.561, 2.927)	0.730	1.171 (0.57, 2.973)	0.702

Continued

Indicator	Subgroup	N	Cancer (%)	Trajectories	Unadjusted		Model 1		Model 2		Model 3	
					RR 95% *CI*	*P*	*RR* 95% *CI*	*P*	*RR* 95% *CI*	*P*	*RR* 95% *CI*	*P*
BMI	≥50 years	5,620	2.56	Inverted U-shape (ref.)								
				Stable	0.843 (0.509, 1.504)	0.534	0.955 (0.576, 1.704)	0.865	0.958 (0.578, 1.712)	0.877	0.964 (0.580, 1.726)	0.895
				U-shape	1.391 (0.638, 2.966)	0.394	1.522 (0.698, 3.249)	0.278	1.509 (0.692, 3.219)	0.289	1.533 (0.701, 3.281)	0.273
WCadjBMI				Slightly increasing (ref.)								
				N-shape	0.693 (0.171, 1.830)	0.530	0.588 (0.145, 1.556)	0.364	0.592 (0.146, 1.568)	0.370	0.606 (0.149, 1.606)	0.392
				Inverted U-shape	2.018 (1.110, 3.377)	0.013	1.776 (0.975, 2.985)	0.043	1.742 (0.955, 2.928)	0.050	1.776 (0.973, 2.991)	0.043
WHRadjBMI				Stable (ref.)								
				Inverted U-shape	1.459 (0.804, 2.441)	0.179	1.431 (0.779, 2.432)	0.213	1.427 (0.776, 2.425)	0.218	1.459 (0.790, 2.493)	0.194

Note: Model 1: adjusted for baseline age and sex (sex was not adjusted in sex -stratified models); Model 2: further adjusted for smoking status and drinking habits; Model 3: further adjusted for hypertension and diabetes.
Abbreviation: BMI=body mass index; WHR=waist-to-hip ratio; WC=Waist circumference; WHRadjBMI=WHR adjusted for age, sex and BMI; WCadjBMI=WC adjusted for age, sex and BMI; *RR*=risk ratio; *CI*=Confidence Interval.

SUPPLEMENTARY TABLE S5. Summary of GMM model fitting results for adiposity indicators across all subgroups

Indicator	Subgroup	No. of Latent class	BIC	Entropy	Sample size per class (%)			Mean posterior probabilities	Shape of trajectory
					Class1	Class2	Class3		
BMI	Overall	1	841630.775	1.000	100.000				Linear
		1	840236.045	1.000	100.000				Quadratic
		1	840036.916	1.000	100.000				Cubic
		2	841661.233	2.062×10^{-5}	52.555	47.445		0.502/0.502	Linear
		2	**833847.004**	**0.601**	**16.813**	**83.187**		**0.787/0.901**	**Quadratic**
	Female	1	397341.503	1.000	100.000				Linear
		1	396822.880	1.000	100.000				Quadratic
		1	396827.110	1.000	100.000				Cubic
		2	397369.696	3.911×10^{-5}	55.170	44.830		0.503/0.503	Linear
		2	**393819.283**	**0.744**	**10.604**	**89.396**		**0.805/0.944**	**Quadratic**
	Male	1	438741.118	1.000	100.000				Linear
		1	437842.683	1.000	100.000				Quadratic
		1	437526.771	1.000	100.000				Cubic
		2	438769.670	4.311×10^{-5}	52.207	47.793		0.503/0.503	Linear
		2	434340.759	0.489	26.560	73.440		0.781/0.860	Quadratic
		2	433721.046	0.470	32.997	67.003		0.795/0.850	Cubic
		3	438798.213	1.699×10^{-5}	28.855	26.059	45.085	0.337/0.338/0.341	Linear
		3	**432713.370**	**0.772**	**7.048**	**87.485**	**5.466**	**0.803/0.918/0.790**	**Quadratic**
	Baseline age<50 years	1	659490.533	1.000	100.000				Linear
		1	658111.737	1.000	100.000				Quadratic
		1	657844.791	1.000	100.000				Cubic
		2	659520.248	2.604×10^{-5}	53.013	46.987		0.502/0.503	Linear
		2	**653179.486**	**0.654**	**14.042**	**85.958**		**0.790/0.918**	**Quadratic**

Continued

Indicator	Subgroup	No. of Latent class	BIC	Entropy	Sample size per class (%)			Mean posterior probabilities	Shape of trajectory
					Class1	Class2	Class3		
	Baseline age≥50 years	1	180808.705	1.000	100.000				Linear
		1	180729.800	1.00	100.00				Quadratic
		1	180737.943	1.000	100.000				Cubic
		2	180834.607	$8.332×10^{-5}$	50.658	49.342		0.504/0.504	Linear
		2	179193.804	0.499	26.690	73.310		0.792/0.862	Quadratic
		2	179102.053	0.464	35.712	64.288		0.802/0.844	Cubic
		3	180859.472	0.016	31.833	33.719	34.448	0.374/0.412/0.396	Linear
		3	**178524.185**	**0.749**	**9.217**	**85.463**	**5.320**	**0.795/0.907/0.805**	**Quadratic**
WCadjBMI	Overall	1	1532144.992	1.000	100.000				Linear
		1	1531756.374	1.000	100.000				Quadratic
		1	1531757.697	1.000	100.000				Cubic
		2	1532175.449	$2.729×10^{-5}$	50.721	49.279		0.502/0.503	Linear
		2	**1531166.131**	**0.566**	**95.115**	**4.885**		**0.892/0.665**	**Quadratic**
	Female	1	727262.968	1.000	100.000				Linear
		1	727271.668	1.000	100.000				Quadratic
		1	727279.538	1.000	100.000				Cubic
		2	727291.161	$6.316×10^{-5}$	50.954	49.046		0.504/0.504	Linear
		2	726998.701	0.163	50.207	49.793		0.689/0.691	Quadratic
		2	**726748.168**	**0.871**	**2.695**	**97.305**		**0.749/0.975**	**Cubic**
	Male	1	804056.219	1.000	100.000				Linear
		1	803193.235	1.000	100.000				Quadratic
		1	803178.470	1.000	100.000				Cubic
		2	804084.770	$4.399×10^{-5}$	50.405	49.595		0.503/0.503	Linear
		2	**802937.070**	**0.726**	**97.829**	**2.171**		**0.939/0.682**	**Quadratic**
	Baseline age<50 years	1	1182941.914	1.000	100.000				Linear
		1	1182612.624	1.000	100.000				Quadratic
		1	1182622.350	1.000	100.000				Cubic
		2	1182971.629	$3.449×10^{-5}$	50.906	49.094		0.503/0.503	Linear
		2	1182169.291	0.538	94.694	5.306		0.883/0.659	Quadratic
		2	**1182060.127**	**0.651**	**96.206**	**3.794**		**0.917/0.683**	**Cubic**
	Baseline age≥50 years	1	347645.159	1.000	100.000				Linear
		1	347590.551	1.000	100.000				Quadratic
		1	347555.148	1.000	100.000				Cubic
		2	347671.060	$8.968×10^{-5}$	50.009	49.991		0.504/0.504	Linear
		2	347498.565	0.305	85.206	14.794		0.793/0.646	Quadratic
		2	347367.483	0.673	5.038	94.962		0.701/0.925	Cubic
		3	347686.362	0.224	0.000	97.223	2.777	NaN/0.497/0.479	Linear
		3	347477.496	0.676	93.448	0.766	5.786	0.876/0.658/0.665	Quadratic
		3	**347330.440**	**0.625**	**91.811**	**3.151**	**5.038**	**0.862/0.679/0.637**	**Cubic**

Continued

Indicator	Subgroup	No. of Latent class	BIC	Entropy	Sample size per class (%)			Mean posterior probabilities	Shape of trajectory
					Class1	Class2	Class3		
WHRadjBMI	Overall	1	-1113332.262	1.000	100.000				Linear
		1	-1113322.392	1.000	100.000				Quadratic
		1	-1113711.742	1.000	100.000				Cubic
		2	-1113301.805	2.141×10^{-5}	51.361	48.639		0.502/0.502	Linear
		2	**-1114799.281**	**0.598**	**91.337**	**8.663**		**0.902/0.713**	**Quadratic**
	Female	1	-509612.312	1.000	100.000				Linear
		1	-509602.916	1.000	100.000				Quadratic
		1	-509770.164	1.000	100.000				Cubic
		2	-509584.120	5.139×10^{-5}	52.1808	47.819		0.503/0.503	Linear
		2	**-510672.191**	**0.681**	**90.929**	**9.071**		**0.926/0.756**	**Quadratic**
	Male	1	-605339.640	1.000	100.000				Linear
		1	-605331.005	1.000	100.000				Quadratic
		1	-605550.723	1.000	100.000				Cubic
		2	-605311.089	3.170×10^{-5}	50.648	49.352		0.503/0.503	Linear
		2	-605781.921	0.283	77.792	22.208		0.781/0.676	Quadratic
		2	-606157.187	0.227	36.130	63.870		0.696/0.744	Cubic
		3	-605335.495	0.612	0.000	99.286	0.714	NaN/0.868/0.654	Linear
		3	-605917.767	0.730	0.670	95.0184	4.312	0.749/0.899/0.680	Quadratic
		3	**-606390.460**	**0.374**	**40.147**	**55.269**	**4.584**	**0.679/0.688/0.615**	**Cubic**
	Baseline age<50 years	1	-884205.042	1.000	100.000				Linear
		1	-884267.289	1.000	100.000				Quadratic
		1	-884653.528	1.000	100.000				Cubic
		2	-884175.327	1.976×10^{-5}	51.066	48.934		0.502/0.502	Linear
		2	**-885322.175**	**0.803**	**3.579**	**96.421**		**0.741/0.958**	**Quadratic**
	Baseline age≥50 years	1	-232085.331	1.000	100.000				Linear
		1	-232239.422	1.000	100.000				Quadratic
		1	-232264.021	1.000	100.000				Cubic
		2	-232059.431	8.089×10^{-5}	51.309	48.691		0.504/0.504	Linear
		2	**-232579.190**	**0.692**	**93.128**	**6.872**		**0.929/0.732**	**Quadratic**

Note: No. of Latent class: latent class number of the model; The best-fitting model is highlighted in bold characters. (NaN: not applicable).
Abbreviation: BIC: the Bayesian information criterion; BMI=Body mass index; WCadjBMI=Waist circumference adjusted for age, sex, and BMI; WHRadjBMI=Waist-to-hip ratio adjusted for age, sex, and BMI.

Trajectory Analysis

Latent class mixed modeling (LCMM) was applied to derive long-term trajectory groups for each obesity-related indicator (*3*). The optimal number of latent classes was selected based on a combination of the Bayesian Information Criterion (BIC), average posterior classification probability (≥0.7), minimum class size (≥2% of the sample), and interpretability. These trajectory classes were subsequently entered as categorical predictors in Poisson regression models to assess associations with cancer risk.

All statistical analyses were conducted using R (version 4.2.3, R Foundation for Statistical Computing, Vienna, Austria). Latent class modeling was performed using the “lcmm” package in R.

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Healthy China

Implications of International and Domestic Strategies, Policies, and Practices for Obesity Prevention and Control — China, 2023

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ABSTRACT

Introduction: Obesity has emerged as a critical public health challenge in China, with prevalence rates rising steadily across all age groups and threatening both long-term health outcomes and economic sustainability. This study examines China's current obesity prevention and control landscape, comparing it with international practices to provide evidence-based recommendations for strengthening national strategies.

Methods: Between July and October 2023, we conducted a comprehensive literature review and engaged 19 experts (9 from China; 10 from the United States (US), Japan, the United Kingdom (UK), and Spain) through purposive, criterion-based sampling. We collected data using a semi-structured questionnaire covering personal information, obesity-related policies and service status, and recommendations for China. Quantitative data underwent descriptive analysis, while qualitative data were examined using thematic analysis.

Results: Experts identified persistent barriers in China's obesity control efforts, including fragmented policies, insufficient public awareness, suboptimal service quality, and limited healthcare facilities. Compared with high-income countries, China's approach lacks robust regulatory frameworks and effective multisectoral coordination mechanisms.

Conclusions: These findings underscore the urgent need for China to strengthen evidence-based, integrated approaches to obesity prevention and management. Adapting successful international experiences to local contexts will be essential for enhancing national obesity control efforts and advancing the *Healthy China* initiative goals.

The global obesity pandemic represents one of the most pressing public health crises of the 21st century. China confronts escalating challenges, with 50 million children (20% prevalence) and 600 million adults (50% prevalence) currently affected by overweight or obesity (*1*), and projections indicating these rates will reach 30% and 70% respectively by 2030. Despite implementing multiple national initiatives, current interventions have demonstrably failed to reverse the rapid increase in obesity prevalence. High-income countries have successfully integrated obesity-related policies within comprehensive, multisectoral frameworks that incorporate both regulatory measures (such as marketing restrictions) and fiscal interventions (including sugar taxes) (*2*). In contrast, China's approach remains in development, characterized by fewer binding regulations, enforcement challenges, and ongoing efforts to strengthen intersectoral coordination (*3*). These critical gaps highlight the urgent need for evidence-based strategies that effectively balance proven global practices with China's unique sociocultural context to achieve *Healthy China* objectives (*2*). We therefore conducted targeted literature reviews and expert consultations to systematically compare international strategies, identify key implementation challenges, and develop tailored policy recommendations for China's obesity prevention framework.

METHODS

We implemented a comprehensive dual-approach methodology combining a systematic literature review with targeted expert consultations to gather comprehensive data on domestic and international obesity-related policies, service delivery systems, and clinical guidelines. The literature review fulfilled two strategic objectives: first, informing the development of our semi-structured questionnaire instrument, and second, identifying relevant official policy documents that directly supplemented the policy and guideline information presented in Tables 1 and 2, alongside questionnaire-derived data. Our finalized semi-structured questionnaire comprised 17 carefully designed items organized into three distinct modules: (1) demographic and professional background information (age, country, education level, professional positions, years of obesity-related experience, specific obesity prevention and treatment projects); (2) a comprehensive assessment of obesity prevention and control status within respondents' respective countries (existing policies, service utilization patterns and quality metrics, clinical guidelines, primary implementation challenges); and (3) strategic recommendations (specific recommendations for China's context, successful international practices for potential adaptation). Between July and October 2023, we employed a purposive sampling methodology to engage 19 experts selected from an initial pool of 33 qualified candidates (Supplementary Table S1, available at https://weekly.chinacdc.cn/). To ensure both professional authority and geographic representativeness, we included experts from five countries representing diverse institutional sectors, including government agencies, academic research institutions, and international health organizations. Questionnaire responses were systematically entered into Excel databases and organized for comprehensive analysis. Open-ended qualitative responses underwent thematic analysis, while quantitative multiple-choice data were evaluated using descriptive statistical methods.

RESULTS

As summarized in Table 1, a cross-national analysis reveals divergent policy approaches to obesity prevention, with the included policies reflecting those explicitly highlighted by experts during consultations, thus representing authoritative consensus priorities rather than a comprehensive catalogue of all measures. Experts from China, the UK, the US, and Spain consistently reported established national policies explicitly targeting obesity. In contrast, Japanese experts indicated their nation currently lacks dedicated obesity-specific policies. However, based on expert consultations, one relevant national health policy

TABLE 1. Domestic and international key components of obesity prevention and control policies from 2000 to 2025.

Country	Obesity-specific policy	Obesity-related policy	Core content
China	Yes	2016, The State Council of the People's Republic of China, *Healthy China 2030*	Implement comprehensive public health campaigns to promote healthy living practices, expand counseling and intervention programs targeting healthy lifestyle adoption among families and high-risk populations, and initiate targeted strategies addressing key health priorities, including weight management, dental hygiene, bone health, and other essential wellness areas.
		2017, The State Council of the People's Republic of China, *China's Medium-to-Long Term Plan for the Prevention and Treatment of Chronic Diseases (2017-2025)*	Promote nationwide health education on chronic disease prevention, advocating healthy and civilized lifestyles. Encourage government agencies and workplaces to organize fitness breaks, employee sports events, walking campaigns, and health knowledge competitions. Mobilize volunteers, community sports instructors, and health lifestyle counselors through local committees to guide self-management of health. Advance the National Healthy Lifestyle Campaign, including the "Three Reductions and Three Health".
		2019, The Standing Committee of the 13th National People's Congress, *Law of the People's Republic of China on Basic Medical and Health Care and the Promotion of Health*	Integrate health education into the national education system, requiring schools to deliver health, fitness, and first aid education, raise students' awareness of disease prevention, and foster healthy habits to reduce problems such as myopia and obesity.
		2024, National Health Commission of the People's Republic of China, *Implementation Plan for the "Year of Weight Management" Campaign*	Cultivate a comprehensive weight management culture that encourages universal participation and delivers population-wide benefits. Promote healthy lifestyles by establishing supportive environments for weight management, ensuring widespread accessibility to resources and information. Enhance public awareness and competency in effective weight management strategies to reduce the prevalence of weight-related abnormalities across diverse population groups.
		2025, Ministry of Health of the People's Republic of China, *National Food Safety Standard - Standard for Nutrition Labelling of Prepackaged Foods*	Advance public health by regulating labeling content and encouraging the food industry to optimize the nutritional composition of products.

Continued

Country	Obesity-specific policy	Obesity-related policy	Core content
The United States	Yes	2018, The United States Food and Drug Administration, *Menu Labeling Requirements*	Mandate that consumers have access to calorie and nutrition information in designated chain establishments subject to regulatory requirements. These establishments must prominently display calorie content of standard menu items on menus and menu boards.
		2020, The United States Department of Agriculture, *Nutrition Education Programs*	Leverage the collective strengths and contributions of individuals, families, communities, organizations, and diverse societal sectors to drive meaningful changes in dietary behaviors while promoting health equity and overall well-being.
		2020, The Office of Disease Prevention and Health Promotion, *Healthy People 2030*	Healthy People 2030 aims to catalyze, strengthen, and systematically evaluate nationwide initiatives designed to enhance population health outcomes and well-being across all demographic groups. This comprehensive framework establishes 357 quantifiable targets, strategically prioritizing reductions in pediatric and adult obesity prevalence alongside decreased consumption of added sugar compounds.
		2023, Obesity Action Coalition, *The Treat and Reduce Obesity Act (TROA)*	Critical policy recommendations include expanding Medicare beneficiaries' accessibility to specialized healthcare providers optimally qualified to deliver intensive behavioral therapy interventions, while simultaneously modifying Medicare Prescription Drug Benefit (Part D) coverage parameters to encompass U.S. Food and Drug Administration-approved anti-obesity pharmacotherapeutics.
		2025, The United States Food and Drug Administration and the National Institutes of Health, *Nutrition Regulatory Science Program*	This collaborative scientific initiative seeks to investigate and address the fundamental etiological factors underlying diet-related chronic diseases through rigorous evidence-based methodologies. Priority research domains encompass: comprehensive assessment of ultra-processed foods' (UPFs) physiological impact; elucidation of specific food additives' mechanistic roles in metabolic dysregulation potentially precipitating chronic disease pathogenesis; and systematic examination of maternal-infant nutritional patterns as determinants of longitudinal health trajectories across the lifespan continuum.
Japan	No	2000, Ministry of Health, Labor and Welfare, *Health Japan 21*	Establish a comprehensive national framework to enhance population health through targeted interventions in workplace environments, educational institutions, and community settings, emphasizing the promotion of regular physical activity, balanced nutritional practices, smoking cessation programs, and responsible alcohol consumption behaviors.
Spain	Yes	2006, The Ministry of Health and Consumer Affairs of Spain, *Strategy for Nutrition, Physical Activity and the Prevention of Obesity (NAOS)*	Implement a comprehensive lifelong approach to obesity prevention and control through coordinated action plans across four strategic domains: family and community engagement, educational institutions, private sector partnerships, and healthcare system integration. Prioritize the enhancement of dietary behaviors and promotion of consistent physical activity across all population segments, with particular emphasis on pediatric populations.
The United Kingdom	Yes	2016, Department of Health (Ireland), *A Healthy Weight for Ireland: Obesity Policy and Action Plan 2016 – 2025*	Increase the proportion of individuals maintaining healthy weight status and establish pathways toward normalizing healthy weight across populations while eliminating obesity-related stigma, particularly among pediatric populations.
		2018, Scottish Government, *Diet and Healthy Weight*	Implement comprehensive restrictions on promotional activities and marketing strategies for foods and beverages with elevated fat, sugar, or salt content.
		2019, Welsh Government, *Healthy Weight Strategy (2019)*	Develop healthy environments, establish supportive settings, promote healthy populations, and provide leadership while enabling transformative change to prevent and reduce obesity prevalence throughout Wales.
		2022, Department of Health and Social Care, *Tackling Obesity: Empowering Adults and Children to Live Healthier Lives*	Develop and deploy evidence-based digital tools and mobile applications to guide individuals through effective weight reduction strategies and sustainable long-term weight maintenance protocols. Expand comprehensive weight management services within the *National Health Service*, ensuring broader population access to essential support systems for achieving and maintaining optimal weight status.
		2024, Public Health Scotland, *Improving Scotland's Diet and Weight*	Provide strategic leadership to promote optimal dietary practices and healthy weight maintenance; ensure children receive the most advantageous foundation for lifelong health; prioritize environments where people live, work, learn, receive care, and engage in recreational activities to emphasize healthier food options and physical activity opportunities; guarantee population access to effective weight management support services and comprehensive care programs.

Note: This table summarizes domestic and international obesity-related macro policies in China, the US, Japan, Spain, and the UK, outlining key measures and their implementation details. Data are derived from expert responses and official documents. An obesity-specific policy is defined as a national policy or program that explicitly targets obesity prevention, treatment, or management as a primary objective; in the case of Japan, the listed policy is a relevant national health policy identified during expert consultations.

(Health Japan 21) that addresses obesity-related risk factors was included in Table 1.

Expert responses to the "service utilization and quality" section revealed significant cross-national variations in obesity treatment service availability and utilization, reflecting distinct differences in healthcare priorities, resource allocation, and policy commitments. The US and Japan maintain well-established obesity management services, while UK experts reported insufficient national prioritization of obesity treatment. International experts consistently highlighted substantial regional and individual disparities in both service access and utilization patterns. China's obesity treatment infrastructure remains in early developmental stages, characterized by limited service availability, absence of standardized treatment protocols, and marked inconsistencies in service quality. Although existing interventions may yield short-term benefits, experts emphasized the critical need to prioritize long-term outcomes while enhancing nationwide accessibility and service uptake.

Health insurance coverage for obesity treatment demonstrates pronounced international disparities. The US incorporates obesity treatment within its national health insurance framework. However, the UK, Japan, and Spain provide no comparable coverage. China exhibits highly fragmented insurance coverage for obesity management. Experts noted that the lack of an official disease classification for obesity excludes it from National Healthcare Security Administration coverage. Nevertheless, reimbursement remains available for specific procedures, including bariatric surgery, under particular clinical circumstances such as morbid obesity or metabolic syndrome.

Table 2 summarizes selected domestic and international guidelines for obesity diagnosis and treatment. However, implementing these recommendations encounters substantial challenges, including inadequate funding, poor patient compliance, and multifactorial etiology of obesity. China faces additional implementation barriers, including insufficient healthcare professional training, limited institutional guideline adoption, and the absence of government-led initiatives to promote and enforce standardized treatment practices.

International experts identified three major challenges in obesity management: *difficulty in maintaining weight loss*, *limited economic affordability*, and *low levels of patient participation and adherence* (Figure 1). Notably, eight experts emphasized long-term weight maintenance as a particularly significant hurdle. Similar challenges exist in China, where obesity treatment faces barriers including poor patient adherence, suboptimal long-term outcomes, insufficient public recognition of obesity's metabolic risks, and systemic constraints from the shortage of specialized treatment facilities.

DISCUSSION

This study provides a comprehensive examination of expert perspectives on current obesity prevention and control strategies, focusing on the implementation of global policy frameworks. The findings reveal that despite variations in national approaches, countries face common structural and systematic challenges when addressing obesity. In China, key obstacles include fragmented policies, insufficient public awareness, suboptimal service quality, and limited treatment facilities, all of which significantly hinder the effectiveness of prevention and management efforts.

Our findings highlight the inadequacy of China's current obesity treatment policies, which remain fragmented and inconsistently implemented across regions. Currently, no dedicated health insurance policy covers obesity treatment, and bariatric medications are excluded from the *Interim Measures for the Administration of Basic Medical Insurance Drugs*. As documented in Liang Hui's study, although bariatric surgery is gaining recognition in China, its acceptance remains limited, with significant regional disparities in health insurance reimbursement (*4*). Furthermore, the obesity treatment market lacks effective regulatory oversight. A coordinated, government-led, multisectoral framework has yet to be established, and the persistent gap between policy formulation and implementation continues to constrain meaningful progress.

Public awareness of obesity in China remains inadequate, with poor treatment compliance presenting a significant barrier to effective management. Many individuals fail to recognize obesity as a serious medical condition and frequently overlook its long-term health consequences (*5*). Weight loss motivation is often driven by aesthetic rather than health considerations, reducing what should be a medical necessity to a cosmetic concern (*6*). Additionally, widespread misconceptions about available treatments and concerns regarding potential risks lead many patients to resist medical interventions (*7–8*). A lack of confidence in long-term weight management and self-regulation frequently results in

TABLE 2. Domestic and international clinical guidelines for obesity diagnosis and treatment from 2004 to 2025.

Country	Publishing organization	Guidelines/Consensus
China	China Obesity Working Group	2004, *Guidelines for the Prevention and Control of Overweight and Obesity in Adults in China*
	Obesity Group of Chinese Society of Endocrinology	2011, *Consensus of Experts on Prevention and Treatment of Obesity in Adults in China*
	Chinese Society of Health Management	2018, *Expert Consensus & Standard on Weight Management for Overweight or Obese People*
	Chinese Society of Medicine	2019, *Guidelines for Primary Care of Obesity*
	Chinese Society of Surgery	2019, *Guidelines for the Surgical Treatment of Obesity and Type 2 Diabetes in China (2019 Edition)*
	Chinese Society for Metabolic and Bariatric Surgery	2019, *The Clinical Guideline for Surgical Treatment of Childhood and Adolescent Obesity in China (2019 Edition)*
	Chinese Nutrition Society	2019, *China Blue Paper on Obesity Prevention and Control*
	Chinese Research Hospital Association, Society for Diabetes and Bariatric Surgery	2019, *Expert Consensus on Perioperative Management in Bariatric and Metabolic Surgery*
	National Health Commission of the People's Republic of China	2021, *Chinese Guidelines for Prevention and Control of Overweight and Obesity in Adults (2021)*
	Chinese Nutrition Society Clinical Nutrition Section	2021, *Chinese Guidelines on Medical Nutritional Therapy for Overweight/Obesity (2021)*
	Association for Maternal and Child Health Studies	2021, *Guidelines for the Evaluation, Treatment and Prevention of Childhood Obesity in China*
	Chinese Nutrition Society Obesity Prevention and Control Section	2022, *Expert Consensus on Obesity Prevention and Treatment in China*
The United States	American College of Cardiology / American Heart Association / The Obesity Society	2013, *Guideline for the Management of Overweight and Obesity in Adults*
	American Association of Clinical Endocrinologists / American College of Endocrinology	2016, *Clinical Practice Guidelines for Comprehensive Medical Care of Patients with Obesity*
	American Society for Metabolic and Bariatric Surgery	2018, *Pediatric Metabolic and Bariatric Surgery Guidelines*
	American Gastroenterological Association	2022, *Clinical Practice Guideline on Pharmacological Interventions for Adults with Obesity*
Japan	Ministry of Health, Labour and Welfare	2017, *Guidelines for the Treatment of Childhood Obesity*
	Japan Society of Internal Medicine	2018, *Obesity Diagnosis and Treatment Guidelines*
	Japan Obesity Society	2022, *Guide to Improving Lifestyle Habits in Obesity*
Spain	-	-
The United Kingdom	National Institute for Health and Care Excellence	2014, *Weight Management: Lifestyle Services for Overweight or Obese Adults*
	Public Health England	2017, *Health Matters: Obesity and the Food Environment*
	National Institute for Health and Care Excellence	2017, *Obesity: Working with Local Communities*
	Office for Health Improvement and Disparities	2022, *Adult Obesity: Applying All Our Health*
	National Institute for Health and Care Excellence	2023, *Obesity: Identification, Assessment and Management*
	National Institute for Health and Care Excellence	2025, *Overweight and Obesity Management*

Note: This table compares national clinical guidelines for obesity diagnosis and treatment issued by health authorities and professional societies in China, the United States, Japan, and the United Kingdom. Data are based on expert responses and official publications.

irregular medication adherence or non-compliance with medical recommendations, contributing to weight regain following initial loss (*9*).

The overall quality of obesity treatment services in China remains suboptimal despite various initiatives promoting lifestyle modifications. Persistent issues include "insufficient prevention and treatment efforts" and "limited systematic diagnostic and treatment capabilities." The healthcare system lacks professional organizations dedicated specifically to obesity care, authoritative clinical guidelines, and standardized treatment pathways. No national interdisciplinary obesity treatment centers have been established. Furthermore, a comprehensive, tiered obesity diagnosis and treatment network has yet to be developed. Regional disparities in economic development and uneven distribution of healthcare resources further compound these challenges, leaving certain areas

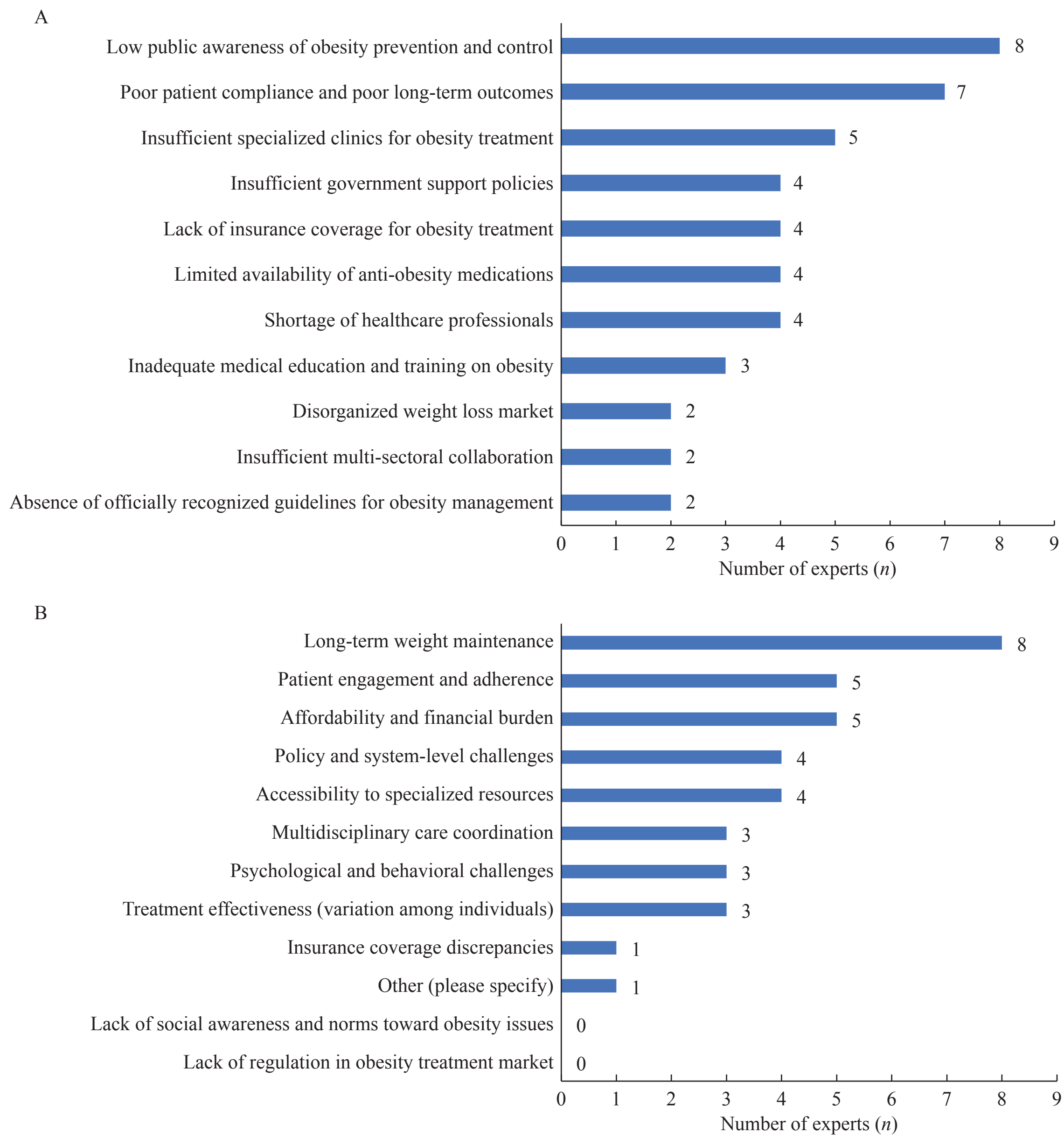

FIGURE 1. Major challenges in obesity treatment identified by domestic and international experts (July–October 2023). (A) Opinions of Domestic Experts; (B) Opinions of International Experts.
Note: Bar heights represent the number of consulted experts who cited each challenge in obesity treatment. Data were collected via semi-structured questionnaires between July and October 2023.

significantly underserved.

To effectively improve obesity prevention and control in China, several key policy recommendations were proposed. First, relevant laws and regulations should be strengthened. This includes implementing taxes on unhealthy foods, restricting or banning advertisements for high-sugar and high-fat products, and introducing a dedicated medical insurance program for obesity treatment. Improving monitoring and evaluation mechanisms is also essential to ensure efficient allocation of healthcare resources. Second, public education on obesity prevention should be reinforced, with greater emphasis on patient-provider communication. A comprehensive policy framework should support nationwide health education efforts and reduce obesity-related stigma. Medical institutions should provide evidence-based guidance and share success stories to boost patient confidence and improve treatment adherence. Finally, medical services must be better equipped to address obesity prevention and treatment. A multi-sectoral collaboration platform should be established, including the development of multidisciplinary weight management clinics and the integration of digital technology into diagnostic and therapeutic processes (*10*).

This study has several strengths. It provides a comparative analysis of obesity prevention and treatment policies and practices in China and other countries, offering a global perspective. By reviewing the experiences across multiple contexts in obesity prevention policies, treatment services, and guideline development, the study provides valuable insights for optimizing obesity-related policies in China.

The study also has limitations. First, the sample size was relatively small, and the consulted experts may not fully represent the global landscape. Second, regional variations in China's obesity prevention and control efforts were not thoroughly explored. Lastly, as a qualitative study, the interpretation of open-ended responses relied on researchers' subjective analysis. Future research should adopt larger sample sizes and mixed-methods designs to provide more comprehensive and data-driven insights.

CONCLUSIONS

In conclusion, there is an urgent need for China to strengthen obesity-related policies and regulations, enhance public education, and improve the accessibility and quality of healthcare services. Comprehensive and coordinated strategies must be developed to curb the rising burden of obesity and related chronic diseases. Lessons learned from China's experience can also provide valuable guidance for other countries facing similar public health challenges.

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SUPPLEMENTARY MATERIALS

SUPPLEMENTARY TABLE S1. Demographic characteristics of 19 domestic and international experts (July–October 2023).

Expert number	Age (years)	Education/Degree	Key job positions/Titles	Years of working experience on obesity	Country
Domestic experts					
C-1	40–64	Master of Science (MS)	Associate Researcher	≤10	China
C-2	40–64	Doctor of Philosophy (PhD)	Chief Physician	23	China
C-3	40–64	Doctor of Philosophy (PhD)	Chief Physician	12	China
C-4	40–64	Doctor of Philosophy (PhD)	Associate Researcher	≤10	China
C-5	40–64	Master of Science (MS)	Professor	33	China
C-6	40–64	Doctor of Philosophy (PhD)	Chief Physician	≤10	China
C-7	40–64	Doctor of Philosophy (PhD)	Chief Physician	28	China
C-8	40–64	Doctor of Philosophy (PhD)	Researcher	≤10	China
C-9	40–64	Doctor of Philosophy (PhD)	Professor	20	China
International experts					
F-1	65–	Doctor of Philosophy (PhD)	Professor	33	The United States
F-2	65–	Doctor of Philosophy (PhD)	Emeritus Professor	33	The United States
F-3	40–64	Doctor of Philosophy (PhD)	Associate Professor	12	The United States
F-4	40–64	Doctor of Philosophy (PhD)	Deputy Chief Physician	≤10	Japan
F-5	65–	Doctor of Philosophy (PhD)	Professor	30	Japan
F-6	40–64	Master of Science (MS)	Officials of international institutions	≤10	The United Kingdom
F-7	32	Doctor of Philosophy (PhD)	Researcher	≤10	The United Kingdom
F-8	40–64	Doctor of Philosophy (PhD)	Director of the Institute	20	The United Kingdom
F-9	40–64	Doctor of Philosophy (PhD)	Senior Lecturer in Clinical Nutrition	10	The United Kingdom
F-10	40–64	Doctor of Philosophy (PhD)	Professor	30	Spain

Note: Demographic data were collected from the 19 experts participating in this study.

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