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

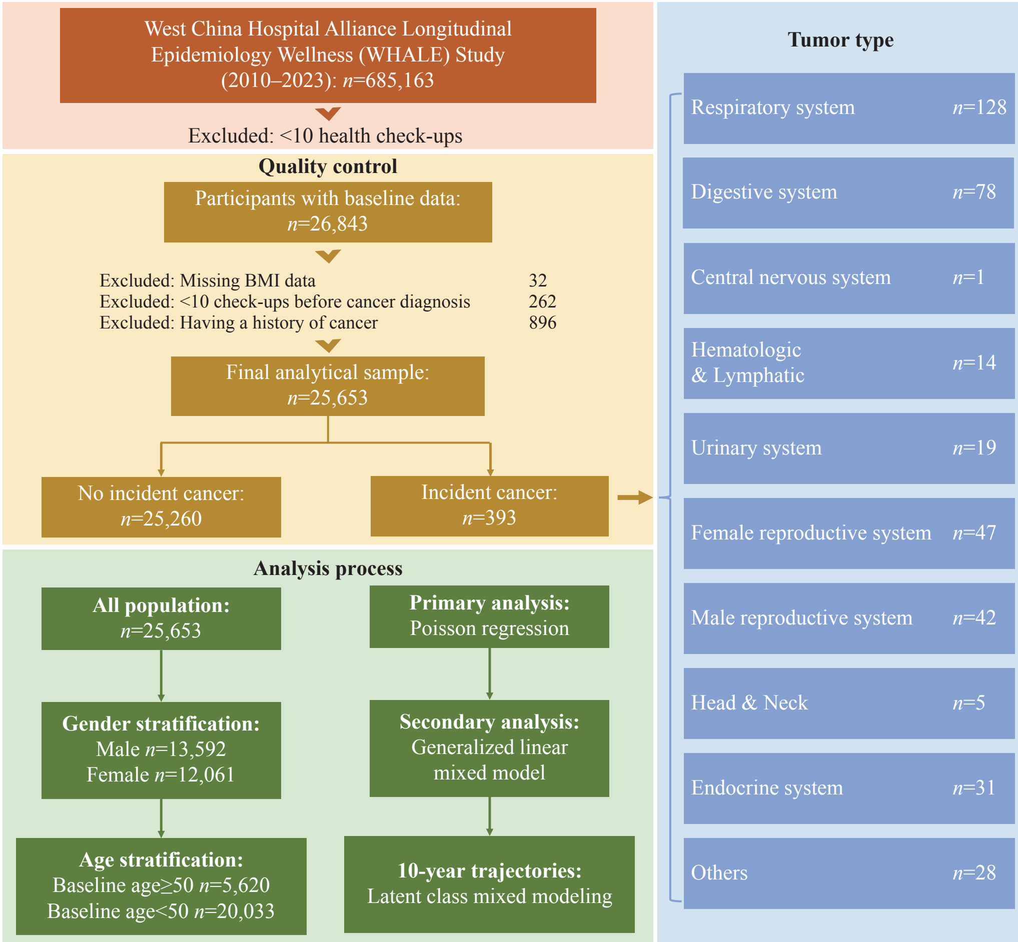

FIGURE 1. Flowchart of study population selection from the WHALE Study, 2010–2023.

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

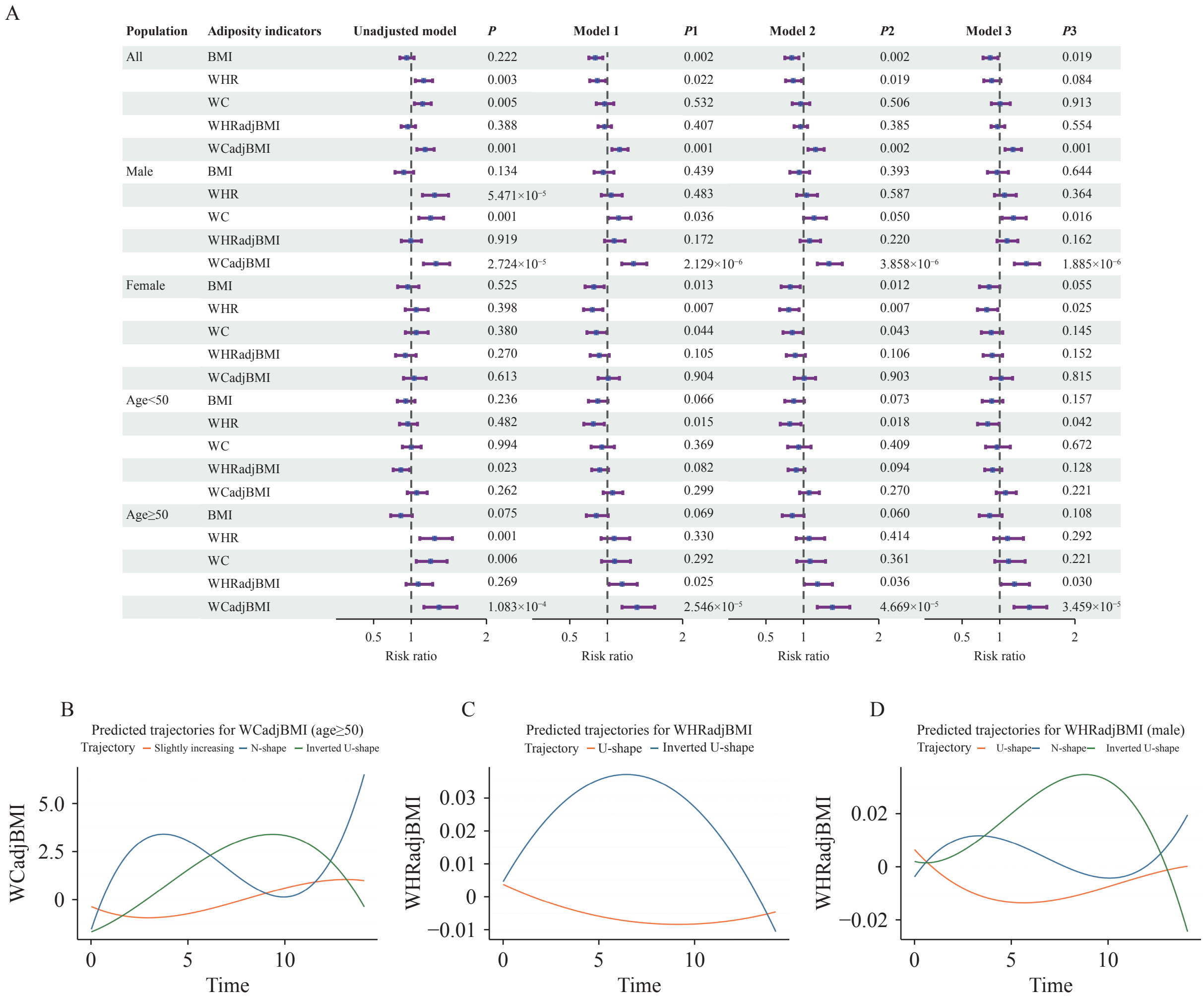

FIGURE 2. Longitudinal trajectories of adiposity indicators and their associations with cancer risk in the WHALE Study (2010–2023). (A) Forest plot of *RR*s and 95% *CI*s for the associations between adiposity indicators and cancer risk across the total population and subgroups (by sex and age group); (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.

Acknowledgements: All colleagues and staff members who contributed to the data collection for this study.

Funding: Supported by the National Natural Science Foundation of China (32471519), National Natural Science Foundation of China (32171285), the 1.3.5 project for Disciplines of Excellence from West China Hospital of Sichuan University (ZYGD23039).

doi: 10.46234/ccdcw2025.191

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Submitted: June 30, 2025
Accepted: August 03, 2025
Issued: August 29, 2025

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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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