Preplanned Studies

Long-Term Trends and Regional Heterogeneity in Overweight and Obesity Among Adults — 11 Intermittent Surveys in China, 1991–2024

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Summary

What is already known about this topic?

Overweight and obesity have increased in China. Evidence integrating long-term trends, regional heterogeneity, and multilevel factors remains limited.

What is added by this report?

From 1991 to 2024, age-standardized combined prevalence of overweight and obesity rose from 20.20% (1,567/8,445) to 53.10% (7,286/13,112) and obesity from 3.70% (259/8,445) to 18.10% (2,303/13,112). Men, adults aged 40–79 years, and those with lower education showed outcome-specific higher odds.

What are the implications for public health practice?

Regionally tailored population-wide prevention, weight management for higher-burden adults, healthier diets and community food environments, and attention to air quality as a contextual factor are suggested.

ABSTRACT

Introduction: Overweight and obesity have increased substantially in China. Limited studies integrate long-term trends, regional heterogeneity, and multilevel factors.

Methods: Eleven China Health and Nutrition Survey waves (1991 to 2024) provided 115,541 person–wave observations (ages 18–79). Prevalence was age-standardized to the 2020 Chinese census population. Inverse-variance weighted regression assessed trends; Cochran's *Q* test assessed regional heterogeneity. Three-level logistic regression examined individual-, community-, and provincial-level factors.

Results: From 1991 to 2024, age-standardized prevalence increased from 20.20% (1,567/8,445) to 53.10% (7,286/13,112) for combined overweight and obesity, from 16.51% (1,308/8,445) to 35.00% (4,983/13,112) for overweight, and from 3.70% (259/8,445) to 18.10% (2,303/13,112) for obesity (all $P<0.001$). The prevalence was the highest for combined overweight and obesity and for overweight in North China and for obesity in Northeast China. Men and adults age 40–79 years had higher odds of combined overweight and obesity and of overweight; high education was inversely associated with all outcomes. Drinking and meat intake were positively associated with combined overweight and obesity and with obesity. Community Western fast-food restaurant availability was associated with combined overweight and obesity, and provincial $PM_{2.5}$ with all outcomes.

Conclusion: Overweight and obesity increased over three decades but varied regionally. Population-wide prevention should be complemented by targeted measures for higher-burden groups and for North and Northeast China.

Overweight and obesity pose challenges to noncommunicable disease prevention and control. Over recent decades in China, their prevalence has risen substantially (*1*), with national surveillance efforts having identified considerable provincial variation in adult obesity (*2*). Temporal and geographic patterns have been examined separately; separating overweight from obesity can show whether regional differences reflect either/both outcomes. Because excess weight is associated with multilevel factors (*3*), whether provincial heterogeneity persists after considering individual and community characteristics and how it relates to provincial socioeconomic and environmental indicators remain unclear. This repeated cross-sectional study used 11 China Health and Nutrition Survey (CHNS) waves to estimate age-standardized trends among adults and compare seven regions.

The 11 CHNS waves used in this study were 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011, 2015, 2018, and the combined 2022–2024 follow-up round (*4*). Participating provincial-level administrative

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divisions (PLADs) increased from nine in 1991–2009 to 12 in 2011, 15 in 2015, and 16 in 2018. In 2022–2024, Hainan was added and Beijing was not included, leaving 16 PLADs; all others were unchanged. Analyses included adults aged 18–79 years with non-missing body mass index (BMI) and excluded identified pregnant women. Standing height and weight were measured with participants in light clothing and no shoes. BMI was calculated as weight in kilograms divided by height in meters squared. Overweight, obesity, and combined overweight and obesity were defined as 24.0≤BMI<28.0 kg/m^2, BMI≥ 28.0 kg/m^2, and BMI≥24.0 kg/m^2, respectively (*5*). Prevalence and 95% confidence intervals (*CI*s) were directly age-standardized to the 2020 Chinese population using 12 groups: 18–24 and five-year groups from 25–29 through 75–79 years (*6*). Standard errors were derived from age-specific binomial variances and *CI*s used the normal approximation.

Temporal trends were assessed by the inverse-variance weighted least-squares regression of age-standardized prevalence on survey year. Coefficients were average annual percentage-point changes with 95% *CI*s. The 16 participating PLADs were grouped into North, Northeast, East, Central, South, Southwest, and Northwest China. For each outcome, regional observations were pooled before direct age standardization. Cochran's *Q* tests with inverse-variance weighting assessed regional heterogeneity.

Three-level random-intercept logistic models were fitted using only 2022–2024 data to reassess provincial heterogeneity, with individuals (level 1) nested within communities (level 2) and communities within PLADs (level 3). Each binary outcome was modeled separately; participants not meeting its definition formed the comparison group. Covariates were sex, age (18–39, 40–59, or 60–79 years), education, household income, smoking, alcohol consumption, total energy intake, percentage energy from fat, and daily staple food, vegetable, fruit, and meat intakes. Community variables were residence, agricultural labor force proportion, and availability of Western fast-food restaurants and a park or stadium. PLAD variables were mean GDP per capita from the 2023–2025 editions of the China Statistical Yearbook (*7*) and mean $PM_{2.5}$ concentration from the 1-km ChinaHighPM$_{2.5}$ V4 product (*8*). Household income and continuous dietary variables were winsorized at the 0.5th and 99.5th percentiles; income was $\log_2$-transformed. Continuous covariates were scaled and grand-mean-centered at their respective analytical levels. Multilevel analyses used complete cases. Model 0 (M0) included community- and PLAD-level random intercepts; Models 1–3 (M1–M3) sequentially added individual-, community-, and PLAD-level covariates. PLAD intraclass correlation coefficients (ICCs) and community variance partition coefficients used the latent logistic scale with $\pi^2/3$ individual-level variance. Parametric-bootstrap likelihood-ratio tests evaluated the M0 PLAD variance component. The proportional change in PLAD variance from M2 to M3 quantified reduction after adding GDP per capita and $PM_{2.5}$. Fixed effects were reported as odds ratios (*OR*s) with 95% *CI*s. PLAD random effects were assumed independent and did not incorporate geographic adjacency; models quantified between-PLAD heterogeneity and associated factors, not spatial clustering.

Analyses used R (version 4.4.3, R Foundation for Statistical Computing, Vienna, Austria) and two-sided tests (significance: P<0.05). All participants provided written informed consent.

After exclusions (adults aged ≥80 years, 2,967 observations; pregnant women, 577; missing BMI, 5,562), 115,541 adult person–wave observations remained across 11 waves. The 2022–2024 round comprised 13,112 observations from 16 PLADs; multilevel analyses included 12,748 participants with complete covariates from 380 communities.

The age-standardized combined overweight and obesity prevalence increased from 20.20% (1,567/8,445) (95% *CI*: 19.27%–21.13%) in 1991 to 53.10% (7,286/13,112) (52.02%–54.18%) in 2024; overweight from 16.51% (1,308/8,445) (15.65%–17.36%) to 35.00% (4,983/13,112) (34.01%–36.00%); obesity from 3.70% (259/8,445) (3.24%–4.15%) to 18.10% (2,303/13,112) (17.25%–18.94%) (Table 1). Average annual percentage-point increases were 0.991 (0.911–1.071), 0.552 (0.464–0.640), and 0.422 (0.362–0.482), respectively (all P<0.001; Figure 1).

In 2022–2024, the age-standardized prevalence differed across regions for all outcomes (all Cochran's *Q* P<0.001; Table 2). Combined prevalence was the highest in North China at 67.56% (456/668) (95% *CI*: 62.82%–72.29%) and the lowest in South China at 42.74% (763/1,710) (40.12%–45.36%); results for overweight were similar (North China: highest, 42.34%, 274/668, 95% *CI*: 37.37%–47.31%; South China: lowest, 30.86%, 566/1,710, 95% *CI*: 28.51%–33.21%). Obesity was the highest in Northeast China at 27.12% (346/1,575)

TABLE 1. Age-standardized prevalence of combined overweight and obesity, overweight, and obesity by survey wave, China, 1991–2024.

Survey wave	*N*	Combined overweight and obesity *n*, % (95% *CI*)	Overweight *n*, % (95% *CI*)	Obesity *n*, % (95% *CI*)
1991	8,445	1,567, 20.20 (19.27–21.13)	1,308, 16.51 (15.65–17.36)	259, 3.70 (3.24–4.15)
1993	8,033	1,659, 21.89 (20.94–22.85)	1,406, 18.28 (17.38–19.18)	253, 3.61 (3.16–4.07)
1997	8,379	2,200, 26.99 (26.02–27.96)	1,771, 21.49 (20.59–22.39)	429, 5.50 (4.99–6.02)
2000	9,327	3,029, 31.99 (31.05–32.93)	2,386, 25.11 (24.23–25.99)	643, 6.88 (6.36–7.40)
2004	8,932	3,211, 33.87 (32.90–34.83)	2,486, 26.22 (25.33–27.12)	725, 7.64 (7.10–8.18)
2006	8,852	3,308, 35.11 (34.10–36.11)	2,563, 27.26 (26.32–28.20)	745, 7.84 (7.28–8.40)
2009	9,194	3,694, 37.57 (36.56–38.59)	2,801, 28.47 (27.52–29.42)	893, 9.10 (8.50–9.70)
2011	12,208	5,510, 42.13 (41.21–43.05)	4,023, 30.50 (29.65–31.35)	1,487, 11.63 (11.03–12.23)
2015	14,857	7,152, 45.42 (44.57–46.27)	5,091, 31.86 (31.08–32.63)	2,061, 13.56 (12.97–14.16)
2018	14,202	7,166, 46.60 (45.73–47.48)	4,977, 31.81 (31.01–32.61)	2,189, 14.79 (14.15–15.43)
2022–2024	13,112	7,286, 53.10 (52.02–54.18)	4,983, 35.00 (34.01–36.00)	2,303, 18.10 (17.25–18.94)

Note: The data stem from the China Health and Nutrition Survey, specifically from the 1991 to the 2024 survey rounds. Participating PLADs were not identical across survey waves because the China Health and Nutrition Survey coverage changed over time; each wave-specific estimate reflects the PLADs participating in that round.
Abbreviation: *CI*=confidence interval.

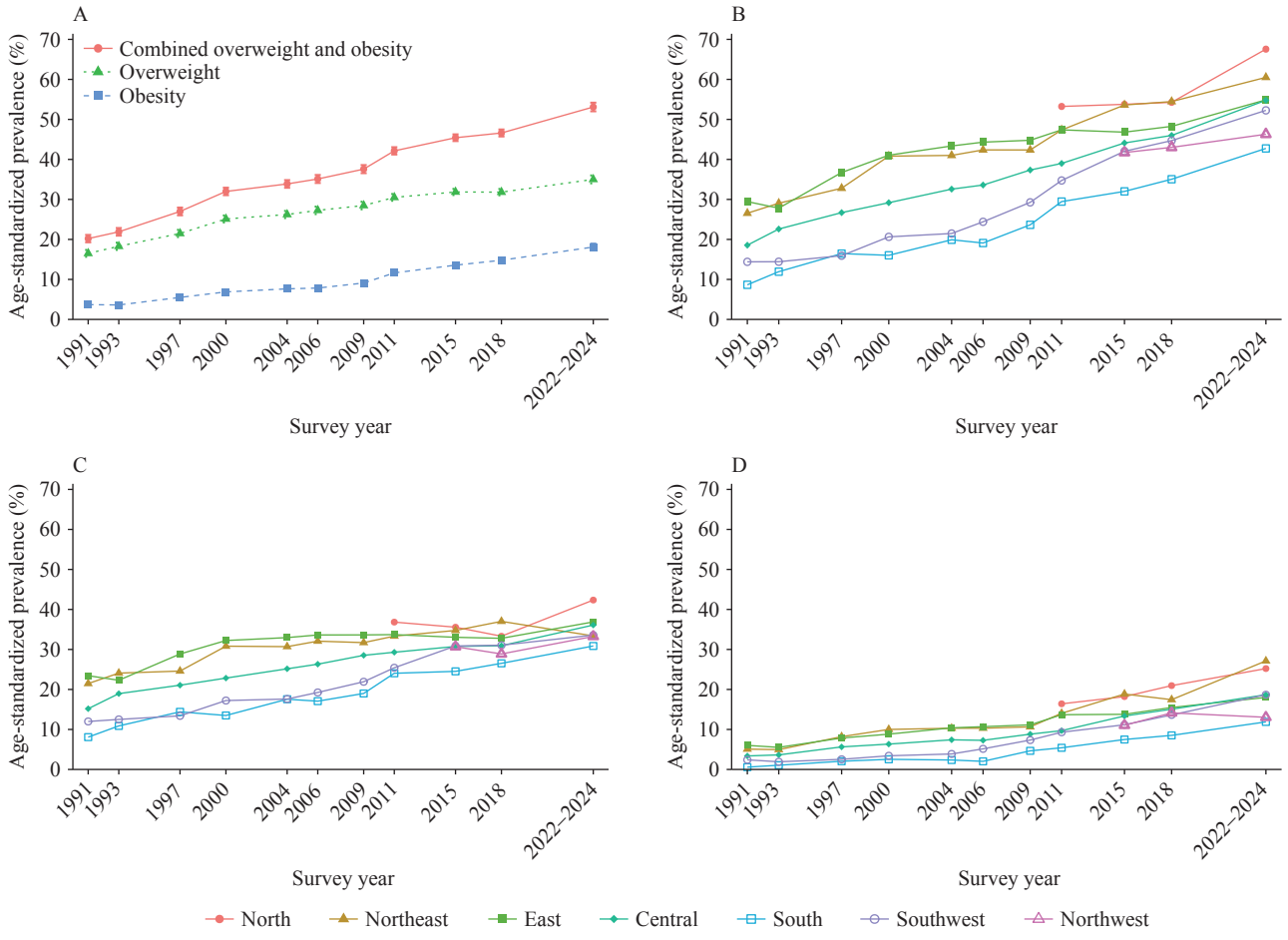


FIGURE 1. Age-standardized prevalence trends for combined overweight and obesity, overweight, and obesity at the national level and by geographic region, China, 1991–2024. (A) National; (B) Combined overweight and obesity by geographic region; (C) Overweight by geographic region; (D) Obesity by geographic region.
Note: The data stem from the China Health and Nutrition Survey's rounds from 1991 to 2024. The regional estimates are shown for survey rounds for which there are available data.

TABLE 2. Age-standardized prevalence of overweight and obesity by geographic region, China, 2022–2024.

Region	No. of PLADs*	*N*	Combined overweight and obesity *n*, % (95% *CI*)	Overweight *n*, % (95% *CI*)	Obesity *n*, % (95% *CI*)
North	1	668	456, 67.56 (62.82–72.29)	274, 42.34 (37.37–47.31)	182, 25.22 (21.23–29.20)
Northeast	2	1,575	947, 60.50 (55.96–65.05)	601, 33.38 (30.64–36.12)	346, 27.12 (22.65–31.60)
East	4	3,400	1,992, 54.88 (52.62–57.15)	1,392, 36.88 (34.75–39.00)	600, 18.00 (16.27–19.74)
Central	3	2,424	1,347, 54.77 (51.96–57.59)	949, 36.09 (33.55–38.64)	398, 18.68 (16.34–21.02)
South	2	1,710	763, 42.74 (40.12–45.36)	566, 30.86 (28.51–33.21)	197, 11.88 (10.10–13.66)
Southwest	3	2,481	1,371, 52.26 (49.92–54.59)	894, 33.59 (31.44–35.73)	477, 18.67 (16.88–20.46)
Northwest	1	854	410, 46.28 (42.26–50.31)	307, 33.25 (29.68–36.82)	103, 13.04 (10.12–15.95)
Cochran's *Q* (df=6)	–	–	120.15, *P*<0.001	26.88, *P*<0.001	81.44, *P*<0.001

Note: The data stem from the China Health and Nutrition Survey's 2022–2024 survey round.
Abbreviation: *CI*=confidence interval; PLAD=provincial-level administrative division.
* The number of participating PLADs included in each geographic region.

(22.65%–31.60%) and the lowest in South China at 11.88% (197/1,710) (10.10%–13.66%).

In intercept-only models, PLAD-level ICCs were 2.77%, 0.56%, and 3.18% for combined overweight and obesity, overweight, and obesity, respectively. Bootstrap tests supported a PLAD variance component for each outcome (Supplementary Table S1, available at https://weekly.chinacdc.cn/). In M3 (adding GDP per capita and $PM_{2.5}$), the estimated PLAD-level variance was 46.02% lower for combined overweight and obesity and 25.75% lower for obesity (*vs.* M2; Supplementary Table S2, available at https://weekly.chinacdc.cn/).

Fully adjusted models showed higher odds of combined overweight and obesity and of overweight among men (*OR*s=1.349 and 1.299), adults aged 40–59 years (1.378 and 1.400), and those aged 60–79 years (1.179 and 1.425). High education was inversely associated with all outcomes (*OR*s=0.727, 0.853, and 0.780). Each income doubling was positively associated with combined overweight and obesity and with overweight (1.026 and 1.016). Current smoking was inversely associated with all outcomes (*OR*s=0.799, 0.874, and 0.862; all *P*<0.05). Current drinking (*OR*s=1.158 and 1.215) and meat intake per 100 g/day (1.058 and 1.071) were positively associated with combined overweight and obesity and with obesity. Vegetable intake per 100 g/day was inversely associated with obesity (*OR*=0.941). At the community–level, Western fast-food restaurant availability was associated with combined overweight and obesity (*OR*=1.167, 95% *CI*: 1.024–1.331). At the PLAD–level, per 10 μg/m^3 $PM_{2.5}$ increase, the *OR*s were 1.366 (95% *CI*: 1.136–1.642) for combined overweight and obesity, 1.156 (1.082–1.234) for overweight, and 1.304 (1.029–1.653) for obesity (Table 3).

DISCUSSION

From 1991 to 2024, combined overweight and obesity, overweight, and obesity prevalence increased substantially among adult CHNS participants. Combined prevalence more than doubled, while obesity increased nearly fivefold, indicating a broad expansion of excess weight and increase in its more severe form. This sustained age-standardized rise is consistent with previous evidence from China and occurred alongside major changes in food consumption, transportation, work patterns, and living environments during the country's rapid socioeconomic development (*1*,*3*).

Increases were widespread but geographically unequal. North China had the highest combined and overweight prevalence, whereas obesity was the highest in Northeast China, consistent with reported disparities among Chinese adults (*2*). This regional distribution suggests that conditions associated with moderate and more severe excess weight may differ. The substantial burden across regions, nonetheless, shows that excess weight is not confined to a few high-prevalence areas. Regional differences should guide intervention delivery within population-wide prevention.

Individual-level findings situated this transition within demographic, socioeconomic, and behavioral changes. Men and adults aged 40–79 years had higher odds of combined overweight and obesity and of overweight, making them potential targets for prevention and weight-management services. Higher education was consistently associated with lower odds of all outcomes, whereas income was positively associated with combined overweight and obesity and with overweight. Accordingly, increased economic

TABLE 3. Associations of individual-, community-, and PLAD-level characteristics with overweight and obesity in the fully adjusted three-level logistic regression models, China, 2022–2024.

Characteristics	Combined overweight and obesity		Overweight		Obesity	
	OR (95% *CI*)	*P*	*OR* (95% *CI*)	*P*	*OR* (95% *CI*)	*P*
Individual-level variables						
Sex		–				
Female	1.000	–	1.000	–	1.000	–
Male	1.349 (1.221–1.490)	<0.001	1.299 (1.178–1.433)	<0.001	1.067 (0.941–1.210)	0.312
Age group (years)						
18–39	1.000	–	1.000	–	1.000	–
40–59	1.378 (1.234–1.539)	<0.001	1.400 (1.250–1.569)	<0.001	0.993 (0.864–1.143)	0.927
60–79	1.179 (1.041–1.335)	0.009	1.425 (1.257–1.615)	<0.001	0.749 (0.638–0.879)	<0.001
Education						
Low	1.000	–	1.000	–	1.000	–
Middle	0.899 (0.821–0.983)	0.020	0.968 (0.886–1.057)	0.463	0.897 (0.800–1.005)	0.061
High	0.727 (0.630–0.839)	<0.001	0.853 (0.741–0.983)	0.027	0.780 (0.649–0.937)	0.008
Household income, per doubling	1.026 (1.010–1.042)	0.001	1.016 (1.001–1.031)	0.040	1.016 (0.996–1.036)	0.124
Current smoking						
No	1.000	–	1.000	–	1.000	–
Yes	0.799 (0.717–0.891)	<0.001	0.874 (0.785–0.972)	0.013	0.862 (0.752–0.989)	0.034
Current drinking						
No	1.000	–	1.000	–	1.000	–
Yes	1.158 (1.053–1.273)	0.003	1.025 (0.933–1.125)	0.610	1.215 (1.078–1.370)	0.001
Energy intake, per 500 kcal/day	1.040 (1.006–1.075)	0.019	1.018 (0.986–1.050)	0.274	1.040 (0.999–1.084)	0.057
Fat-derived energy, per 10 percentage points	1.000 (0.966–1.035)	0.980	1.011 (0.977–1.045)	0.536	0.983 (0.940–1.027)	0.439
Staple food intake, per 100 g/day	0.991 (0.961–1.022)	0.548	0.980 (0.952–1.010)	0.192	1.006 (0.968–1.047)	0.753
Vegetable intake, per 100 g/day	0.973 (0.945–1.002)	0.070	1.005 (0.977–1.033)	0.747	0.941 (0.905–0.978)	0.002
Fruit intake, per 100 g/day	0.964 (0.917–1.013)	0.148	1.002 (0.955–1.051)	0.933	0.945 (0.886–1.007)	0.083
Meat intake, per 100 g/day	1.058 (1.006–1.113)	0.028	1.013 (0.966–1.062)	0.597	1.071 (1.005–1.141)	0.035
Community-level variables						
Residence						
Rural	1.000	–	1.000	–	1.000	–
Urban	1.059 (0.934–1.201)	0.371	0.997 (0.898–1.106)	0.951	1.119 (0.961–1.303)	0.149
Agricultural labor, per 10 percentage points	0.991 (0.972–1.010)	0.359	0.991 (0.976–1.007)	0.270	0.999 (0.976–1.022)	0.921
Western fast-food restaurant: not available	1.000	–	1.000	–	1.000	–
Western fast-food restaurant: available	1.167 (1.024–1.331)	0.021	1.101 (0.989–1.226)	0.078	1.117 (0.955–1.306)	0.165
Park or stadium: not available	1.000	–	1.000	–	1.000	–
Park or stadium: available	0.977 (0.881–1.084)	0.667	0.987 (0.907–1.074)	0.756	0.987 (0.870–1.121)	0.843
PLAD-level variables						
GDP per capita, per 10,000 CNY	1.008 (0.975–1.041)	0.651	1.013 (1.001–1.024)	0.026	0.995 (0.955–1.038)	0.831
$PM_{2.5}$, per 10 μg/m^3	1.366 (1.136–1.642)	<0.001	1.156 (1.082–1.234)	<0.001	1.304 (1.029–1.653)	0.028

Note: The data stem from the China Health and Nutrition Survey's 2022–2024 survey round. Estimates are *OR*s (95% *CI*s) from the fully adjusted three-level logistic regression models (M3; *n*=12,748). Reference categories are indicated by *OR*=1.000. Continuous covariates were scaled as shown and grand-mean-centered. All tests are two-sided.
Abbreviation: BMI=body mass index; *CI*=confidence interval; CNY=Chinese yuan; GDP=gross domestic product; *OR*=odds ratio; PLAD=provincial-level administrative division; $PM_{2.5}$=particulate matter with an aerodynamic diameter ≤2.5 μm.

resources do not necessarily translate into healthier weight. This is despite education being associated with healthier choices during socioeconomic transitions (*3*). Positive associations of current drinking and meat intake with combined overweight and obesity and with obesity, and the inverse vegetable–obesity association connect excess weight with changing consumption patterns. Inverse associations with current smoking may reflect post-cessation weight gain, illness-related weight loss, or residual confounding by other health behaviors — not smoking's protective effect. These findings support health education and practical support for healthier diets.

These individual characteristics operated within community and provincial contexts. Community fast-food availability was positively associated with combined overweight and obesity, while higher PLAD-level $PM_{2.5}$ concentrations were associated with all outcomes, consistent with evidence connecting food environments and air pollution to excess-weight risk (*9*–*10*). The lower estimated between-PLAD variance in M3 (*vs.* M2) suggests that GDP per capita and $PM_{2.5}$ accounted (without establishing causality) for part of the observed between-PLAD variation. Most of the variation occurred among individuals and communities within PLADs; provincial conditions remain relevant, but prevention should also address local conditions.

The findings in this report are subject to at least five limitations. First, CHNS participants were recruited from selected communities, reducing generalizability to included PLADs' complete populations (*4*). Second, PLAD participation varied across waves, so part of the temporal and regional variation may reflect coverage changes. Third, only 16 PLADs were included, limiting macro-level characteristics assessments. Fourth, the latest-round multilevel analysis was cross-sectional; *OR*s indicate associations, and the available community and PLAD indicators could not capture all relevant contextual conditions. Finally, complete-case analysis, measurement error, residual confounding, and BMI's inability to characterize body-fat distribution may also have affected the findings.

The continuing shift toward obesity calls for coordinated actions toward the general adult population that are responsive to regional- and community-level circumstances. Prevention should combine health education, weight-management services, and healthy food environment promotion. The role of broader environmental conditions warrants evaluation. Population groups and areas experiencing a greater burden require attention without limiting prevention to selected regions or PLADs.

Conflicts of interest: No conflicts of interest.

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SUPPLEMENTARY MATERIALS

SUPPLEMENTARY TABLE S1. Parametric bootstrap tests of the PLAD-level random-intercept variance in intercept-only models, China, 2022–2024.

Outcome	PLAD variance	LRT statistic	Asymptotic *P*	Bootstrap *P*	Requested simulations	Used simulations
Combined overweight and obesity	0.097	92.938	<0.001	0.001	1,000	793
Overweight	0.019	20.677	<0.001	0.001	1,000	910
Obesity	0.112	67.236	<0.001	0.003	1,000	340

Note: The data stem from the China Health and Nutrition Survey's 2022–2024 survey round. The intercept-only model containing PLAD- and community-level random intercepts was compared with a reduced model containing only a community-level random intercept. Each parametric bootstrap test requested 1,000 simulations; 793, 910, and 340 simulations produced usable model fits for combined overweight and obesity, overweight, and obesity, respectively. Bootstrap *P* values were calculated from these valid simulations and should be interpreted together with the variance estimates.
Abbreviation: LRT=likelihood ratio test.

SUPPLEMENTARY TABLE S2. Variance components and intraclass correlation coefficients across the sequential three-level logistic regression models, China, 2022–2024.

Outcome	Model	PLAD variance	Community variance	PLAD ICC (%)	Community VPC (%)	Same-community ICC (%)	PLAD PCV, M3 *vs.* M2 (%)	Fit status
Combined overweight and obesity	M0	0.097	0.102	2.77	2.93	5.70	—	Non-singular
Combined overweight and obesity	M1	0.102	0.104	2.91	2.98	5.89	—	Non-singular
Combined overweight and obesity	M2	0.098	0.101	2.80	2.89	5.69	—	Non-singular
Combined overweight and obesity	M3	0.053	0.101	1.53	2.92	4.46	46.02	Non-singular
Overweight	M0	0.019	0.034	0.56	1.02	1.57	—	Non-singular
Overweight	M1	0.011	0.034	0.34	1.01	1.35	—	Non-singular
Overweight	M2	0.009	0.033	0.27	0.99	1.26	—	Non-singular
Overweight	M3	0.000	0.031	0.00	0.94	0.94	100.00	Singular
Obesity	M0	0.112	0.125	3.18	3.53	6.71	—	Non-singular
Obesity	M1	0.122	0.124	3.44	3.52	6.95	—	Non-singular
Obesity	M2	0.121	0.122	3.42	3.46	6.88	—	Non-singular
Obesity	M3	0.089	0.122	2.56	3.49	6.05	25.75	Non-singular

Note: The data stem from the China Health and Nutrition Survey's 2022–2024 survey round. All models used the same complete-case sample (*N*=12,748; 380 communities; 16 PLADs). M0 included only PLAD- and community-level random intercepts; M1 added individual-level covariates; M2 added community-level covariates; M3 added PLAD-level GDP per capita and $PM_{2.5}$. ICCs were calculated on the latent logistic scale using $\pi^2/3$ as the individual-level variance. The same-community ICC represents the correlation between two individuals from the same community, and includes both PLAD- and community-level variance components. PLAD-level PCV was calculated as (variance in M2 − variance in M3)/variance in M2 × 100%. The PLAD-level variance for overweight reached the boundary at zero in M3; accordingly, its nominal 100% proportional change in variance should be interpreted cautiously.
Abbreviation: GDP=gross domestic product; ICC=intraclass correlation coefficient; PCV=proportional change in variance; PLAD=provincial-level administrative division; $PM_{2.5}$=particulate matter with an aerodynamic diameter ≤2.5 μm; VPC=variance partition coefficient.