Iran J Public Health, Vol. 54, No.11, Nov 2025, pp.2454-2462

Original Article

Long-Term Dynamics of Overweight and Obesity in Chinese Adults and Association with Blood Pressure: Evidence from the China Health and Nutrition Survey

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(Received 12 Jul 2025; accepted 05 Sep 2025)

Abstract

Background: Overweight and obesity have turned into a substantial public health crisis worldwide. We aimed to estimate the prevalence and risk factors of overweight and obesity.

Method: Data collected from the China Health and Nutrition Survey (CHNS) from 1993 to 2015, including 75,559 adults. We used linear-by-linear trend tests, logistic models, and Cox regression models to test the relationship between the prevalence of overweight and obesity and blood pressure.

Results: From 1993 to 2015, the prevalence of overweight and obesity increased from 34.94% to 69.63%, and the prevalence of females was higher than that of males. Cox regression analysis showed that systolic pressure (SBP) <140 and diastolic pressure (DBP) <90 was associated with a lower prevalence in participants. Compared by both age and gender, SBP and DBP were risk factors for the prevalence of overweight and obesity.

Conclusion: Higher DBP and SBP were associated with a higher risk of overweight and obesity. When developing blood pressure control strategies, comprehensive consideration should be given to population demographics, with an emphasis on promoting individualized intervention approaches.

Keywords: Overweight; Obesity; Systolic pressure; Diastolic pressure; Chinese adults

Introduction

A growing body of evidence has established a strong association between obesity and a range of non-communicable diseases, particularly type 2 diabetes, cardiovascular diseases, cancer, and chronic respiratory disorders (1). Beyond its physiological consequences, obesity imposes significant social and psychological burdens, escalates healthcare costs, and exerts considerable strain on health systems (2). In 2022, approximately 2.5 billion adults aged 18 years and older were classified as overweight, with 890 million diagnosed with obesity (3). The global age-standardized prevalence of obesity rose markedly from 8.8% in 1990 to 18.5% in 2022 (4). Overweight and obesity have evolved into a global public-health crisis where their prevalence and rapid escalation are placing unprecedented strain on regional health systems (5).

In China, rapid economic and societal transformation over the past few decades has significantly altered lifestyles, characterized by increased caloric intake and sedentary behavior (6). The country now faces not only a vast number of overweight and obese individuals but also a concerning acceleration in obesity prevalence (7). By 2030, nearly two-thirds of Chinese adults may fall into the overweight or obese category (8).

To address this growing challenge, the Chinese government has implemented a series of national strategies aimed at promoting healthy lifestyles and preventing non-communicable diseases (9). In June 2024, the National Health Commission, in conjunction with the Ministry of Education, the General Administration of Sport, and 13 other governmental agencies, initiated a three-year nationwide campaign titled "Year of Weight Management," aimed at raising awareness, creating supportive environments, and strengthening population-level weight control competencies (10). Continued and intensified efforts are crucial to confront this escalating public health threat.

Body Mass Index (BMI) is currently the most widely used screening tool for assessing obesity (11). However, BMI primarily reflects general body mass and fails to differentiate between fat and lean mass, thereby limiting its ability to capture fat distribution patterns (12). Waist circumference (WC), on the other hand, is considered a more specific marker for central adiposity, particularly visceral fat accumulation (13). Combining BMI and WC offers a more comprehensive assessment of obesity and the associated health risks (14).

Therefore, based on the data of 8 follow-up cohorts, we comprehensively considered the BMI and WC, and analyzed the overweight and obesity trend of adults in China and its influencing factors.

Methods

Study population

We utilized data from the China Health and Nutrition Survey (CHNS), a nationally representative, ongoing prospective cohort study initiated in 1989, encompassing nine rounds of data collection up to 2015. A multistage, stratified cluster sampling strategy was employed to select provinces, counties, and urban districts across varying levels of socioeconomic development and urbanization.

Within these strata, communities and households were randomly chosen to ensure population representativeness (15). This study focused on adults aged ≥ 18 years. Since WC measurements were introduced in 1993, the analysis included data from eight survey waves conducted between 1993 and 2015. Participants with complete and plausible data on key variables-such as age, sex, blood pressure, anthropometric indicators, and physical activity—were eligible for inclusion. Individuals who were pregnant or breastfeeding during data collection, or whose biometric data were implausible (e.g., body weight <20 kg or >300 kg), were excluded from the analytic sample. For the survival analysis, participants classified as overweight or obese at baseline were excluded to facilitate the assessment of incident overweight/obesity. Additionally, individuals who only contributed data in a single survey wave post-1993 were not considered in longitudinal analyses.

Definition of indicators

According to the WHO's recommendation for Asian population, overweight is defined as 23 $kg/m^2 \leq$ BMI <27.5 kg/m^2, and obesity is defined as BMI ≥27.5 kg/m^2 (16). In addition, abdominal obesity is defined as WC ≥90 cm in men and 80 cm in women as recommended by the International Diabetes Federation (IDF) for Chinese adults (17). Therefore, in this article, overweight and obesity is defined as BMI ≥23 kg /m^2 and WC ≥ 90 cm in males; BMI ≥23 kg/m^2 and WC ≥80 cm in females.

Statistical analysis

Data were presented as the means ± standard deviations (SDs) for continuous variables and frequencies (percentages) for categorical variables. T-test for continuous variables and chi-square test of classified variables were used to compare the baseline characteristics between the overweight and obesity group and the non-obese group.

Analyses were stratified by gender and age group. Trends in the prevalence of overweight and obesity among participants from 1993 to 2015 were assessed by a linear-by-linear trend test. A logistic model was established to estimate the odds ratio (ORs) by the prevalence of gender and age groups, and it was adjusted according to the regions, smoking status, drinking status and sports activity.

Cox regression was used to calculate the hazard ratios (HRs), with overweight or obesity as the final event, and the time interval between the baseline data collection and overweight or obesity, loss to follow-up, or the end of this study (whichever came first) as the time variable. Chi-square statistics were used to test the regression coefficients. In adjusted models, the age, gender, smoking status, drinking status, physical activity and regions at baseline were adjusted. Age was modeled as a categorical variable. All analyses were conducted using Stata 15.0 (StataCorp., College Station, TX, United States) and SPSS 25.0 (IBM Corp., Armonk, NY, USA). A p-value < 0.05 was considered statistically significant.

Results

Participant characteristics

A total of 75559 subjects were included in this study, including 41268 overweight and obesity subjects. In the subsequent study, 8811 people were subjected to Cox regression analysis, of which 4674 people obtained overweight and obesity. The characteristics of all participants are displayed in Supplementary Table 1. Our analysis revealed that age, gender, urban/rural residence, and blood pressure are significantly associated with overweight and obesity prevalence.

Table 1: Prevalence of overweight and obesity: CHNS 1993-2015

Variable		1993	1997	2000	2004	2006	2009	2011	2015	*p* for trend
Total		34.94	40.99	49.51	53.55	55.18	58.76	63.41	69.63	<0.001
		(33.87-36.01)	(39.93-42.06)	(48.48-50.53)	(52.52-54.59)	(54.14-56.21)	(57.76-59.76)	(62.57-64.26)	(68.77-70.49)	
	ORs		1.44	1.34	1.25	1.21	1.17	1.08	0.97	
			(1.42-1.46)	(1.32-1.37)	(1.23-1.27)	(1.19-1.23)	(1.15-1.19)	(1.06-1.10)	(0.96-0.99)	
Males		27.62	34.98	43.72	48.64	50.42	53.93	60.40	65.87	<0.001
		(26.18-29.07)	(33.51-36.45)	(42.23-45.18)	(47.14-50.14)	(48.90-51.94)	(52.46-55.40)	(59.14-61.65)	(64.56-67.18)	
	ORs		1.2	1.11	1.03	0.98	0.95	0.86	0.78	
			(1.17-1.23)	(1.08-1.14)	(1.00-1.05)	(0.96-1.01)	(0.93-0.97)	(0.84-0.88)	(0.76-0.80)	
18-39 years		22.01	28.83	38.16	42.1	45.4	47.44	56.57	60.54	<0.001
		(20.17-23.97)	(26.75-30.90)	(35.94-40.38)	(39.51-44.70)	(42.562-48.24)	(44.58-50.31)	(53.912-59.22)	(57.31-63.78)	
	ORs		0.89	0.76	0.67	0.64	0.63	0.58	0.56	
			(0.85-0.93)	(0.73-0.80)	(0.65-0.70)	(0.62-0.67)	(0.60-0.65)	(0.57-0.61)	(0.54-0.58)	
40–59 years		33.96	40.2	48.54	53.72	54.91	58.67	64.74	69.78	<0.001
		(31.35-36.57)	(37.73-42.67)	(46.22-50.86)	(51.49-55.95)	(52.69-57.12)	(56.54-60.80)	(62.96-66.53)	(67.90-71.67)	

Table 1: Continued…

	ORs		1.45	1.39	1.3	1.25	1.21	1.09	0.99	
			(1.40-1.51)	(1.34-1.44)	(1.26-1.35)	(1.21-1.30)	(1.17-1.26)	(1.05-1.14)	(0.95-1.03)	
≥60 years		31.22	39.77	45.8	47.97	47.7	52.13	56.45	63.66	<0.001
		(27.45-34.99)	(36.15-43.40)	(42.38-49.21)	(44.80-51.13)	(44.64-50.77)	(49.30-54.96)	(54.10-58.79)	(61.50-65.82)	
	ORs		1.18	1.14	1.11	1.11	1.08	1.00	0.84	
			(1.13-1.24)	(1.09-1.20)	(1.06-1.17)	(1.06-1.16)	(1.03-1.14)	(0.95-1.05)	(0.79-0.88)	
Females		41.79	46.85	54.90	58.04	59.41	63.14	66.09	72.82	<0.001
		(40.24-43.33)	(45.33-48.36)	(53.49-56.32)	(56.63-59.46)	(58.00-60.82)	(61.79-64.49)	(64.94-67.23)	(71.69-73.95)	
	ORs		1.71	1.60	1.51	1.46	1.41	1.32	1.20	
			(1.67-1.74)	(1.57-1.64)	(1.47-1.54)	(1.43-1.50)	(1.38-1.45)	(1.29-1.35)	(1.17-1.23)	
18-39 years		30.65	35.28	40.72	40.63	40.71	41.00	46.10	49.78	<0.001
		(28.59-32.72)	(33.04-37.52)	(38.48-42.96)	(38.11-43.16)	(38.03-43.38)	(38.26-43.75)	(43.65-48.553)	(46.87-52.69)	
	ORs		0.75	0.69	0.66	0.66	0.66	0.63	0.61	
			(0.72-0.79)	(0.66-0.72)	(0.63-0.69)	(0.63-0.69)	(0.63-0.69)	(0.61-0.66)	(0.58-0.63)	
40–59 years		51.44	55.50	64.72	66.11	65.88	69.34	71.44	76.22	<0.001
		(48.81-54.07)	(53.08-57.92)	(62.60-66.83)	(64.11-68.11)	(63.89-67.86)	(67.450-71.23)	(69.85-73.04)	(74.60-77.84)	
	ORs		2.27	2.15	2.04	2.02	1.97	1.85	1.72	
			(2.19-2.35)	(2.06-2.23)	1.96-2.11)	(1.95-2.10)	(1.90-2.04)	(1.783-1.92)	(1.66-1.79)	
≥60 years		54.37	54.60	62.34	65.57	68.09	72.79	74.13	80.68	<0.001
		(50.47-58.28)	(51.13-58.08)	(59.24-65.44)	(62.72-68.43)	(65.42-70.77)	(70.42-75.16)	(72.16-76.10)	(79.02-82.33)	
	ORs		2.63	2.60	2.49	2.42	2.29	2.14	1.82	
			(2.50-2.75)	(2.47-2.72)	(2.37-2.61)	(2.30-2.54)	(2.18-2.41)	(2.03-2.25)	(1.73-1.92)	

Tendency in prevalence of overweight and obesity over the years

Table 1 shows the prevalence of overweight and obesity. Between 1993 and 2015, overweight and obesity among Chinese adults increased markedly, nearly doubling from 34.94% to 69.63% (*P* for trend <0.001). This growth was evident across all subgroups, though the magnitude and trajectory varied by gender and age.

A clear gender disparity emerged over the study period. Women consistently exhibited higher prevalence rates than men. Although women had higher absolute prevalence, their ORs relative to 1993 declined more substantially over time. In contrast, males demonstrated a steadier pattern, with ORs peaking in 2006 before falling back below 1.0 in 2015.

Age-stratified trends revealed that all age groups experienced rising overweight and obesity prevalence, though the slopes of increase varied. Among young adults (18-39 years), prevalence increased sharply for both genders. The ORs in this group showed a stable and gradual decline track in both genders. Middle-aged adults (40-59 years) exhibited both high and rising overweight and obesity rates. Despite this, their ORs showed a consistent decline. The ≥60 years group consistently had the highest ORs across the entire period in females, indicating they remained at disproportionately high risk.

Associations between Blood Pressure Indices and the Prevalence of Overweight and Obesity

In the continuous variable models (Model 1 and Model 2), each 1 mmHg increase in SBP or DBP was associated with a 1% increase in the hazard of overweight and obesity (*P*<0.0001). These results were consistent in both crude and adjusted analyses (Table 2)

Categorical analyses further delineated this relationship (Model 3 and Model 4). For SBP categories, individuals with SBP ≥160 mmHg exhibited a markedly increased risk of overweight and obesity compared to those with SBP <140 mmHg. In contrast, those with SBP <140 mmHg demonstrated a significantly reduced risk, reinforcing the protective effect of normotension.
Similarly, higher DBP categories were associated with increased overweight and obesity risk. Participants with DBP ≥100 mmHg had a 43% higher hazard, and those in the 90–100 mmHg range also showed a significant elevation in risk compared to the reference group with DBP <90 mmHg. Notably, the adjusted model consistently showed greater explanatory power, as reflected in the substantially elevated chi-squared statistics across all models.

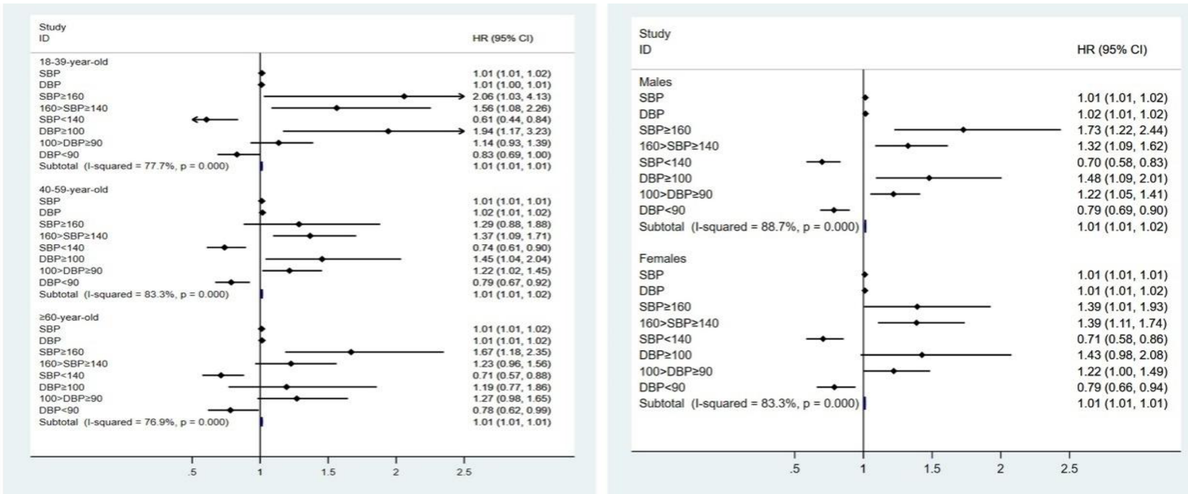
Table 2: Effects of SBP and DBP on the Prevalence of overweight and obesity in Sample from Cox Regression

Model	Crude					Adjusted [a]				
	β	x^2	p	HR	HR 95% CI	β	x^2	p	HR	HR 95% CI
Model 1										
SBP	0.008	70.94	<0.0001	1.01	1.01-1.01	0.012	333.50	<0.0001	1.01	1.01-1.01
Model 2								<0.0001		
DBP	0.009	37.82	<0.0001	1.01	1.01-1.01	0.013	283.34	<0.0001	1.01	1.01-1.02
Model 3										
SBP≥160	0.445	12.17	0.0005	1.56	1.24-1.97	0.450	221.77	<0.0001	1.57	1.24-2.00
160>SBP≥140	0.248	10.58	0.0011	1.28	1.11-1.48	0.308	224.71	<0.0001	1.36	1.17-1.58
SBP<140	0.305	21.25	<0.0001	0.74	0.65-0.83	0.366	237.32	<0.0001	0.69	0.61-0.79
Model 4										
DBP≥100	0.323	6.59	0.0102	1.38	1.09-1.75	0.360	217.43	<0.0001	1.43	1.13-1.82
100>DBP≥90	0.120	3.95	0.047	1.13	1.00-1.27	0.201	219.90	<0.0001	1.22	1.09-1.38
DBP<90	0.161	8.50	0.0036	0.85	0.77-0.95	0.240	227.06	<0.0001	0.79	0.71-0.88

Data were from the China Health and Nutrition Survey from 1993 to 2015.
[a] Adjusted for gender, age, smoking status, drinking status, physical activity, and residence

Blood Pressure Stratification and Its Association with Overweight and Obesity Risk Across Age and Gender Subgroups

As illustrated in Fig. 1, the association between blood pressure categories and the prevalence of overweight and obesity was consistent across different age and gender strata. SBP <140 mmHg and DBP <90 mmHg were consistently linked to a reduced risk of overweight and obesity, with HRs below 1 in all age groups and both genders (*P* < 0.0001).



A) Cox regression stratified by age groups **B) Cox regression stratified by gender**

Fig. 1: Results of Cox Regression: A) Cox regression stratified by age groups; B) Cox regression stratified by gender

In the study of age groups, the increase of 160> SBP ≥140 and 100> DBP ≥90 mmHg is related to the increase of overweight and obesity prevalence in all ages. Moreover, DBP ≥100 mmHg was another significant risk factor, with elevated HRs across subgroups. At the same time, SBP ≥160 mmHg emerged as a strong independent risk factor, particularly in the 18–39-year subgroup.

Gender-specific analysis revealed that 160> SBP ≥140 and 100> DBP ≥90 mmHg were associated with moderate increases in risk in both genders. Similarly, both males and females with SBP ≥160 mmHg had increased overweight and obesity prevalence, although the magnitude of risk differed slightly. Notably, DBP ≥100 mmHg posed a particularly elevated risk in males and females.

Discussion

Our two-decade surveillance reveals a dramatic and sustained rise in overweight and obesity among Chinese adults between 1993 and 2015. Related studies have found that as China's urbanization level increases, the chance of being overweight is also gradually increasing (18).

The study showed that gender was a significant factor influencing overweight and obesity prevalence. This finding is consistent with earlier studies, which suggest that women are more prone to obesity than men (19). Hormonal differences, including the impact of estrogen on fat distribution, might partly explain this gender disparity (20). Despite higher absolute prevalence in females, their adjusted ORs relative to 1993 exhibited a more marked decline than men, potentially reflecting generational shifts in baseline adiposity, improved early-life nutrition, or changes in reproductive patterns and menopause timing. This finding is consistent with earlier studies (21). This may be because men are more receptive to obesity, especially manual workers (22).

Age was found to be positively associated with overweight and obesity. With the increase of individual age, changes in metabolic rate, physical activity levels and hormone level may cause weight gain (23). In addition, the elderly often experience a decrease in muscle mass, which can further slowdown metabolism and make individuals more likely to gain weight (24). Moreover, older women maintained the highest prevalence throughout, potentially due to post-menopausal metabolic changes and reduced physical activity, as supported by sex-stratified cohort data (25).

This study demonstrated that both SBP and DBP significantly influence the risk of overweight and obesity across diverse age and gender subgroups.

The influence of SBP and DBP on risk varies nonlinearly with age. In the young group, the slight increases of blood pressure have little effect on adverse outcomes, and the risk will increase significantly only when there is severe hypertension, such as SBP ≥ 160 mmHg or DBP ≥ 100 mmHg. This shows that young people may have a certain tolerance to the increase of blood pressure, but hypertension still needs attention. In contrast, the risk of the middle-aged group was significantly higher than that of other groups, especially when SBP ≥ 160 mmHg and diastolic pressure ≥ 100 mmHg, the risk is obviously increased. Although the increase of blood pressure in the elderly group is also related to the increase of risk, the HR value is slightly lower, which may be related to the decrease of sensitivity of the elderly group to traditional cardiovascular risk factors. In addition, although the relationship between the overall blood pressure level of men and women and the risk is weakly correlated, the risk increased significantly at the level of hypertension. It is worth noting that when DBP ≥ 100 mmHg, the risk ratio of women is obviously higher than that of men, suggesting that women may face greater risks when facing severe hypertension. This phenomenon may be related to differences in blood vessel structure, physiological regulation and endocrine characteristics among women. Moreover, DBP <90 mmHg emerged as a protective factor in both genders, underscoring the clinical importance of tight diastolic control in overweight and obesity prevention.

These results emphasize the urgent need for targeted interventions, which means that the age and gender characteristics of the population should be fully considered and individual intervention should be promoted when formulating blood pressure control strategies. Young and middle-aged adults—particularly women—should be prioritized with lifestyle-focused programs, workplace initiatives, and nutrition education. The persistent high burden in older adults highlights the importance of integrating geriatric care, physical activity promotion, and weight management into routine community health services. Sex- and age-tailored strategies, including menopause-specific programs for women and age-adjusted physical activity guidance for men, can enhance efficacy. In addition, given the graded risk increases observed with SBP and DBP, our data advocate for age- and gender-tailored hypertension management, prioritizing early identification and control of even mild blood pressure elevations. This stratified approach could optimize prevention of overweight and obesity and related cardiometabolic complications. Future work should explore the impact of integrated lifestyle and pharmacologic interventions on vascular outcomes across these demographic subgroups.

Strengths and limitations

A major strength of this study is its large, nationally representative longitudinal design spanning more than two decades. Using BMI and WC to define overweight and obesity could improve the accuracy of the analyses in this study.

However, there were several limitations. First, our data has not been updated to the recent past, which may make the current situation less accurate. However, the data year in this study (1993-2015) were a period when China experienced major economic reforms, urbanization and lifestyle changes, which probably had the greatest impact on health and nutrition trends. Second, in defining the year of occurred, as precise overweight or obesity events were inaccessible, we designated the discovery year of these conditions as the occurrence year. Further, the observational design precludes definitive causal inference. Despite employing Cox regression with adjustments, residual confounding (e.g., medication regimens) cannot be excluded. Future investigations could apply cohort studies to clarify causality.

Conclusion

Overweight and obesity prevalence in Chinese adults has risen dramatically from 1993 to 2015, with differential trajectories by age and gender. The prevalence of overweight and obesity has gradually increased, and the prevalence of women is always higher than that of men. However, the prevalence of oral contraceptives among men has grown faster than that of women. Young and middle-aged females, as well as elderly individuals, remain primary targets for intervention. SBP and DBP are associated with a higher prevalence of overweight and obesity. In particular, higher DBP and SBP were associated with a higher risk of overweight and obesity in both males and females and were also shown to be risk factors in all age groups. These findings emphasize the critical need for tailored, multidimensional public health strategies to curb the obesity epidemic in China. Public health policies should focus on promoting healthier lifestyles, improving dietary habits, and increasing physical activity, especially in high-risk populations such as older adults and women. Future research should also explore other socio-cultural factors and genetic predispositions that contribute to the rising rates of obesity in China.

Journalism Ethical considerations

The data were from publicly official datasets. Ethical approval should be exempted.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available on the web: https://www.cpc.unc.edu/projects/china.

Acknowledgements

This research was funded by Fujian Health College, grant number MWY2025-5-01.

Conflict of Interest

The authors declare that there is no conflict of interests.

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