

# The Influence of Body Fat Percentage on Body Type Cognitive Bias Among Young Chinese Hospital Staff Members: A Cross-Sectional Study

Lu Wang<sup>1</sup>, Jing Wen<sup>2</sup>, Zhen Xu<sup>3</sup>, Ke Guan<sup>2</sup>, Yongchun Chen<sup>2,\*</sup>

<sup>1</sup>Department of Clinical Nutrition, The Third Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, Zhejiang, China

<sup>2</sup>Department of Clinical Nutrition, Henan Provincial People's Hospital, People's Hospital of Zhengzhou University, Zhengzhou, Henan, China

<sup>3</sup>Department of Clinical Nutrition, Fuwai Central China Cardiovascular Hospital, Fuwai Central China Cardiovascular Hospital of Zhengzhou University, Zhengzhou, Henan, China

\*Correspondence: [henancyc@zzu.edu.cn](mailto:henancyc@zzu.edu.cn) (Yongchun Chen)

## Abstract

**Aims/Background** This study expanded the existing literature on obesity and distortion of body image by examining subjective and objective body type among young medical workers, specifically investigating whether fat percentage independently influences body type cognitive bias.

**Methods** We recruited 264 participants (41.29% male, mean age  $26.2 \pm 3.1$  years, mean body mass index (BMI)  $21.7 \pm 3.1$  kg/m<sup>2</sup>) at a comprehensive hospital in central China. The questionnaire responses of the enrolled participants concerning basic information and body type self-assessment were extracted. Their weights and body compositions were evaluated by the bioelectrical impedance analysis technique (BIA). Objective indicators included measured weight, BMI, fat percentage, waist circumference (WC) and waist-to-hip ratio (WHR).

**Results** Based on this sample, the prevalence rate of body type cognitive bias was 28.79%. For women, the univariate regression analysis showed that fat percentage was significantly correlated with body type cognitive bias (odds ratio [OR] 1.107, 95% confidence interval [CI] 1.033–1.185,  $p = 0.004$ ). BMI (OR 1.303, 95% CI 1.098–1.546,  $p = 0.002$ ) and WC (OR 1.109, 95% CI 1.043–1.180,  $p = 0.001$ ) might also be positively associated with body type cognitive bias. After adjusting for age, BMI, WHR, and job position, the risk of body type cognitive bias decreased with fat percentage up to the first inflection point (26.8%) (OR 0.78, 95% CI 0.62–0.98,  $p = 0.036$ ), and then it increased up to the second inflection point (33.0%). When fat percentage exceeded 33.0%, the relationship lost statistical significance. No significant relationships were found for men.

**Conclusion** Fat percentage is an independent, nonlinear factor influencing women's body type cognitive bias. Gender and fat percentage should be considered when establishing weight management intervention strategies to prevent obesity from becoming a public health problem.

**Key words:** body composition; cognitive bias; public health; weight management

Submitted: 19 July 2024 Revised: 22 August 2024 Accepted: 10 September 2024

## How to cite this article:

Wang L, Wen J, Xu Z, Guan K, Chen Y. The Influence of Body Fat Percentage on Body Type Cognitive Bias Among Young Chinese Hospital Staff Members: A Cross-Sectional Study. *Br J Hosp Med.* 2024. <https://doi.org/10.12968/hmed.2024.0444>.

Copyright: © 2024 The Author(s).

## Introduction

Obesity is a medical problem that has social and cultural implications. Its prevalence rate has nearly tripled since 1975 (Who.int, 2019). About 13% of the world's adults (11% of men and 15% of women) were obese in 2016. In most

countries, the overweight problem has claimed more lives than the underweight one ([Who.int, 2019](#)). Weight abnormalities are often regarded as external manifestations of physical and mental disorders. It has been established that possessing a correct understanding of weight/body type is an important for obesity prevention and control.

The body fat percentage may affect individuals' perception of their body shape, primarily because it is directly related to their health status, physical function, and appearance. Firstly, the body fat percentage is a crucial indicator for assessing the level of obesity and is associated with various health issues such as cardiovascular diseases, hypertension, and diabetes ([Cai, 2019](#); [Chao et al, 2022](#)). Secondly, changes in body fat percentage can influence an individual's physical function and athletic performance. For instance, studies have shown a significant correlation between body fat percentage and physical fitness indicators like lung capacity and maximum oxygen intake ([Potocka et al, 2019](#); [Wang et al, 2019](#)). Moreover, body fat percentage also affects an individual's perception of their appearance and self-evaluation. Research has found that an increase or decrease in body fat percentage can impact an individual's body esteem and self-worth ([Zhou and Qiu, 2022](#)).

However, most individuals have an inaccurate perception of their body weight and fat, forming a perceptual error that leads to misunderstandings about their body shape ([Mutter et al, 2020](#)). For example, a study suggests that it's common to misjudge changes in the actual weight and body fat percentage ([Bui et al, 2019](#)). This bias in perception may further exacerbate dissatisfaction and anxiety about one's body shape, thereby affecting mental health and social functioning ([Kagawa and Hills, 2020](#); [Talbot et al, 2019](#)).

There is often a deviation and dislocation (overestimation or underestimation) of subjective perceptions of body weight/type. [Burke and Heiland \(2018\)](#) found that the probability of self-classifying as overweight was significantly lower, on average, based on the National Health and Nutrition Examination Survey (NHANES) data published in the more recent years (1999–2004 vs. 1988–1994). This is an apparent reason that weight management, either gain or loss, becomes less of an appealing idea for people, thus limiting public health campaign effectiveness.

On the other hand, traditional weight evaluation indexes, such as the body mass index (BMI), may be insufficient for assessing the effects of body weight, especially the health effects of different body composition ratios, which are key to affecting visual body type (the appearance of being fat or thin) ([Zhou and Qiu, 2022](#)). Recently, a new technology called bioelectrical impedance analysis (BIA) for measuring both weight and body composition has emerged ([Holmes and Racette, 2021](#)), providing a non-invasive, cost-effective, and time-efficient way to obtain potentially more sensitive measures of adiposity.

In this study, we expanded the existing literature by describing the differences between subjective and objective body types among young medical workers, and we tested the hypothesis that body fat percentage has an independent influence on body type cognitive bias. Most previous studies explained the reasons for misconceptions of body weight from a social psychology perspective. This study is the first to examine the relationship between BIA-derived body composition indica-

tors and subjective body type cognitive bias, providing a reasonable, potentially new physiological perspective.

## Methods

### Participants

A total of 331 participants aged 20–39 years were voluntarily recruited from among the recruits of a comprehensive hospital in central China in July 2017. Three women who were pregnant were found to be ineligible. Twenty-one individuals who had missing questionnaire information, forty-two who had missing BIA data, and another person who had missing anthropometry information were also excluded. Finally, 264 participants (41.29% male) were included in the analysis. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human participants were approved by the Ethics Committee of the Henan Provincial People's Hospital (Ethics Approval Number: 2016-185). Written informed consent was obtained from each participant. All participants gave written informed consent before participating in the study.

### Anthropometry and Body Composition Measurements

Weight and height were measured while the participants were standing, bare-foot, and wearing light clothes. Height was measured to the nearest 0.1 cm. Weight was measured to the nearest 0.01 kg (Health-O-Meter 500KL, Sunbeam Products, Inc., Boca Raton, FL, USA). Waist circumference (WC) was measured in centimeters at the mid-point between the costal margin and the iliac crest while the participants were unclothed and standing in an erect position. Hip circumference (HC) was measured at the widest point of the buttock region. BMI was calculated as body weight (in kilograms) divided by height (in meters) squared, and waist-to-hip ratio (WHR) was calculated as the ratio of WC and HC. All measurements were repeated three times, and averages were recorded.

The InBody 230 body composition analyzer (Biospace, Seoul, Korea) was used to measure weight and fat percentage using the BIA technique. The InBody 230 is a segmental impedance device equipped with a four-pole, eight-point tactile electrode, utilizing frequencies of 20 kHz and 100 kHz for each body segment. This approach presents a complex procedure that eliminates the possibility of inaccuracies. The InBody 230 is an accurate and convenient BIA instrument used to measure weight, total body water, lean body mass, lean mass (dry), muscle mass (skeletal), body fat mass, fat-free mass, BMI, body fat percentage, basal metabolic rate (BMR), and impedance analysis of each segment (right and left arm, trunk, right and left legs). The analysis of data output was conducted according to the manufacturer's algorithms, including the computation of fat percentage (fat percentage (%) = body fat mass/weight × 100%) and BMI (BMI = weight in kilograms/squared height in meters). A standardized protocol was applied according to the InBody 230 user manual (InBody Co, Ltd., 1996). Subjects entered the testing area, with their shoes and socks removed, wearing only light clothing. The measurement of

impedance began when they stood on the device platform and held the handles with both hands.

### Questionnaire Survey and Variable Definitions

The questionnaire was completed on the same day as the anthropometric measurements, in the testing room before the measurements began, under the supervision of the personnel responsible for data collection. Self-administered questionnaires were used to collect subjective body type perception data. Participants were required to respond to the question “Which body type do you think you have?” by choosing only one of the following options: “thin”, “normal”, “overweight”, or “obese”. Since “obese” responses were not frequently given by the respondents ( $n = 11$ ), we combined these with the “overweight” responses to represent above-normal body type. Objective body type was defined according to the National Health and Family Planning Commission of the People’s Republic of China (PRC)’s criteria for adult weight. Participants were classified as either underweight ( $BMI < 18.5$ ), normal ( $18.5 \leq BMI < 24.0$ ), overweight ( $24 \leq BMI < 28$ ), or obese ( $BMI \geq 28$ ) (Chen et al, 2023). According to the consistency of objective and subjective body types, the participants were divided into accordance and deviated groups.

### Statistical Analysis

Means and standard deviations (SDs), or medians and ranges, were calculated for all continuous variables. Categorical variables are expressed as count (%). Statistical analyses were performed to compare the variable groups. An exploratory data analysis was undertaken, complemented by the application of Shapiro-Wilk tests, to ascertain the normal distribution of the data set.

Independent sample  $t$ -tests (or Mann-Whitney U tests) were used to compare continuous variables, and  $\chi^2$  tests (or Fisher’s exact tests) were used for the categorical variables. For continuous variables, the Kruskal-Wallis rank-sum test was employed to derive the results. In the case of categorical variables with expected frequencies less than 10, Fisher’s exact probability test was utilized for statistical inference.

Univariate logistic regression was used to examine whether fat percentage and other covariates influenced body type cognitive bias. Multivariate logistic regression analyses were carried out to identify the independent risk factors of body type cognitive bias, adjusting for various confounders, including age, BMI, WHR, and fat percentage. Taking into account the potential impact of a professional education background, we also adjusted for job positions (doctors, nurses, medical technicians, pharmacists, and administrative staff). Then, we explored the relationship between fat percentage and body type cognitive bias through smoothed curve fitting and adjustment for potential confounders. We further applied a three-piecewise linear regression model to examine the threshold effect of fat percentage on body type cognitive bias according to the smoothing plot. The threshold level of fat percentage at which the relationship between body type cognitive bias and fat percentage level began to change notably was determined using a trial method. The trial’s inflection point moved along a pre-defined interval and was detected when indicating

the maximum model likelihood. Considering the interaction results concerning the subjects' sex reported in previous research (Kye and Park, 2021; Roshandel et al, 2023; Sasikala et al, 2018) and our interaction test results, a sex-specific correlation analysis was implemented. In the multicollinearity test, we excluded variables with a variance inflation factor greater than 5 before performing the multivariate logistic regression analyses. All data were double-entered with EpiData 3.1 (The EpiData Association, Odense, Denmark). Then, they were exported to tab-delimited text files.

Data processing and analysis were performed using R version 4.4.0 (Hangzhou zhenglaoshi statistics technology Co., Ltd, Hangzhou, China) (2024-04-24), along with Zstats v1.0 (<https://www.zstats.net>) (Hangzhou, China). A  $p$ -value of  $<0.05$  was considered statistically significant.

## Results

### Results of Objective Measurement

Participants' demographic and body type-related characteristics, including age, objective and subjective body types, and job position, are summarized in Table 1. Among the 264 participants included in this study, nearly 80% were of a normal body type. The sample included 50.00% doctors, 22.73% nurses, 18.18% medical technicians, 5.30% pharmacists, and 3.79% administrative staff. There were no noticeable differences in the basic characteristics between the accordance and deviated groups, except for the WHR, fat percentage and the subjective body type distribution. Slightly more than a quarter of the participants (28.79%) overestimated or underestimated their objective body type, while more than half (66.49%) of the accordance group participants reported having a normal body type.

### Potential Influencing Factors of Body Type Cognitive Bias

The univariate regression analysis showed that fat percentage was significantly correlated with body type cognitive bias among women (odds ratio [OR] 1.107, 95% confidence interval [CI] 1.033–1.185,  $p = 0.004$ ). In addition, BMI (OR 1.303, 95% CI 1.098–1.546,  $p = 0.002$ ) and WC (OR 1.109, 95% CI 1.043–1.180,  $p = 0.001$ ) might also be associated with body type cognitive bias among women (Table 2). However, no significant correlation was observed between any variables and the risk of body type cognitive bias in either men or the entire sample. After excluding WC, the multiple collinear factors, multivariate linear regression was conducted with adjustment for potential confounding factors (Table 3). However, no significant linear correlation was found.

### Relationship between Fat Percentage and Probability of Body Type Cognitive Bias

After adjusting for the possible factors related to body type cognitive bias, a nonlinear relationship between fat percentage and body type cognitive bias was observed (Fig. 1). Among women, the risk of body type cognitive bias decreased with fat percentage up to the first inflection point (26.8%) (OR 0.78, 95% CI 0.62–0.98,  $p = 0.036$ ). Then, it increased up to the second inflection point (33.0%). When

**Table 1. Participants' demographic and body type-related characteristics.**

	Total (n = 264)	Accordance group (n = 188)	Deviated group (n = 76)	Statistic	p-value
Men, n (%)	109 (41.29%)	78 (41.49%)	31 (40.79%)	$\chi^2 = 0.01$	0.917
Age, M (Q <sub>1</sub> , Q <sub>3</sub> ), years	26.00 (25.00, 27.00)	26.00 (24.00, 27.00)	26.00 (25.00, 28.00)	$Z = -1.79$	0.074
Weight, M (Q <sub>1</sub> , Q <sub>3</sub> ), kg	58.35 (51.68, 67.73)	57.30 (50.80, 67.27)	59.90 (54.72, 67.78)	$Z = -1.68$	0.094
BMI, M (Q <sub>1</sub> , Q <sub>3</sub> ), kg/m <sup>2</sup>	21.15 (19.50, 23.20)	20.80 (19.48, 23.00)	22.00 (19.70, 23.40)	$Z = -1.62$	0.104
WC, M (Q <sub>1</sub> , Q <sub>3</sub> ), cm	71.00 (64.00, 78.00)	69.00 (63.00, 78.25)	72.00 (67.75, 78.00)	$Z = -1.92$	0.054
WHR, M (Q <sub>1</sub> , Q <sub>3</sub> )	0.85 (0.82, 0.89)	0.85 (0.82, 0.88)	0.87 (0.84, 0.89)	$Z = -2.61$	0.009
Fat percentage, Mean $\pm$ SD	25.66 $\pm$ 6.18	25.21 $\pm$ 5.76	26.76 $\pm$ 7.03	$t = 1.86$	0.004
Objective body type, n (%)				$\chi^2 = 0.15$	0.925
Thin	35 (13.26%)	24 (12.77%)	11 (14.47%)		
Normal	174 (65.90%)	125 (66.49%)	49 (64.47%)		
Overweight/Obese	55 (20.83%)	39 (20.74%)	16 (21.05%)		
Subjective body type, n (%)				$\chi^2 = 44.41$	<0.001
Thin	40 (15.15%)	24 (12.77%)	16 (21.05%)		
Normal	142 (53.79%)	125 (66.49%)	17 (22.37%)		
Overweight/Obese	82 (31.06%)	39 (20.74%)	43 (56.58%)		
Job position, n (%)				$\chi^2 = 8.54$	0.074
Doctor	132 (50.00%)	95 (50.53%)	37 (48.68%)		
Nurse	60 (22.73%)	48 (25.53%)	12 (15.79%)		
Medical technician	48 (18.18%)	33 (17.55%)	15 (19.74%)		
Pharmacist	14 (5.30%)	6 (3.19%)	8 (10.53%)		
Administrative staff	10 (3.79%)	6 (3.19%)	4 (5.26%)		

Non-normally distributed measurement data are described by the median (M) and interquartile range (Q<sub>1</sub>, Q<sub>3</sub>); Normally distributed measurement data are described by the Mean  $\pm$  standard deviation (SD).

BMI, body mass index; WC, waist circumference; WHR, waist-to-hip ratio.

Table 2. Univariate analysis of related factors on body type cognitive bias by sex.

Variables	Total (n = 264)						
	B	SE	Wald chi-square	df	p-value	Exp (B)	95% CI of Exp (B)
Fat percentage	0.041	0.022	3.378	1	0.066	1.042	0.997, 1.089
Age, years	0.105	0.045	5.506	1	0.019	1.111	1.017, 1.213
BMI, kg/m <sup>2</sup>	0.072	0.043	2.796	1	0.095	1.075	0.988, 1.169
WC, cm	0.022	0.013	2.777	1	0.096	1.023	0.996, 1.050
WHR	-2.451	2.081	1.388	1	0.239	0.086	0.001, 5.088
Job position							
Doctor (ref)	—	—	—	—	—	—	—
Nurse	-0.537	0.674	0.636	1	0.425	0.584	0.156, 2.189
Medical technician	-0.981	0.722	1.847	1	0.174	0.375	0.091, 1.543
Pharmacist	-0.383	0.717	0.286	1	0.593	0.682	0.167, 2.778
Administration staff	0.693	0.842	0.678	1	0.410	2.000	0.384, 10.409
	Women (n = 155)						
Fat percentage	0.101	0.035	8.305	1	0.004	1.107	1.033, 1.185
Age, years	0.146	0.079	3.420	1	0.064	1.157	0.991, 1.351
BMI, kg/m <sup>2</sup>	0.264	0.087	9.152	1	0.002	1.303	1.098, 1.546
WC, cm	0.104	0.032	10.784	1	0.001	1.109	1.043, 1.180
WHR	-6.918	3.555	3.786	1	0.052	0.001	0.000, 1.051
Job position							
Doctor (ref)	—	—	—	—	—	—	—
Nurse	-0.577	0.476	1.473	1	0.225	0.561	0.221, 1.426
Medical technician	0.128	0.484	0.070	1	0.791	1.137	0.440, 2.937
Pharmacist	1.486	0.683	4.738	1	0.030	4.421	1.159, 16.857
Administration staff	0.927	1.036	0.800	1	0.371	2.526	0.332, 19.249
	Men (n = 109)						
Fat percentage	-0.012	0.039	0.093	1	0.761	0.988	0.915, 1.067
Age, years	0.100	0.059	2.871	1	0.090	1.105	0.985, 1.240
BMI, kg/m <sup>2</sup>	0.005	0.066	0.005	1	0.944	1.005	0.883, 1.142
WC, cm	0.008	0.025	0.104	1	0.747	1.008	0.960, 1.058
WHR	-2.193	3.869	0.321	1	0.571	0.112	0.000, 219.171
Job position							
Doctor (ref)	—	—	—	—	—	—	—
Nurse	-0.139	0.640	0.047	1	0.828	0.870	0.248, 3.054
Medical technician	0.187	0.566	0.109	1	0.742	1.205	0.397, 3.655
Pharmacist	0.267	1.256	0.045	1	0.832	1.306	0.111, 15.299
Administration staff	0.267	0.909	0.086	1	0.769	1.306	0.220, 7.759

BMI, body mass index; WC, waist circumference; WHR, waist-to-hip ratio; CI, confidence interval; SE, standard error; ref, reference group.

the fat percentage was higher than 33.0%, it was not associated with the risk of body type cognitive bias (OR 0.77, 95% CI 0.52–1.14,  $p = 0.191$ ) (Table 3). The male

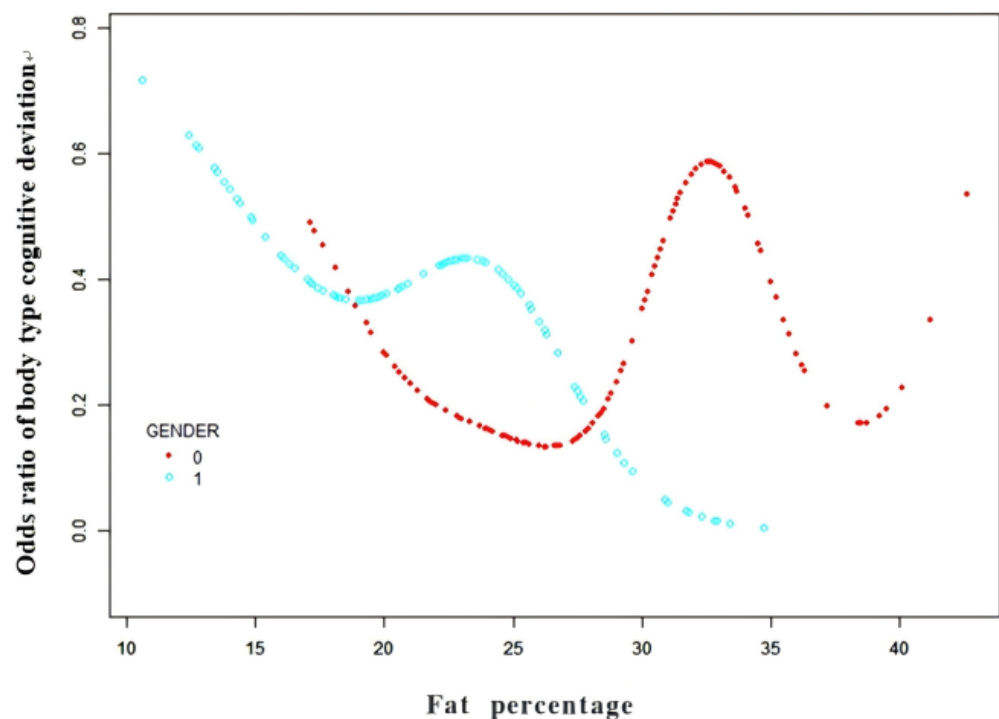
**Table 3. Threshold effect analysis of fat percentage on body type cognitive bias using piecewise linear regression by sex.**

	Women (n = 155)		Men (n = 109)	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
Model I <sup>a</sup>				
Linear regression coefficient	1.02 (0.91, 1.15)	0.714	0.94 (0.83, 1.07)	0.331
Model II <sup>a</sup>				
Inflection point of fat percentage (K1, K2) <sup>b</sup>				
<K1 segment regression coefficient 1	0.78 (0.62, 0.98)	0.036	0.74 (0.53, 1.03)	0.072
K1–K2 segment regression coefficient 2	1.58 (1.19, 2.08)	0.001	1.42 (0.95, 2.11)	0.086
>K2 segment regression coefficient 3	0.77 (0.52, 1.14)	0.191	0.67 (0.44, 1.01)	0.054

<sup>a</sup> Adjusted: Age, job position, BMI and WHR.

<sup>b</sup> Women: K1 = 26.8, K2 = 33.0; Men: K1 = 18.5, K2 = 23.5.

BMI, body mass index; CI, confidence interval; OR, odds ratio; WHR, waist-to-hip ratio.



**Fig. 1. The relationship between fat percentage and the probability of body type cognitive bias by sex.** A nonlinear relationship between the fat percentage and probability of body type cognitive bias was observed after adjusting for age, job position, BMI and WHR. In the graph, ‘0’ denotes women, whereas ‘1’ represents men. BMI, body mass index; WHR, waist-to-hip ratio.

subjects also exhibited a similar trend in the relationship between fat percentage and probability of body type cognitive bias, which was however not significant.

## Discussion

A previous work showed that approximately 30% of the NHANES participants had misperception about body type (Ver Ploeg et al, 2008). This finding resonates with ours, but there is a deviation of the subjective body type, which was self-evaluated by the participants (i.e., young hospital staff members), from their objective body type, although they possessed accurate cognition about their body weight (Supplementary Table 1). The discordance in these findings indicates that integrating only traditional indicators in obesity assessment is inappropriate.

The prevalence rate of obesity has dramatically increased on a global scale in recent decades, making it a top public health priority in both developed and developing countries. The similar increasing trend is also reflected in the persistent growth rate of overweight and obese incidence in China, and the diseases/deaths related to these conditions have imposed heavy social and economic burdens (GBD 2017 Risk Factor Collaborators, 2018). Paradoxically, malnutrition and underweight condition also present increasing trends in incidence, occurring especially among young urban women (Kye and Park, 2021). For healthy weight maintenance, having a correct body type cognition is necessary for behavioural change and is a key indicator of intervention effectiveness assessment (Binsaheed et al, 2023; Nutter et al, 2021). It is related to demographic factors such as age, sex, income, and education level. For example, Kye and Park (2021) have reported that the misconception about overweight issues is more prevalent among low-income individuals, African Americans, and men. Research has shown that body fat percentage has an influence on the health status, physical function, and appearance of individuals, indirectly affecting their perception and evaluation of their body shape (Cai, 2019; Wang et al, 2019). At the same time, the presence of perceptual errors may amplify the impact of body fat percentage, leading to more serious self-cognitive issues (Bui et al, 2019; Mutter et al, 2020; Kagawa and Hills, 2020; Talbot et al, 2019).

In China, the number of underweight adults surpasses the national average, while their overweight/obese counterparts are lower. There were more women than men grappling with malnutrition, while the gender difference in overweight/obesity rates was the opposite. With regard to gender, the inflection points were slightly different. People with lower fat percentage were more susceptible to higher body type misjudgement risk, but this is the contrary to people with high fat percentage, as a higher fat percentage with associated with a lower misjudgement risk. For a population with moderate fat percentage levels, the risk of body type misjudgement tends to gradually increase with fat percentage.

Our correlation analysis showed only statistically significant results in women. The gender disparity in the results significance can be attributed to the relatively small sample of men. On the other hand, they may account for the higher sensitivity of women in terms of their psychological characteristics (Wyssen et al, 2020). These findings suggest that women serving the medical field are generally slim, to a great extent owing to their rather stricter requirements concerning their weight, which are influenced or governed by their subjective consciousness. This also tends to lead them to overestimate their body weight/type.

In the medical field, obesity criteria are set to reflect relevant health risks. However, in daily life, the term “obesity” often contains connotations related to public culture and aesthetics, complicated further by social psychology factors. Through the lens of social psychology, this study explores objective and subjective physiology biases in understanding the concept of “obesity”. The significant impact of body fat percentage on women’s body shape cognition, which does not seem to affect men, can be analyzed from multiple facets. Firstly, from a biological and physiological standpoint, there are intrinsic differences in fat distribution between women and men. A study has shown that women typically have a higher body fat percentage, with fat predominantly stored in the hip and thigh areas, whereas men tend to store more fat in the abdominal region (Camilleri et al, 2021). Secondly, from a socio-cultural perspective, the perceptions of women’ toward their body shape and weight are often influenced by media and societal beauty standards, which tend to emphasize thinness as attractive. For instance, a study found that overrepresentation of thin body images in visual media could affect young women’s perceptions of body size, leading them to view such body shape as “normal” (Devine et al, 2022). Finally, from the perspective of gender roles and expectations, society holds different expectations for men and women, posing an influence on their cognition and evaluation of body shape. For instance, men are often encouraged to develop muscle mass and strength, rather than focusing on body fat percentage. In contrast, women are expected to maintain a slimmer figure, forming a habitual emphasis about their body fat percentage (Watson et al, 2019). Throughout these studies, women vignette characters were more likely to be negatively judged. Thus, gender bias should be considered in strategizing and implementing preventative and remedial services for outreach and obesity prevention works.

Our results confirmed that, in addition to psychosocial factors, objective body components may play a role in body type cognitive bias. Body type cognitive bias has a physiologic basis, that is, abnormal body fat accumulations may be reflected through subconscious thoughts. Firstly, it is known that fat volume is about three times that of skeletal muscle of the same weight (Burton, 2019). Two people of the same sex and body weight may appear to have quite different visual body types because of the differences in body compositions (body fat and fat-free mass ratios). Thus, body composition, as well as weight, may determine figure type. Secondly, considering sex differences in fat distribution, even women with a normal BMI may have relatively more subcutaneous fat than men. Obese women have fat that is easily concentrated in the buttocks and legs, which results in pear-type obesity, non-central obesity or women-type obesity, in professional terms (Bredella, 2017). However, fat is mainly distributed in the visceral part of male bodies, especially in the peritoneal cavity around the kidneys. It is not easy to see whether they have a normal BMI. In obese men, the fat is mainly concentrated in the subcutaneous and abdominal cavity, resulting in apple-type obesity, which is also known as centripetal obesity, men-type obesity, or visceral obesity. This kind of obesity poses more harmful threats to health (Bredella, 2017). Therefore, when formulating the normal fat percentage reference range, it is necessary to consider factors such as sex and fat

distribution (local fat amounts and proportions). Further research should consider the effects of segmental fat (trunk fat, limb fat) on body type cognition.

Special attention needs to be paid to how medical staff members define correct body type cognition. On the one hand, medical staff have a higher-than-average level of education and health knowledge, which may improve their accuracy in assessing weight/body type. According to some surveys, physician advice stands as one of the strongest predictors for successful weight management efforts among obese patients (Katzel and Sorkin, 2019; Durrer et al, 2019). However, the obesity rates documented from the primary care visits remain low (Jiang et al, 2020); this could possibly be caused by the inability of physicians to accurately identify true obesity (Santo and Kang, 2023). Thus, the first, crucial step in obesity control encompasses providing sufficient trainings to physicians in obesity identification. However, medical staff represents a professional group of workers that constantly grapple with high work intensity and pressure and have irregular meal timings—factors or habits that make them neglect any potential health risks (Srivastava et al, 2018). Moreover, their biases in weight/body cognition will not only threaten their health, but may also affect their status assessment and decision-making concerning clinical patients. Berry et al (2018) reported that nonobese physicians were more likely to identify obesity in their patients, indicating that addressing weight loss in obese patients should start at the treatment provider level.

There are several limitations in this study. Firstly, the sample was not randomly selected from a cohort study. Thus, the results may not be generalizable to other populations within China. However, this is a cross-sectional study attempting to explore the relationship between body type cognitive bias and body composition; therefore, the non-randomized sampling might not affect the association results. To determine the effect of the sample size on statistical power, we used a simulation model: When the OR value was 1.1 and the sample size was 200, the test efficiency was 0.966, which could be raised to 0.998 or 1.000 when the sample size was increased to 300 or 400. However, the increase in test efficiency was not significant. In our opinion, the current study's sample size may not be large, but it is sufficient for drawing conclusions that could inform clinical practice. Nevertheless, a larger sample size may yield a larger number of observed events. Secondly, due to limited resources, we did not validate the BIA method, which is considered the gold standard for body composition measurement. However, this non-invasive technology method may complement dual-energy x-ray absorptiometry (DXA) imaging in the study of human body composition (Marra et al, 2019; McLester et al, 2020; Moore et al, 2020). Lastly, the causal effect could not be defined due to the cross-sectional design. In future studies, we plan to examine the causal effect through follow-up surveys.

Despite these limitations, this study features several strengths. Firstly, we included 264 new hospital recruits in this analysis. This was one of the largest studies examining body type cognitive bias, especially among Chinese medical professionals. Additionally, we used BIA to measure body composition and fat distribution. This was the first study to examine the relationship between BIA-derived body composition indicators and subjective body type cognitive bias. This method is

non-invasive, provides an estimate in only a few minutes, and does not need to consider racial differences. In addition, this study provides a reasonable, potentially new physiological perspective regarding body weight misconceptions. Nonetheless, further research is warranted.

## Conclusion

This study showed that fat percentage is an independent factor influencing women's body type cognitive bias. After adjusting for age, BMI, WHR, and job position, the risk of body type cognitive bias was found to be much higher in women with very low or very high fat percentage. Sex differences should be considered when establishing weight management intervention strategies, given the differences in fat percentage and body type cognitive bias between men and women. Therefore, more information and body composition measurements, such as fat percentage, are required for formulating approaches to controlling obesity to prevent it from becoming a public health issue.

### Key Points

- Most people tend to underreport being overweight, probably owing to the reluctance to seek health advice for weight conditions.
- There are obvious sex differences in body shape cognitive bias, with women showing a greater susceptibility to overestimate their weight or body type.
- Body fat percentage is an independent factor influencing women's body type cognitive bias.
- This study offers new physiological insights about body weight misconceptions.

## Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

## Author Contributions

LW and YCC contributed to the conception of the study. LW designed the study. JW and ZX collected the data. LW and KG analyzed and interpreted the data. LW drafted the manuscript. All authors contributed to important editorial changes of important content in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

## Ethics Approval and Consent to Participate

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human participants were approved

by the Ethics Committee of the Henan Provincial People's Hospital (Ethics Approval Number: 2016-185). All participants gave written informed consent before participating in the study.

## Acknowledgement

The authors thank Jie Shen, Yangyang Huang, Jing Sun, and Tingting Yang for their helpful comments and careful reading of the final manuscript.

## Funding

This research received no external funding.

## Conflict of Interest

The authors declare no conflict of interest.

## Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://www.magonlinelibrary.com/doi/suppl/10.12968/hmed.2024.0444>.

## References

- Berry AC, Berry NA, Myers TS, Reznicek J, Berry BB. Physician Body Mass Index and Bias Toward Obesity Documentation Patterns. *Ochsner Journal*. 2018; 18: 66–71.
- Binsaeed B, Aljohani FG, Alsobaii FF, Alraddadi M, Alrehaili AA, Alnahdi BS, et al. Barriers and Motivators to Weight Loss in People With Obesity. *Cureus*. 2023; 15: e49040. <https://doi.org/10.7759/cureus.49040>
- Bredella MA. Sex Differences in Body Composition. *Advances in Experimental Medicine and Biology*. 2017; 1043: 9–27. [https://doi.org/10.1007/978-3-319-70178-3\\_2](https://doi.org/10.1007/978-3-319-70178-3_2)
- Bui AL, Moscoso MG, Bernabe-Ortiz A, Checkley W, Gilman RH, Smeeth L, et al. A secondary analysis examining the concordance of self-perception of weight and actual measurement of body fat percentage: The CRONICAS Cohort Study. *BMC Obesity*. 2019; 6: 9. <https://doi.org/10.1186/s40608-019-0229-5>
- Burke MA, Heiland FW. Evolving Societal Norms of Obesity: What Is the Appropriate Response? *JAMA*. 2018; 319: 221–222. <https://doi.org/10.1001/jama.2017.18947>
- Burton RF. Relationships Between Fat Mass and Lean Mass. *Obesity*. 2019; 27: 873. <https://doi.org/10.1002/oby.22467>
- Cai WN. Application of body fat percentage in evaluating obesity level. *Smart Healthcare*. 2019; 5: 97–98.
- Camilleri G, Kiani AK, Herbst KL, Kaftalli J, Bernini A, Dhuli K, et al. Genetics of fat deposition. *European Review for Medical and Pharmacological Sciences*. 2021; 25: 14–22. [https://doi.org/10.26355/eurev\\_202112\\_27329](https://doi.org/10.26355/eurev_202112_27329)
- Chao H, Hu Y, Wang Q, Tang B, Adji A, Avolio A, et al. Impact of Obesity Phenotype on Central Aortic Hemodynamics and Arterial Stiffness in a Chinese Health Assessment Population. *Reviews in Cardiovascular Medicine*. 2022; 23: 216. <https://doi.org/10.31083/j.rcm2306216>
- Chen K, Shen Z, Gu W, Lyu Z, Qi X, Mu Y, et al. Prevalence of obesity and associated complications in China: A cross-sectional, real-world study in 15.8 million adults. *Diabetes, Obesity & Metabolism*. 2023; 25: 3390–3399. <https://doi.org/10.1111/dom.15238>

- Devine S, Germain N, Ehrlich S, Eppinger B. Changes in the Prevalence of Thin Bodies Bias Young Women's Judgments About Body Size. *Psychological Science*. 2022; 33: 1212–1225. <https://doi.org/10.1177/09567976221082941>
- Durrer SD, Busetto L, Dicker D, Farpour-Lambert N, Pryke R, Toplak H, et al. European practical and patient-centred guidelines for adult obesity management in primary care. *Obesity Facts*. 2019; 12: 40–66. <https://doi.org/10.1159/000496183>
- GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018; 392: 1923–1994.
- Holmes CJ, Racette SB. The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. *Nutrients*. 2021; 13: 2493. <https://doi.org/10.3390/nu13082493>
- InBody Co, Ltd.: Seoul, Korea. InBody230 User's Manual. 1996. Available at: <https://www.manualslib.com/manual/760762/Biospace-Inbody230.html> (Accessed: 9 October 2024).
- Jiang H, Jiang XM, Shen XH, Wan YP, Fan ZP, Xu RY. Prevalence of metabolically healthy overweight/obesity in health check-up population: a five-year follow-up. *Journal of Tongji University (Medical Science)*. 2020; 4: 454–459. (In Chinese)
- Kagawa M, Hills AP. Preoccupation with Body Weight and Under-Reporting of Energy Intake in Female Japanese Nutrition Students. *Nutrients*. 2020; 12: 830. <https://doi.org/10.3390/nu12030830>
- Katzel LI, Sorkin JD. Advising Patients on How to Achieve Long-Term Weight Loss. *Annals of Internal Medicine*. 2019; 170: 724–725. <https://doi.org/10.7326/M19-0782>
- Kye SY, Park K. Gender differences in factors associated with body weight misperception. *Public Health Nutrition*. 2021; 24: 2483–2495. <https://doi.org/10.1017/S1368980020003262>
- Marra M, Sammarco R, De Lorenzo A, Iellamo F, Siervo M, Pietrobelli A, et al. Assessment of Body Composition in Health and Disease Using Bioelectrical Impedance Analysis (BIA) and Dual Energy X-Ray Absorptiometry (DXA): A Critical Overview. *Contrast Media & Molecular Imaging*. 2019; 2019: 3548284. <https://doi.org/10.1155/2019/3548284>
- McLester CN, Nickerson BS, Kliszczewicz BM, McLester JR. Reliability and Agreement of Various InBody Body Composition Analyzers as Compared to Dual-Energy X-Ray Absorptiometry in Healthy Men and Women. *Journal of Clinical Densitometry*. 2020; 23: 443–450. <https://doi.org/10.1016/j.jocd.2018.10.008>
- Moore ML, Benavides ML, Dellinger JR, Adamson BT, Tinsley GM. Segmental body composition evaluation by bioelectrical impedance analysis and dual-energy X-ray absorptiometry: Quantifying agreement between methods. *Clinical Nutrition*. 2020; 39: 2802–2810. <https://doi.org/10.1016/j.clnu.2019.12.009>
- Mutter CM, Belal N, Khanna D. Perception of weight status in relationship to self-reported BMI. *The FASEB Journal*. 2020; 34: 1–1. <https://doi.org/10.1096/fasebj.2020.34.s1.09738>
- Nutter S, Russell-Mayhew S, Saunders JF. Towards a sociocultural model of weight stigma. *Eating and Weight Disorders*. 2021; 26: 999–1005. <https://doi.org/10.1007/s40519-020-00931-6>
- Potocka N, Penar-Zadarko B, Skrzypa M, Braun M, Zadarko-Domaradzka M, Ozimek M, et al. Association of ACTN3 Polymorphism with Body Somatotype and Cardiorespiratory Fitness in Young Healthy Adults. *International Journal of Environmental Research and Public Health*. 2019; 16: 1489. <https://doi.org/10.3390/ijerph16091489>
- Roshandel D, Lu T, Paterson AD, Dash S. Beyond apples and pears: sex-specific genetics of body fat percentage. *Frontiers in Endocrinology*. 2023; 14: 1274791. <https://doi.org/10.3389/fendo.2023.1274791>
- Sasikala P, Maruthy KN, Kumar CH. Effect of body fat percentage on cognition in males & females. *International Journal of Physiology*. 2018; 6: 95–98.
- Santo L, Kang K. National Ambulatory Medical Care Survey: 2019 National Summary Tables. Table 16. 2023. Available at: <https://dx.doi.org/10.15620/cdc:123251>. (Accessed: 9 October 2024).
- Srivastava G, Johnson ED, Earle RL, Kadambi N, Pazin DE, Kaplan LM. Underdocumentation of Obesity by Medical Residents Highlights Challenges to Effective Obesity Care. *Obesity*. 2018; 26: 1277–1284. <https://doi.org/10.1002/oby.22219>

- Talbot D, Smith E, Cass J. The relationship between psychophysical body categorization performance and male body dissatisfaction. *Scientific Reports*. 2019; 9: 3882. <https://doi.org/10.1038/s41598-019-40502-z>
- Ver Ploeg ML, Chang HH, Lin BH. Over, under, or about right: misperceptions of body weight among food stamp participants. *Obesity*. 2008; 16: 2120–2125. <https://doi.org/10.1038/oby.2008.306>
- Wang H, Zhang CL, Hu DD, Chen WR, Liu HM, Wang QJ, et al. Correlation between body fat percentage with physical fitness in female college students. *Chinese Journal of School Health*. 2019; 40: 100–103. (In Chinese)
- Watson A, Murnen SK, College K. Gender differences in responses to thin, athletic, and hyper-muscular idealized bodies. *Body Image*. 2019; 30: 1–9. <https://doi.org/10.1016/j.bodyim.2019.03.010>
- Who.int. Obesity and overweight. 2019. Available at: <https://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight> (Accessed: 10 October 2024).
- Wyssen A, Leins J, Reichenberger J, Blechert J, Munsch S, Steins-Loeber S. Body-related cognitive distortions (thought-shape fusion body) associated with thin-ideal exposure in female students-An ecological momentary assessment study. *Clinical Psychology & Psychotherapy*. 2020; 27: 220–227. <https://doi.org/10.1002/cpp.2421>
- Zhou L, Qiu M. Analysis on the effect of percentage body fat on body self-esteem of female college students. *Liaoning Sport Science and Technology*. 2022; 44: 79–83. (In Chinese)