Accuracy of self-reported height, weight and waist circumference in rural poor areas of China

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Abstract

Background There were different voices about the accuracy of self-reported data. This study was to assess awareness and accuracy of self-reported height, weight and waist circumference (WC) among adult residents in rural poor areas of China for the first time. **Methods** Multi-stage stratified cluster random sampling was used to sample. Intraclass correlations (ICCs), Bland-Altman plots with limits of agreements (LOAs), Cohen's kappa were used to examine the accuracy. Multi-factor Logistics and multiple linear regression were used to explore the effect of demographic and socioeconomic variables. **Results** Awareness rate of height, weight and WC were 66.29%, 82.29% and 60.00%, respectively. Height was over-reported 0.67 cm, weight and WC were under-reported 0.00 kg and 1.09 cm. ICC for height was 0.92, weight was 0.93 and WC was 0.93. Mostly differences were within 95% LOAs, but 95% LOAs were wide, especially WC. The percentage agreement (kappa) for BMI was 82.10% (0.71), for WC were 83.56% (0.66). Overall, obesity, overweight and increased WC were underestimated by 0.56%, 2.64% and 6.89%, respectively. Regression analysis showed some demographic and socioeconomic variables could affect the awareness and accuracy. **Conclusions** The self-reported height and weight could be used in rural poor areas of China, but the WC should be used with caution. The main task now is to further improve the awareness rate and accuracy of self-reported data, especially the people with low awareness rate and accuracy in certain subgroups. In addition, differences from the developed countries should be more discussed and investigated: all others showed people tend to under-reported weight, but the self-reported weight is amazingly accurate in our study; and contrary to studies in developed country, we found people tend to under-report WC.

Background

Height and weight are often used to calculate BMI (Body Mass Index), which is a measurement index of overweight and obesity. Self-reported height and weight were often used to save time and money, especially in the large-scale nutritional surveys[1]. In developed countries, self-reported weight and height has been studied frequently in epidemiological studies[2-4]. Some studied thought that the accuracy of self-reported was high, although systematic bias was found. Lucca A et al [5] found the self-reported weight and height in their study were valid to estimate the obesity prevalence. Result of Bowring AL et al [6] showed the self-reported weight and height can identified overweight or obesity accurately in the majority young people in their study. Araújo R et al [7] thought the self-reported data were valid for their study population and could be used in the populations with similar characteristics. However, there were also different voices about the accuracy of self-reported data. Béghin L et al[1] confirmed that self-reports of weight and height were inaccurate among adolescents. Carvalho AM et al [8] found self-reported weight can substitute measured parameters, but the self-reported height should be used with caution.

Waist circumference (WC) is considered a measurement index of abdominal or central adiposity[9]. WC may be used more frequent than BMI because the abdominal fat predicated the risk of obesity-related disorders more accurate[10]. A study showed that the increased WC was strongly linked to cardiovascular disease than BMI, especially diabetes mellitus[11]. Therefore, it is important to assess the accuracy of self-reported WC. However, so far, there were still limited number of studies to study the self-reported WC[12-14] and mostly studies were more likely to study the self-reported height and weight[1, 2, 4-9, 15-19].

In spite of these findings, the current researches focused on the Western countries and the awareness rate and accuracy of self-reported height, weight, and WC has rarely been studied in China, especially in rural poor areas. Compared with developed countries, study of self-reported height, weight and WC has more practical significance in the developing countries, especially in rural poor areas. In addition, we think the researches that do not take into account the awareness rates of height, weight and WC may be not rigorous. Therefore, this study was mainly to assess the awareness and self-reported accuracy for height, weight and waist circumference among adult residents in rural poor areas of China using the data collected in the first Non-communicable and Chronic Risk Factor Surveillance (NCD Surveillance) in Jinzhai County, 2017. Then, we assess the extent that the awareness rate and accuracy were affected by the situation of demographic and socioeconomic in rural poor areas of China, including gender, age, occupation, marital status, education, and annual family income.

Methods

2.1 Setting and sample

Jinzhai County located in the western region of Anhui Province, which situated in Eastern China[20]. There are 68 thousand people and 3814 km² of total area in Jinzhai County. Jinzhai County is an important source of the Chinese Revolution and the birthplace of the people's army. However, Jinzhai County is one of the first state-level key poverty-stricken counties, with a poverty rate of 11.2%[21].

The data in this article came from the first Non-communicable and Chronic Disease Risk Factor Surveillance (NCD Surveillance) in Jinzhai County, 2017, which was launched by Jinzhai County Health and Family Planning commission, Lu'an Municipal Center for Disease Control and Prevention and Jinzhai County Center for Disease Control and Prevention. The multi-stage stratified cluster random sampling was used to sample rural adult residents in Jinzhai County. Firstly, Probability Proportionate to Size (PPS) sampling was used to randomly select six towns from Jinzhai County which had 23 towns or townships. Then, five administrative villages were randomly selected by PPS sampling from the above each town which had already been selected. Thirdly, simple random sampling was used to randomly select two village groups from the each selected administrative village. Fourthly, 45 residential households were randomly selected from each village group by cluster random sampling. Finally, one permanent resident aged 18 or above in each residential household was randomly selected to participate in this survey by Kish Grid Sampling.

The sample size was calculated according to the following calculation formula, $N = \frac{deff * \mu^2 * p(1-p)}{d^2}$, which $\alpha = 0.05$, $\mu = 1.96$, $p = 9.7\%$ (Data of this study from NCD Surveillance, so value of p adopted the prevalence of diabetes in China[22]), design effect ($deff$) = 1.5, relative error (RE) = 15%, permissible error (d) = $RE * P = 15\% * 9.7\%$. By the calculation, $N \approx 2385$. If considering the rate of rejecting accept investigation was 10%, the final sample size $N = 2623.5 \approx 2700$, which could assure adequate power to detect statistical significance.

2.2 Questionnaire survey

2.2.1 Demographic and socioeconomic data

The uniform questionnaire in Non-communicable and Chronic Disease Risk Factor Surveillance in China[23] was used to collect the demographic and socioeconomic information, including gender (males, females), age (years old), occupation (agriculture and forestry, professionals, industrial and commercial service, housework, others), marital status (single, married / cohabitation, Divorced / widowed / separated), education (primary or below, junior school, senior or above) and annual family income (RMB).

2.2.2 Self-reported data of height, weight and waist circumference

The self-reported data of height, weight and waist circumference were collected before the actual measurement. The participants were asked: "Do you know your height?" "Do you know your weight?" "Do you know your waist circumference?" Once participants answered that they don't know, jump to the next question. If the participants answered "Yes", the self-reported data will be collected with the question: "What is your height?" "What is your current weight?" "What is your current waist circumference?" In order to avoid misunderstanding to the null value of self-reported height, weight and WC which may mean missing or unknown, each questionnaire was checked carefully.

2.3 Body measurement

Body measurement of height, weight and waist circumference was conducted by trained fieldworkers from the NCD Surveillance. Measurement of height and weight and WC was conducted on an empty stomach in the morning, which the respondents had been informed one day in advance. The physical examinations were completed by two investigators. Height and weight were measured with an accuracy of 0.1 cm and 0.1 kg, respectively. WC was measured at the iliac crest with an accuracy of 0.1 cm. In order to improve the accuracy of measurement, the participants should remove shoes and heavy clothing when measured the height and weight; and the waist should be completely exposed when measured the WC.

2.4 Definition of index

2.4.1 Classification of BMI

BMI was calculated by the calculation formula: $BMI = \text{weight (kg)} / \text{height}^2 \text{ (m)}$ and used both self-reported (namely self-reported BMI) and measured (namely measured BMI) data. Classification of BMI was according to the Chinese adult classification system[24, 25]: underweight ($BMI < 18.5 \text{ kg/m}^2$); normal weight ($18.5 \leq BMI < 24.0 \text{ kg/m}^2$); overweight ($24.0 \leq BMI < 28.0 \text{ kg/m}^2$); and obesity ($BMI \geq 28 \text{ kg/m}^2$).

2.4.2 Classification of increased WC

Classification of WC was according to the sex-specific cut-offs for Chinese adults[25, 26]: normal WC or increased WC ($WC \geq 85 \text{ cm}$ for men and $WC \geq 80 \text{ cm}$ for women).

2.4.3 Difference value between self-reported and physical measured

The Difference value (D) was calculated by subtracting the physical measured data from the self-reported data. Therefore, a negative value indicates the participants under-reported the data and a positive value indicates they over-reported the data.

2.5 Statistical Methods

The double entry and validation of the data used Epi Data 3.1 software (Epi Data foreningen [Epi Data Association], Odense, Denmark), and the data analysis used SPSS 10.01 (SPSS Inc., Chicago, IL, USA). The awareness rate was described by rate (%) and 95%CI. A chi-squared test was used to compare the awareness rate among the different groups. The accuracy of self-reported was described by the mean difference value ($D = \text{self-reported data} - \text{physical measured data}$) and 95%CI. Paired Sample *t* test was used to compare the self-reported and measured data between the different groups. The agreement between self-reported data and measured data was analyzed by the intraclass correlations (ICCs). In addition, Bland-Altman plots with limits of agreements (LOAs), which gives the mean and 95%CI of the difference between self-reported values and measured, was also used to assess the concordance[27]. The impact of self-report on categorization of BMI (underweight, normal weight, overweight, obesity) and categorization of WC (normal WC and increased WC) were also assessed using Cohen's kappa and 95%CI. The criteria of Landis and Koch [28] was used, namely < 0 is poor; 0 - 0.20 is slight; 0.21 - 0.40 is fair; 0.41 - 0.60 is moderate; 0.61 - 0.80 is substantial; and 0.81 - 1.00 is almost perfect. The effect of demographic and socioeconomic variables affected the rate of awareness for height, weight and WC were analyzed by multi-factor Logistics regression, which used the variable of *aware or not aware* (0 = yes, 1 = no) as the dependent variable. The effect of self-report accuracy for height, weight and WC were analyzed by multiple linear regression, which used the difference value ($D = \text{self-reported data} - \text{physical measured data}$) as the dependent variable. The *p*-values < 0.05 was considered to be significant.

2.6 Ethical aspects

The need for ethics approval is deemed unnecessary, because the Non-communicable and Chronic Disease Risk Factor Surveillance (NCD Surveillance) is a responsibility for the government department to know the chronic diseases and the risk factors in the local according to the government document[29]. Each participants signed the informed consent before the survey.

Results

3.1 Awareness of height, weight and WC and how affected by the demographic and socioeconomic variable

The awareness rate of height, weight and WC were 66.29% (95%CI: 64.52% ~ 68.06%), 82.29% (95%CI: 80.86% ~ 83.72%), and 60.00% (95%CI: 58.15% ~ 61.85%), respectively. Table 1 showed all the demographic and socioeconomic variable, including gender, age, occupation, marital status, education, and annual family income, had the statistical relation with awareness of height and weight. Also, the age, education, marital status, and annual family income had the statistical relation with awareness of WC. (Table 1)

In the multi-factor Logistics regression model, the awareness rate of height and weight were lower than in females, decreased with the age, and increased with education. Compared with the people who were 18-44 years, the 60 years or above had a lower awareness rate of WC; the awareness rate of WC also increased with education. In addition, the awareness rate of height increased with annual family income. Among the marital status, compared with the married or cohabitation, awareness rate of height was lower in single; the awareness rate of WC was lower in divorced or widowed or separated; the awareness rate of weight was lower in divorced or widowed or separated, and the single was lowest. (Table 2)

3.2 Reliability of self-reported height, weight, WC and BMI

The self-reported and measured height were 161.54 cm (SD: 7.89 cm) and 160.88 cm (SD: 7.73 cm), respectively; weight were 61.56 kg (SD: 10.29 kg) and 61.56 kg (SD: 10.27 kg), respectively; WC were 80.44 cm (SD: 10.43 cm) and 81.53 cm (SD: 9.91 cm), respectively. Compared with the measured value, height ($p < 0.001$) was over-reported 0.67 (0.48 ~ 0.86) cm, weight ($p > 0.05$) was under-reported 0.00 (-0.17 ~ 0.16) kg, and WC ($p < 0.001$) was under-reported 1.09 (-1.42 ~ -0.76) cm. In the subgroup analysis, the difference between self-reported and measured height had a statistical difference in the majority of subgroups, and the difference between self-reported and measured WC had a statistical difference in more than half of subgroups; however, the difference between self-reported and measured weight had a statistical difference only in two subgroups. (Table 3)

The average ICCs for height, weight and WC showed good coherence between self-reported and measured data, which were 0.92(0.92 ~ 0.93), 0.93(0.92 ~ 0.93), and 0.93(0.93 ~ 0.94), respectively. This good coherence was also found in the different subgroups. (Table 4)

Bland-Altman plots showed the 95% LOAs were wide, especially for the WC: 8.79 and -7.45 for height, 7.72 and -7.73 for weight, 12.39 and -14.57 for WC, 4.42 and -4.60 for BMI. The mostly differences between self-reported and measured data were within the 95% LOAs, and the proportions of which beyond the 95% LOAs were 7.68%~6.90%~5.62%~3.26%, respectively. (Fig.1a, Fig.1b, Fig.1c, Fig.1d)

The percentage agreement between self-reported and measured BMI and increased WC was 82.10% (95%CI: 80.32% ~ 83.88%) and 83.56% (95%CI: 81.77% ~ 85.35%), respectively. Among the measured overweight population, 19.27% were categorized as normal weight according to the self-reported height and weight. Among the measured obese population, 23.38% were categorized as overweight according to the self-reported height and weight. Overall, the prevalence of obesity was only underestimated by 0.56%, overweight was underestimated by 2.64%, underweight was overestimated by 0.67%. Among the measured increased WC population, 26.73% were categorized as normal WC. Overall, the prevalence of increased WC was underestimated by 6.89%. (Table 5)

The kappa for categorization of BMI was 0.71 (95%CI: 0.68 ~ 0.74) with $p < 0.001$, and for categorization of WC was 0.66 (95%CI: 0.62 ~ 0.70) with $p < 0.001$.

3.3 How extent the accuracy was affected by the demographic and socioeconomic variable

Results of univariate regression analyses showed the effect of gender, age, education, annual family income and occupation on the difference between self-reported and measured height, weight, and/or WC were statistically significant. Females were more likely to over-report their height on average 1.11 cm and under-report their WC on average 1.57 cm more than males. People who were 60 years or over would over-report their height on average 0.86 cm compared with people who were 18-44 years. People with education of junior school under-reported height on average 0.75 cm and over-reported WC on 1.00 cm compared with the people with education of primary or below. People with higher annual family income were more likely to under-report their height (on average 0.29 cm) and over-report their weight (on average 0.27 kg). People who were industrial and commercial service would over-report their weight on average 1.29 kg compared with the professionals. (Table 6)

However, results of multivariate regression analyses showed only the education was significantly independently associated with height ($\beta = -0.56$, 95%CI: -1.01 ~ -0.11, $p < 0.05$); only the occupation was significantly independently associated with weight ($\beta = 1.57$, 95%CI: 0.52 ~ 2.61, $p < 0.01$); only gender ($\beta = -1.74$, 95%CI: -2.51 ~ -0.97, $p < 0.001$) and age ($\beta = -1.62$, 95%CI: -2.88 ~ -0.36, $p < 0.05$) were significantly independently associated with WC. (Table 7)

Discussion

Current researches of self-reported height, weight and WC focused on the Western countries, we only found Zhou X et al [30] studied self-reported height and weight in Chinese adolescents; Lu SR et al [13] explored the accuracy of self-reported height, weight and WC in the Jiangsu Province, where has the top-ranking GDP per capita in China. However, as China is a developing country, we need the self-reported data more than Western countries, especially in the rural poor areas in China. If the self-reported data are confirmed to have a high accuracy, it will produce greater effect in the field epidemiological investigation in developing country. To our knowledge, there are no published studies to investigate the validity and reliability of self-reported height, weight, especially the WC, in rural poor areas of China. Therefore, this study was conducted and the results were in satisfactory: the self-reported height and weight could be used in rural poor areas of China, but the WC should be used with caution. However, the awareness rate of height, weight and WC were low, and the awareness rate and accuracy of self-reported data could be affected by some demographic and socioeconomic.

The awareness rate of height, weight and WC were 66.29%, 82.29%, and 60.00%, respectively, among adult residents in rural poor areas of China. The studies which reported the awareness rate were very few. Bowring AL et al [6] reported the missing or unknown of self-reported height or weight was 25% among a

young population. A study conducted in a rural population aged 18 years or more of Northeast Brazil showed 58.5% subjects did not know their height or weight and the weight was the most known which was same with ours [31]. In fact, those subjects who reported their data with big bias compared with measured data also could be classified into the population who did not know their anthropometrics data. We also found the females, elderly people, lower education and annual family income, single, divorced or widowed or separated could reduce the awareness rate of height, weight, and/or WC. Therefore, the real awareness rate should be lower. Therefore, we should further strengthen health education and physical examination among these populations.

Consistent with the previous studies, people tend to over-report their height[1, 2, 7, 9, 12, 13, 32] and height was over-reported 0.67 cm in this study. The majority of subgroups had a statistical difference. Mostly studies also showed people tend to over-report their weight[1, 2, 7, 9, 12, 13, 32]. However, the difference of self-reported and measured weight approach zero in this study, and this phenomenon exist in nearly all of the subgroups. This phenomenon was worthy to probe in our further study, and it may be related to the health education or the degree of recognition of overweight and/or obesity. Although the central or abdominal obesity which was measured by the WC was more dangerous than the simple increase in BMI, the number of study for self-reported WC was rare. Among the few articles, a study in a Dutch overweight working population showed the WC was over-reported by 1.1 cm[12]; a study in a Japanese sample also showed the WC was over-reported by 0.79 cm[14]. Only the study of Lu SR et al [13] is similar to ours, which found the Chinese adults under-reported the WC. The inconsistent results among the different countries showed the important of studying the self-reported WC.

In this study, the average ICCs were high which indicated a high agreement between self-reported and measured height, weight and WC and it was also found in the different subgroups. The results of Bland-Altman plots also were satisfactory that mostly differences between self-reported and measured data were within the 95% LOAs. Moreover, the percentage of agreement for classification of BMI and increased WC were high, and the kappa showed substantial agreement. Overall, the prevalence of obesity and overweight were only underestimated by 0.56% and 2.64%, respectively, according to the self-reported data. Therefore, the prevalence of overweight and obesity could be estimated with reasonable accuracy in this population according to the self-reported data. However, we should note the 95% LOAs were wide, especially for the WC, which indicated substantial discrepancies between self-reported and measured values at the individual level[33]. Some other studies also found this result [12, 13, 16, 30, 33]. As the plots showed the majority of data points within the 95% LOAs, the wide 95% LOAs should be caused by the variability of self-reported data at the individual level[33, 34]. In addition, we should note that the prevalence of increased WC was underestimated by 6.89% according to the self-reported WC. Consequently, the self-reported data were not suitable for the assessment on an individual level; especially the WC should be used cautiously.

In the multi-factor Logistics regression analyses, junior school of education had a higher accuracy of height compared with primary or below, so the low education population should be given more attention; Industrial and commercial service of occupation had a lower accuracy of weight compared with professionals, which suggested us that different interventions should be conducted in different occupations; females and 60 years or over had a lower accuracy of WC compared with males and 18-44 years. Therefore, in order to improve the accuracy the self-reported data, these key populations should be given targeted health education and intervention.

This is the firstly to study the accuracy of self-reported height, weight and WC in rural poor areas of China, which had an important significance. However, our study also had some limitations, firstly, more than 60% participants were primary or below of education, which may have an adverse effect throughout the study; secondly, we did not ask the time of last measurement and the frequency of measurement, which may have an important influence of the self-reported data. Finally, this study only conducted in one county, so the generalization of the results is limited.

Conclusions

In conclusion, the results of this study showed that although the self-reported height is biased, the self-reported weight is not biased and the self-reported BMI which calculated used height and weight is satisfactorily accurate for the assessment of the overweight and obesity in rural poor areas of China. The self-reported WC also has a high agreement and has a high sensitivity to assess the increased WC, but the 6.89% of underestimate rate of increased WC should be noted. In addition, the awareness rate and accuracy of self-reported data could be affected by some demographic and socioeconomic variables, so some certain key population should be given more attention. A more important point, differences from the developed countries should be more discussed and investigated: all others showed people tend to under-reported weight, but the self-reported weight is amazingly accurate in our study; and contrary to studies in developed county, we found people tend to under-report WC.

Abbreviations

WC: Waist circumference; ICCs: Intraclass correlations; LOAs: Limits of agreements; BMI: Body Mass Index; Deff: Design effect; RE: Relative error.

Declarations

Ethics approval and consent to participate

The need for ethics approval is deemed unnecessary, because the Non-communicable and Chronic Disease Risk Factor Surveillance (NCD Surveillance) is a responsibility for the government department to know the chronic diseases and the risk factors in the local according to the government document. This study was approved by government departments and launched by Jinzhai County Health and Family Planning commission, Lu'an Municipal Center for Disease Control and Prevention and Jinzhai County Center for Disease Control and Prevention. Each participant signed the informed consent before the survey.

Consent for publication

Each participant signed the informed consent before the survey, which included the statement of publication, so the consents for publication have been obtained from them.

Availability of data and material

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

Competing interests

The authors declare that they have no competing interests.

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None.

Authors' contributions

XDL participated in the data analysis and drew up the manuscript. YL, QZW, HJC, SYX, LBZ, FH participated in the data checking, data entry and the modification of the manuscript. XDL, YL, SYX participated in the design and conducted of the study. All authors read and approved the final manuscript.

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Tables

Table 1 Awareness rate of height, weight and WC and the results of chi-squared test

Variable	Population		Height		Weight			WC			
			N	Rate (%)	95%CI (%)	N	Rate (%)	95%CI (%)	N	Rate (%)	95%CI (%)
Gender											
Men	980	748	76.33	73.67-78.99	850	86.82	84.70-88.94	594	61.43	58.36-64.50	
Women	1749	1061	60.66	58.37-62.95	1394	79.75	77.87-81.63	1023	59.17	56.85-61.49	
c ²			68.95			21.55			1.32		
P			<0.001			<0.001			0.251		
Age[years]											
18-44	669	583	87.14	84.60-89.68	621	92.96	91.02-94.90	426	64.74	61.09-68.39	
45-59	1481	1000	67.52	65.14-69.91	1247	84.26	82.41-86.12	931	63.77	61.30-66.24	
60-	579	226	39.03	35.06-43.00	376	64.94	61.05-68.83	260	44.98	40.92-49.04	
c ²			69.10			175.74			69.10		
P			<0.001			<0.001			<0.001		
Education											
Primary or below	1742	934	53.62	51.28-55.96	1327	76.22	74.22-78.22	950	55.00	52.65-57.35	
Junior school	803	705	87.80	85.54-90.06	745	92.77	90.98-94.56	535	67.55	64.29-70.81	
Senior or above	184	170	92.39	88.56-96.22	172	93.99	90.58-97.43	132	74.58	68.17-80.99	
c ²			347.49			121.78			52.40		
P			<0.001			<0.001			<0.001		
Marital status											
Single	72	42	58.33	46.94-69.72	54	75.00	65.00-85.00	35	48.61	37.07-60.16	
Married/ cohabitation	2505	1711	68.30	66.48-70.12	2101	83.94	82.50-85.38	1530	61.89	59.98-63.80	
Divorced/ widowed / separated	152	56	36.84	29.17-44.51	89	58.55	50.72-66.38	52	34.21	26.67-41.75	
c ²			65.57			66.06			49.70		
P			<0.001			<0.001			<0.001		
Occupation											
Agriculture and forestry	1948	1235	63.40	61.26-65.54	1572	80.74	78.99-82.49	1159	60.02	57.84-62.21	
Professionals	95	89	93.68	88.79-98.57	91	95.79	91.75-99.83	61	68.54	58.89-78.19	
Industrial and commercial service	192	163	84.90	79.84-89.97	181	94.27	90.98-97.56	117	62.23	55.30-69.16	
Housework	427	273	63.93	59.38-68.49	346	81.22	77.51-84.93	243	57.31	52.60-62.02	
Others	67	49	73.13	62.52-83.74	54	80.60	71.13-90.07	37	57.81	45.71-69.91	
c ²			71.40			34.47			4.50		
P			<0.001			<0.001			0.343		
Annual family income *											
Less than 10, 000 RMB	131	52	39.69	31.31-48.07	91	69.47	61.58-77.36	64	48.85	40.29-57.41	
10000 RMB-	1278	856	66.98	64.40-69.56	1067	83.55	81.52-85.58	765	60.52	57.83-63.22	
50000 RMB-	891	629	70.59	67.60-73.58	758	85.07	82.73-87.41	567	64.29	61.13-67.45	
100000RMB-	221	169	76.47	70.87-82.06	185	84.09	79.26-88.92	143	66.51	60.20-72.82	
c ²			58.45			20.28			14.50		
P			<0.001			<0.001			<0.001		
Total	2729	1809	66.29	64.52-68.06	2244	82.29	80.86-83.72	1617	60.00	58.15-61.85	

WC: waist circumference. * having missing value.

Table 2 Multi-factor Logistics regression of the awareness of height, weight and WC

Variable	Height	Weight	WC
Gender			
Men	Ref	Ref	Ref
Women	2.78 (2.21~3.49)^c	1.99(1.52~2.60)^c	1.12(0.93~1.36)
Age[years]			
18-44	Ref	Ref	Ref
45-59	2.25(1.69~2.99)^c	1.97(1.35~2.87)^c	0.90(0.72~1.12)
60-	6.46(4.56~9.16)^c	4.82(3.15~7.38)^c	1.60(1.20~2.14)^b
Education			
Primary or below	Ref	Ref	Ref
Junior school	0.35(0.27~0.45)^c	0.51(0.37~0.71)^c	0.68(0.55~0.85)^c
Senior or above	0.24(0.13~0.46)^c	0.37(0.17~0.82)^a	0.43(0.28~0.65)^c
Annual family income	0.83(0.73~0.94)^b	1.00(0.86~1.17)	0.91(0.81~1.02)
Marital status			
Married/ cohabitation	Ref	Ref	Ref
Single	3.08(1.70~5.58)^c	2.59(1.36~4.94)^b	1.64(0.97~2.75)
Divorced/ widowed /separated	1.39(0.92~2.11)	1.97(1.32~2.96)^b	1.89(1.29~2.78)^b
Occupation			
Professionals	Ref	Ref	Ref
Agriculture and forestry	2.04(0.76~5.52)	1.40(0.47~4.15)	0.86(0.50~1.47)
Industrial and commercial service	1.38(0.47~4.05)	0.64(0.18~2.27)	1.10(0.60~2.00)
Housework	1.64(0.59~4.54)	1.18(0.39~3.62)	0.92(0.52~1.64)
Others	1.20(0.35~4.08)	1.90(0.53~6.89)	0.79(0.36~1.73)

^a $p \leq 0.05$.

^b $p \leq 0.01$.

^c $p \leq 0.001$.

WC: waist circumference.

Table 3 Mean of self-reported and measured, the mean difference value and the *p*-value of *t* test

Variable	Height (cm)				Weight (kg)				WC (cm)		
	Self-reported	Measured	D:SD, 95%CI	<i>P</i>	Self-reported	Measured	D:SD, 95%CI	<i>P</i>	Self-reported	Measured	WC (cm)
Gender											
Men	166.90(6.21)	166.07(6.00)	0.83±3.96, 0.55~1.11	<0.001	66.10(10.64)	66.06(10.71)	0.03±4.05, -0.24~0.30	0.813	83.68(10.69)	83.77(9.76)	-0.09
Women	157.77(6.67)	157.22(6.63)	0.55±4.27, 0.29~0.81	<0.001	58.79(9.01)	58.81(8.960)	-0.03±3.87, -0.23~0.17	0.795	78.56(9.80)	80.23(9.77)	-1.67
Age(years)											
18-44	160.91(7.60)	160.55(7.40)	0.36±3.86, 0.05~0.67	0.027	59.93(10.17)	59.91(10.27)	0.02±3.88, -0.29~0.33	0.903	78.37(11.59)	79.12(10.02)	-0.75
45-59	161.74(7.98)	161.02(7.91)	0.72±4.12, 0.46~0.98	<0.001	63.00(10.25)	62.89(10.27)	0.11±3.80, -0.10~0.32	0.309	81.43(9.94)	82.56(9.80)	-1.13
60+	162.33(8.10)	161.11(7.72)	1.21±4.84, 0.58~1.84	<0.001	59.47(9.88)	59.89(9.68)	-0.42±4.46, -0.87~0.03	0.068	80.31(9.59)	81.96(9.38)	-1.65
Education											
Primary or below	160.62(7.60)	159.65(7.45)	0.97±4.40, 0.69~1.25	<0.001	61.21(10.18)	61.27(10.14)	-0.06±3.99, -0.27~0.15	0.562	80.66(10.45)	82.12(9.98)	-1.46
Junior school	161.84(8.10)	161.62(7.79)	0.22±3.91, -0.07~0.51	0.131	61.83(10.25)	61.77(10.21)	0.06±3.41, -0.19~0.31	0.61	80.19(10.33)	80.65(9.75)	-0.46
Senior or above	165.37(7.285)	164.52(7.45)	0.85±3.40, 0.34~1.36	0.001	63.04(11.22)	62.88(11.53)	0.16±5.43, -0.65~0.97	0.702	79.90(10.70)	80.93(9.80)	-1.03
Marital status											
Single	163.60(7.44)	163.39(7.61)	0.20±4.11, -1.04~1.44	0.752	59.24(8.68)	59.74(8.49)	-0.50±3.31, -1.38~0.38	0.275	79.03(9.46)	79.57(9.03)	-0.54
Married/cohabitation	161.51(7.89)	160.82(7.71)	0.69±4.14, 0.49~0.89	<0.001	61.71(10.35)	61.69(10.35)	0.02±3.93, -0.15~0.19	0.817	80.41(10.34)	81.55(9.93)	-1.14
Divorced/widowed / separated	161.02(8.13)	160.69(8.05)	0.33±4.40, -0.82~1.48	0.576	59.28(9.51)	59.55(9.25)	-0.28±4.50, -1.22~0.66	0.566	82.10(13.24)	82.21(9.84)	-0.11
Occupation											
Agriculture and forestry	161.58(8.17)	160.87(7.88)	0.71±4.16, 0.48~0.94	<0.001	61.36(10.22)	61.42(10.24)	-0.05±3.87, -0.24~0.14	0.573	80.51(10.24)	81.75(9.75)	-1.24
Professionals	164.28(6.91)	164.33(7.18)	-0.05±3.11, -0.70~0.60	0.878	63.16(11.40)	63.73(11.49)	-0.58±2.79, -1.15~0.01	0.051	79.57(11.57)	79.84(9.37)	-0.27
Industrial and commercial service	164.27(7.16)	163.71(6.92)	0.56±4.22, -0.09~1.21	0.093	64.83(10.57)	64.12(10.43)	0.71±4.61, 0.04~1.38	0.039	83.23(11.80)	83.48(9.49)	-0.25
Housework	158.76(6.36)	158.21(6.69)	0.55±4.29, 0.04~1.06	0.037	60.56(9.75)	60.49(9.62)	0.06±4.15, -0.38~0.50	0.781	79.26(9.96)	80.49(10.66)	-1.23
Others	162.11(7.34)	160.23(7.36)	1.88±4.22, 0.70~3.06	0.003	59.93(10.63)	60.30(11.08)	-0.38±3.81, -1.39~0.63	0.469	78.56(11.18)	78.49(10.70)	0.07
Annual family income *											
Less than 10,000 RMB	162.03(7.23)	161.83(7.71)	0.20±3.90, -0.86~1.26	0.71	58.69(9.32)	60.08(9.39)	-1.39±4.76, -2.37~0.41	0.006	80.06(9.83)	81.30(9.20)	-1.24
10000 RMB	161.75(7.56)	160.78(7.45)	0.98±4.46, 0.68~1.28	<0.001	61.61(10.29)	61.57(10.28)	0.04±3.80, -0.19~0.27	0.719	80.09(10.30)	81.20(9.90)	-1.11
50000 RMB	161.54(7.42)	161.00(7.20)	0.54±3.69, 0.25~0.83	<0.001	62.13(10.16)	62.08(10.23)	0.05±3.87, -0.23~0.33	0.727	81.30(10.73)	82.01(9.85)	-0.71
100000RMB	161.34(7.57)	161.10(7.53)	0.23±3.50, -0.30~0.76	0.385	61.67(10.42)	61.29(10.40)	0.38±3.44, -0.11~0.87	0.138	80.46(9.87)	82.14(10.13)	-1.68
Total	161.54(7.89)	160.88(7.73)	0.67±4.14, 0.48~0.86	<0.001	61.56(10.29)	61.56(10.27)	-0.00±3.94, -0.17~0.16	0.959	80.44(10.43)	81.53(9.91)	-1.09

WC: waist circumference; D: self-reported data minus physical measured data.

Table 4 The average intraclass correlations (ICC, 95% CI) of self-reported and measured height, weight and WC

Variable	Height	Weight	WC
Gender			
Men	0.87(0.84-0.89)	0.88(0.87-0.90)	0.91(0.89-0.92)
Women	0.87(0.85-0.88)	0.89(0.87-0.90)	0.90(0.88-0.91)
Age[years]			
18-44	0.93(0.92-0.94)	0.93(0.92-0.94)	0.95(0.93-0.96)
45-59	0.93(0.92-0.94)	0.93(0.92-0.94)	0.93(0.93-0.94)
60-	0.90(0.87-0.92)	0.90(0.87-0.92)	0.90(0.87-0.93)
Education			
Primary or below	0.91(0.89-0.92)	0.91(0.90-0.92)	0.91(0.89-0.92)
Junior school	0.94(0.93-0.94)	0.94(0.93-0.95)	0.95(0.95-0.96)
Senior or above	0.94(0.92-0.96)	0.94(0.92-0.96)	0.94(0.92-0.96)
Marital status			
Single	0.92(0.85-0.96)	0.92(0.85-0.96)	0.90(0.78-0.95)
Married/ cohabitation	0.92(0.92-0.93)	0.93(0.92-0.93)	0.93(0.93-0.94)
Divorced/ widowed / separated	0.92(0.86-0.95)	0.92(0.86-0.95)	0.93(0.86-0.96)
Occupation			
Agriculture and forestry	0.93(0.92-0.94)	0.93(0.92-0.94)	0.94(0.93-0.94)
Professionals	0.95(0.92-0.97)	0.95(0.92-0.97)	0.96(0.93-0.98)
Industrial and commercial service	0.90(0.87-0.93)	0.90(0.87-0.93)	0.91(0.87-0.94)
Housework	0.88(0.85-0.90)	0.88(0.85-0.91)	0.89(0.85-0.92)
Others	0.91(0.84-0.95)	0.90(0.83-0.95)	0.89(0.79-0.94)
Annual family income			
Less than 10, 000 RMB	0.93(0.87-0.96)	0.93(0.87-0.96)	0.94(0.89-0.97)
10000 RMB-	0.90(0.89-0.92)	0.91(0.89-0.92)	0.91(0.89-0.92)
50000 RMB-	0.93(0.92-0.94)	0.93(0.92-0.94)	0.95(0.94-0.96)
100000RMB-	0.94(0.92-0.96)	0.94(0.92-0.96)	0.95(0.93-0.96)
Total	0.92(0.92-0.93)	0.93(0.92-0.93)	0.93(0.93-0.94)

WC: waist circumference.

Table 5 Categorisation of BMI and WC category based on self-reported and measured data

Self-reported	Measured				
Self-reported BMI	Measured BMI				
	Underweight	Normal weight	Overweight	Obese	Total
Underweight	48(73.85)	28(3.17)	1(0.16)	0(0.00)	77(4.33)
Normal weight	16(24.62)	787(89.13)	121(19.27)	4(1.99)	928(52.22)
Overweight	0(0.00)	60(6.80)	474(75.48)	47(23.38)	581(32.70)
Obese	1(1.54)	8(0.91)	32(5.10)	150(74.63)	191(10.75)
Total	65(3.66)	883(49.69)	628(35.34)	201(11.31)	1777

Self-reported WC	Measured WC		
	Normal WC	Increased WC	Total
Normal WC	854(91.53)	193(26.73)	1047(63.26)
Increased WC	79(8.47)	529(73.27)	608(36.74)
Total	933(56.37)	409(43.63)	1655

WC: waist circumference.

Table 6 Univariate regression analyses for demographic and socioeconomic variable with differences between self-reported and measured data

Variable	Height	Weight	WC
Gender			
Men	Ref	Ref	Ref
Women	1.11(0.46~1.75)^c	-0.06(-0.40~0.28)	-1.57(-2.26~-0.89)^c
Age[years]			
18-44	Ref	Ref	Ref
45-59	0.37(-0.05~0.79)	0.09(-0.29~0.47)	-0.49(-1.27~0.29)
60-	0.86(0.22~1.50)^b	-0.44(-0.94~0.07)	-1.00(-2.06~0.05)
Education			
Primary or below	Ref	Ref	Ref
Junior school	-0.75(-1.15~-0.34)^c	0.13(-0.23~0.48)	1.00(0.28~1.72)^b
Senior or above	-0.12(-0.80~0.56)	0.22(-0.40~0.85)	0.43(-0.79~1.65)
Annual family income	-0.29(-0.56~-0.02)^a	0.27(0.04~0.50)^a	-0.01(-0.48~0.46)
Marital status			
Married/ cohabitation	Ref	Ref	Ref
Single	-0.49(-1.76~0.78)	-0.52(-1.58~0.55)	0.60(-1.71~2.90)
Divorced/ widowed /separated	-0.36(-1.46~0.75)	-0.30(-1.13~0.54)	1.03(-0.85~2.92)
Occupation			
Professionals	Ref	Ref	Ref
Agriculture and forestry	0.76(-0.13~1.65)	0.52(-0.31~1.35)	-0.97(-2.66~0.73)
Industrial and commercial service	0.61(-0.46~1.68)	1.29(0.30~2.27)^a	0.02(-2.04~2.08)
Housework	0.60(-0.40~1.59)	0.64(-0.27~1.54)	-0.96(-2.81~0.90)
Others	1.93(0.48~3.37)^b	0.20(-1.13~1.52)	0.34(-2.33~3.02)

^a $p \leq 0.05$.

^b $p \leq 0.01$.

^c $p \leq 0.001$.

WC: waist circumference.

Table 7 Results of multivariate regression analyses for demographic and socioeconomic variable in relation to differences between self-reported and measured height, weight and WC

Variable	Height	Weight	WC
Gender			
Men	Ref	Ref	Ref
Women	-0.16(-0.60~0.27)	-0.11(-0.49~0.26)	-1.74(-2.51~-0.97)^c
Age[years]			
18-44	Ref	Ref	Ref
45-59	0.10(-0.37~0.57)	0.14(-0.28~0.55)	-0.55(-1.41~0.32)
60-	0.26(-0.48~1.01)	-0.40(-1.00~0.20)	-1.62(-2.88~-0.36)^a
Education			
Primary or below	Ref	Ref	Ref
Junior school	-0.56(-1.01~-0.11)^a	-0.03(-0.43~0.37)	0.38(-0.44~1.20)
Senior or above	0.24(-0.55~1.03)	0.33(-0.39~1.05)	-0.65(-2.11~0.81)
Annual family income	-0.25(-0.53~0.03)	0.23(-0.00~0.47)	-0.05(-0.53~0.43)
Marital status			
Married/ cohabitation	Ref	Ref	Ref
Single	-0.82(-2.16~0.51)	-0.45(-1.55~0.65)	-0.24(-2.57~2.09)
Divorced/ widowed /separated	-0.79(-1.93~0.34)	-0.26(-1.16~0.64)	1.60(-0.38~3.58)
Occupation			
Professionals	Ref	Ref	Ref
Agriculture and forestry	0.76(-0.24~1.76)	0.78(-0.15~1.71)	-0.87(-2.80~1.07)
Industrial and commercial service	0.85(-0.28~0.99)	1.57(0.52~2.61)^b	-0.37(-2.57~1.84)
Housework	0.67(-0.43~1.78)	0.97(-0.04~1.98)	-0.57(-2.68~1.53)
Others	2.16(0.62~3.70)^b	0.73(-0.70~2.16)	0.55(-2.30~3.40)

^a $p \leq 0.05$.

^b $p \leq 0.01$.

^c $p \leq 0.001$.

WC: waist circumference.

Figures

Figure 1

Bland Altman plots of the difference versus the average of self-reported and measured data.