

# Validity of Self-Reported Anthropometric Measures in Estimating Obesity Prevalence in Brazil: Study with Data from the National Health Survey (PNS), 2013

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## Abstract

### Background

Self-reported height and weight measurement is a simple and a non-invasive method of collecting data in population surveys. However, the inaccuracy of self-reported data may bias the population nutritional status evaluation. The aim of this study is to compare the obesity prevalence estimated with self-reported anthropometric data and with measured weight and height using data from the National Health Survey, Brazil, 2013.

### Methods

A three-stage cluster sampling (census tracts, households, and individuals) with stratification of the primary sampling units and random selection in all stages was used to select Brazilian adults aged 18 years and over. Excluding pregnant women, measurements of weight and height were taken among all selected adults and were also self-reported during the interview on the same day. Logistic regression models were used to investigate the sociodemographic factors and lifestyles associated with the outcome "reported weight and height during the interview". Obesity prevalence estimates calculated with self-reported and measured weight and height were compared in all variable categories.

### Results

From the sample of 59,402 adults, 70.2% self-reported weight and height. Men were most likely to report their weight (OR = 1.14) and white people when compared to non-white (OR = 0.60). People from the upper socioeconomic class are 6.5 times more likely to report their weight and height during the interview. Healthy habits and medical consultation in the past year were significantly associated with the outcome. Among women, obesity prevalence estimated with self-reported measures (20.5%) was significantly lower than those with measured weight and height (24.4%), with larger differences among women of high socioeconomic status. No significant differences were found among men.

### Conclusions

Given that the body mass index is used as a guide for identifying health risks, these findings indicate that direct measurement of height and weight should be performed whenever possible in Brazilian surveys to adequately support public health policies.

**Keywords:** Health surveys; Nutritional status; Obesity; Self-reported anthropometric measures.

## Introduction

Currently, obesity is one of the most important global health problems and is considered a worldwide epidemic due to the progressive increase in the last decades in many developed and developing countries [1]. Because obesity is a risk factor for several non-communicable chronic diseases, it is responsible for a considerable loss both in life expectancy and quality of life [2, 3].

Globally, a one-third increase in years of life lost due to excess weight/obesity has been estimated since 2003 [4]. Increasing trends in obesity-related diseases such as diabetes and cardiovascular diseases are associated with the increasing number of premature deaths and high degree of severe functional

limitations and disabilities due to those NCDs [5].

In Brazil, the increase in the obesity prevalence took place together with the decline in undernutrition in children and adults. The antagonism in the temporal trends of undernutrition and obesity was a striking feature of the nutritional shift in Brazil [6]. Comparing the prevalence of overweight and obesity across the years 2000s, there is a relevant increase in prevalence estimates for both men and women [7]. In 2017, the Global burden of disease (GBD) estimates indicated that high Body mass index (BMI) was responsible for 13% of all deaths in Brazil, with cardiovascular disease and diabetes the most prevalent causes of deaths [8].

Monitoring obesity prevalence is essential for public health.

Assessing anthropometric measures through health surveys allows us to monitor the overweight/obesity trends in different geographic areas and to identify the main determinants essential to support public health policies for preventing obesity and promoting healthy habits since childhood [9].

There are several different ways of measuring obesity. The Body mass index (BMI) is the most used indicator in clinical practice and research [10]. This indicator is calculated by the ratio between the weight and the square of the height. According to the World Health Organization (WHO) classification, values higher or equal to 25.0 kg/m<sup>2</sup> indicate weight excess and values higher or equal to 30.0 kg/m<sup>2</sup> characterize obesity [1].

Self-reported height and weight measurement is a simple, inexpensive, and non-invasive method of collecting data in population surveys. However, the inaccuracy of self-reported data may bias the Body mass index (BMI) estimates and thus the nutritional status evaluation [11]. The exclusion of participants unaware of their weight or height is an additional source of bias that decreases the sensitivity in measuring the BMI and estimating obesity prevalence [12].

There are controversies in the national and international literature on the validity of self-reported anthropometry to assess the nutritional status of the population. Studies in Brazil, United States and Mexico indicated that reporting errors resulted in small biases and self-reported anthropometry was sufficiently valid for epidemiological purposes [13-15]. In contrast, analyses of anthropometric data in Japan, Korea, and Spain [16-18] led to the conclusion that self-reported weight and height were not sufficiently accurate to assert the validity of their use in epidemiological studies on the general adult population. Finally, some articles have indicated the validity of self-reported weight and height to assess the overall population nutritional status but show significant differences in some specific population groups [19,20].

In Brazil, self-reported weight and height have been annually monitored by the VIGITEL survey ("Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey") since 2006 [21]. The National Health Survey carried out in 2013 brought the opportunity to validate self-reported anthropometric data in Brazil as measured weight and height are also available for all participants [22].

The aim of this study is to compare the obesity prevalence estimated with self-reported anthropometric data and with measured weight and height using data from the National Health Survey-2013. Under the hypothesis that the demographic, socioeconomic and lifestyle factors as well as health care use may influence the self-reported weight and height during interviews [12, 17, 18], these factors were analyzed as potential explanatory variables for missing self-reported anthropometric data and misestimation of obesity prevalence.

## Methods

### Study Design

The National Health Survey is a nationwide household-based survey carried out by the Ministry of Health in partnership with the Brazilian Institute of Geography and Statistics (IBGE) in year 2013 aimed at assessing health conditions and health system performance of Brazilian states and regions. The 2013 PNS was approved by the National Commission of Ethics in Research (CONEP) in June 2013 (No. 328.159).

### Sampling

In the PNS, 2013 the surveyed population includes Brazilian residents of private households, except those located in special census tracts (barracks, military bases, halls of residence, settlements, boats, penitentiaries, penal colonies, prisons, jails, asylums, orphanages, convents, and hospitals) and in indigenous lands. A three-stage cluster sampling (census tracts, households, and individuals) was used with stratification of the primary sampling units (PSUs) and random selection in each stage. Census tracts or set of sectors compose the primary sampling units (PSUs), households are the units of the second stage and the residents selected with equiprobability in sampled households define the third-stage units. Details of the sampling process are available in a previous publication [22].

At the end of fieldwork, 69,994 households were occupied, and 64,348 household interviews were held. The non-response rate was 8.1%. The expansion factors were calculated by the inverse of the selection probability product at each stage [23].

### Measurement Instruments

The PNS questionnaire is divided into three parts: characteristics of the household (water and sanitation, electricity, household assets); demographic and health information on all household residents (sociodemographic characteristics, access and utilization of health care, private health insurance coverage for all household members); and the individual questionnaire, which includes modules on self-perception of health, lifestyles, and non-communicable chronic diseases). Only one household member (key informant) answers the first and second parts for all household residents. The individual questionnaire is answered by a resident selected with equal probability in each sampled household [24].

The total sample of PNS-2013 included 60,202 selected adult individuals, who answered the individual questionnaire and had their anthropometric measurements of weight and height measured by a previously trained interviewer. Excluding 800 women who were pregnant at the survey interview, weight and height were measured in a total of 59,402 individuals. Additionally, self-reported weight and height were questioned during the individual interview on the same day as measurements, allowing a comparison of self-reported weight and height measurements with those measured. The following questions were asked during the interview "Do you know your weight?" and "Do you know your height?" with answers (yes; no). In the case

of affirmative responses, participants were asked to specify their weight and height.

To measure the weight, portable scales with a maximum weight of 180 kilos were used and calibrated daily to ensure the standardization of measurements throughout the anthropometric data collection in the survey. The participants were weighed barefoot, without accessories and wearing light clothing. To measure the height, a stadiometer with a capacity of 210 centimeters was used. The equipment was positioned on a wall with minimal unevenness at the household. The measurement details are described in the PNS anthropometry manual ([www.pns.fiocruz.br](http://www.pns.fiocruz.br)).

### Data Analysis

In this study, the following sociodemographic variables were considered: gender (male, female); age range (18-19, 30-39, 40-49, 50-59, 60-69, 70 years or older); skin color (white, black, brown); and degree of education (incomplete elementary school, complete elementary and incomplete high school, complete high school or more).

To establish the socioeconomic status (SES), we calculated an index based on the number of household goods (attributing higher scores to those with higher value), degree of education of the household head, and presence of monthly paid housekeeper, using a standard Brazilian classification scale for socioeconomic class: (A/B) upper class; C (middle class); and lower class (D/E), adapting the Brazilian Economic Classification Criteria [25].

Regarding lifestyles, the following health behaviors were considered: regular intake of fruits and vegetables; regular practice of leisure-time physical activity; meal replacement with snacks, pizza, sandwiches on 3 days or more per week; consumption of sweets or chocolates on 3 days or more per week.

Finally, to investigate the influence of health care utilization on the self-reported anthropometric measures, the following indicators were used: medical consultation and health examinations (checked blood pressure, blood glucose, cholesterol) in the last 12 months prior to the survey; a year or more prior to the survey; and never.

In the statical data analysis, logistic regression models were used to identify the factors associated to missing self-reported weight, height and both measurements during the interview. The crude and adjusted odds ratio (OR), controlled by degree of education, gender and age range were the measures of association.

The obesity prevalence was estimated with the measured weight and height and with the self-reported anthropometric measures. Prevalence estimates were compared according to the categories of the variables considered in the study and the Mc Nemar test was used for testing differences at the 5% level.

As the PNS design used stratification of census tracts and multiple stage cluster selection, the complex sample design was considered in the statistical analysis.

## Results

A total of 59,402 people had their weight and height measured at the PNS. Among these participants, 85.6% reported their weight and 74.9% reported their height during the interview.

Results presented in table 1 show men were most likely to report their weight when compared to women (OR = 1.14) and white individuals when compared to non-white ones (OR = 0.60). Regarding age, higher odds of reporting weight were found among adults aged 30-39 and 40-49 years while the lower odds-ratio was found among the oldest (OR = 0.59). Socioeconomic inequalities were found: the higher the degree of education and the better the SES, the higher the odds of self-reporting weight.

Associations of self-reporting weight with health behaviors were also found (Table 1). People who have healthy behaviors, such as regular fruit and vegetable intake and regular practice of leisure physical activity, are more likely to report their own weight (OR = 1.22 and OR = 1.84, respectively). However, among individuals who have unhealthy behaviors, such as those who regularly replace meals and consume sweets, direct significant associations with the outcome were also found.

Regarding self-reporting height, the sociodemographic and lifestyle variables were the same that showed a significant association with self-reporting weight, but the odds ratios were higher, and the gradients by educational level and SES were more pronounced (Table 1).

As to reporting both anthropometric measures during the interview, only 70.2% reported both weight and height, resulting in a final loss of 29.8% for the body mass index estimation. The results from the logistic regressions showed higher odds of reporting weight and height (OR crude and adjusted) among males, people aged 30-59 years, and white people. Large socioeconomic gradients were found. People with better educational level are 4 times more likely to inform both anthropometric measures, and people from the upper socioeconomic class are 6.5 times more likely of reporting their weight and height during the interview (Table 2).

Regarding health behaviors, people who regularly intake fruits and vegetables (FLV) and practice recommended physical activity are more likely to report their anthropometric measures (OR = 1.3 and OR = 1.8, respectively). However, people who have unhealthy nutritional behaviors, such as those who regularly replace meals and consume sweets and chocolates, are also more likely to report their weight and height (Table 2).

Analysis of the associations between health care utilization and self-reporting weight and height showed significant odds-ratios with medical consultation, blood pressure measurement and cholesterol and glucose tests in the last 12 months prior to the survey. The highest significant adjusted odds ratio was found among individuals who measured their blood pressure in the past 12 months, even after controlling for sex, age groups and degree of education (OR adjusted = 2.18) (Table 3).

**Table 1: Proportion (%) of individuals who reported weight and height during the interview and associations with sociodemographic and lifestyle indicators. PNS, 2013.**

| Variables                                                              |                              | Reported weight |         |              |         | Reported height |      |         |              |         |        |
|------------------------------------------------------------------------|------------------------------|-----------------|---------|--------------|---------|-----------------|------|---------|--------------|---------|--------|
|                                                                        | Crude OR                     |                 |         | Adjusted OR* |         | Crude OR        |      |         | Adjusted OR* |         |        |
|                                                                        | %                            | OR              | p-value | OR           | p-value | %               | OR   | p-value | OR           | p-value |        |
| Gender                                                                 | Male                         | 86.4            | 1.14    | 0.001        | -       | -               | 79.8 | 1.67    | <0.001       | -       | -      |
|                                                                        | Female                       | 84.8            | 1       | -            | -       | -               | 70.3 | 1       | -            | -       | -      |
| Degree of Education                                                    | Incomplete elementary school | 79.9            | 1       | -            | -       | -               | 59.4 | 1       | -            | -       | -      |
|                                                                        | Incomplete high school       | 85.7            | 1.51    | <0.001       | -       | -               | 76.6 | 2.24    | <0.001       | -       | -      |
|                                                                        | Complete high school or more | 90.4            | 2.37    | <0.001       | -       | -               | 87.6 | 4.84    | <0.001       | -       | -      |
| Age (Years old)                                                        | 18 - 29                      | 84.7            | 1       | -            | -       | -               | 74.7 | 1       | -            | -       | -      |
|                                                                        | 30 - 39                      | 87.7            | 1.29    | <0.001       | -       | -               | 79.5 | 1.32    | <0.001       | -       | -      |
|                                                                        | 40 - 49                      | 87.4            | 1.25    | <0.001       | -       | -               | 78.1 | 1.21    | <0.001       | -       | -      |
|                                                                        | 50 - 59                      | 86.0            | 1.12    | 0.112        | -       | -               | 77.1 | 1.14    | 0.023        | -       | -      |
|                                                                        | 60 - 69                      | 86.3            | 1.14    | 0.069        | -       | -               | 68.4 | 0.73    | <0.001       | -       | -      |
|                                                                        | 70+                          | 76.5            | 0.59    | <0.001       | -       | -               | 59.1 | 0.49    | <0.001       | -       | -      |
| SES***                                                                 | A                            | 91.9            | 3.35    | <0.001       | 2.16    | <0.001          | 90.4 | 8.36    | <0.001       | 3.98    | <0.001 |
|                                                                        | B                            | 85.7            | 1.78    | <0.001       | 1.60    | <0.001          | 75.6 | 2.74    | <0.001       | 2.19    | <0.001 |
|                                                                        | C                            | 77.0            | 1       | -            | 1       | -               | 53.1 | 1       | -            |         |        |
| Skin Color                                                             | White                        | 88.6            | 1       | -            | 1       | -               | 81.5 | 1       | -            | 1       | -      |
|                                                                        | Black                        | 80.6            | 0.53    | <0.001       | 0.60    | <0.001          | 69.2 | 0.51    | <0.001       | 0.73    | <0.001 |
|                                                                        | Brown                        | 83.0            | 0.63    | <0.001       | 0.77    | <0.001          | 68.4 | 0.49    | <0.001       | 0.66    | <0.001 |
| FLV **                                                                 | Yes                          | 87.5            | 1.27    | <0.001       | 1.22    | 0.003           | 79.6 | 1.46    | <0.001       | 1.27    | <0.001 |
|                                                                        | No                           | 84.7            | 1       | -            | 1       | -               | 72.8 | 1       | -            | 1       | -      |
| Physical Activity                                                      | Yes                          | 92.0            | 2.24    | <0.001       | 1.84    | <0.001          | 84.6 | 2.14    | <0.001       | 1.43    | <0.001 |
|                                                                        | No                           | 83.7            | 1       | -            | 1       | -               | 72.0 | 1       | -            | 1       | -      |
| Meal’s Replacement                                                     | 3 days or more               | 87.9            | 1.26    | <0.001       | 1.34    | 0.006           | 80.9 | 1.50    | <0.001       | 1.09    | <0.001 |
|                                                                        | Less than 3 days             | 85.2            | 1       | -            | 1       | -               | 73.9 | 1       | -            | 1       | -      |
| Sweet Consumption                                                      | 3 days or more               | 87.0            | 1.27    | <0.001       | 1.11    | 0.091           | 78.2 | 1.46    | <0.001       | 1.18    | <0.001 |
|                                                                        | Less than 3 days             | 84.6            | 1       | -            | 1       | -               | 72.8 | 1       | -            | 1       | -      |
| Total                                                                  |                              | 85.6            | -       | -            | -       | -               | 74.9 | -       | -            | -       | -      |
| *Adjusted OR by level of education, gender and age;                    |                              |                 |         |              |         |                 |      |         |              |         |        |
| **FLV: Fruits and vegetables regular intake; SES: Socioeconomic status |                              |                 |         |              |         |                 |      |         |              |         |        |

**Table 2: Proportion (%) of individuals who reported both anthropometric measures during the interview and associations with sociodemographic and lifestyle indicators. PNS, 2013.**

| Variables           | Reported both weight and height |      | Crude OR |         | Adjusted OR* |         |
|---------------------|---------------------------------|------|----------|---------|--------------|---------|
|                     | N                               | %    | OR       | p-value | OR           | p-value |
| Gender              |                                 |      |          |         |              |         |
| Male                | 21,338                          | 75.2 | 1.59     | <0.001  | -            | -       |
| Female              | 20,507                          | 65.6 | 1        | -       | -            | -       |
| Degree of Education |                                 |      |          |         |              |         |

|                                                     |        |      |      |        |      |        |
|-----------------------------------------------------|--------|------|------|--------|------|--------|
| Incomplete elementary school                        | 12,824 | 55.0 | 1.00 | -      | -    | -      |
| Incomplete high school                              | 6,594  | 71.3 | 2.04 | <0.001 | -    | -      |
| Complete high school or more                        | 22,426 | 82.9 | 3.98 | <0.001 | -    | -      |
| Age Group (Years old)                               |        |      |      |        |      |        |
| 18 – 29                                             | 10,606 | 69.2 | 1    | -      | -    | -      |
| 30 – 39                                             | 9,565  | 74.7 | 1.31 | <0.001 | -    | -      |
| 40 – 49                                             | 7,990  | 73.6 | 1.24 | <0.001 | -    | -      |
| 50 – 59                                             | 7,064  | 72.5 | 1.18 | 0.002  | -    | -      |
| 60 – 69                                             | 4,025  | 65.7 | 0.85 | 0.005  | -    | -      |
| 70+                                                 | 2,594  | 54.8 | 0.55 | <0.001 | -    | -      |
| SES***                                              |        |      |      |        |      |        |
| A                                                   | 16,634 | 86.2 | 6.59 | <0.001 | 3.27 | <0.001 |
| B                                                   | 18,089 | 70.6 | 2.54 | <0.001 | 2.08 | <0.001 |
| C                                                   | 7,122  | 48.6 | 1    | -      | 1    | -      |
| Skin Color                                          |        |      |      |        |      |        |
| White                                               | 21,833 | 77.2 | 1    | -      | 1    | -      |
| Black                                               | 3,473  | 63.2 | 0.51 | <0.001 | 0.67 | <0.001 |
| Brown                                               | 15,924 | 63.7 | 0.52 | <0.001 | 0.68 | <0.001 |
| FLV**                                               |        |      |      |        |      |        |
| Yes                                                 | 13,356 | 75.0 | 1.40 | <0.001 | 1.28 | <0.001 |
| No                                                  | 28,489 | 68.2 | 1    | -      | 1.00 | -      |
| Physical Activity                                   |        |      |      |        |      |        |
| Yes                                                 | 10,963 | 81.3 | 2.14 | <0.001 | 1.49 | <0.001 |
| No                                                  | 30,882 | 67.0 | 1    | -      | 1.00 | -      |
| Meal Replacement                                    |        |      |      |        |      |        |
| 3 days or more                                      | 6,222  | 76.7 | 1.47 | <0.001 | 1.11 | 0.224  |
| Less than 3 days                                    | 35,623 | 69.2 | 1    | -      | 1    | -      |
| Sweet Consumption                                   |        |      |      |        |      |        |
| 3 days or more                                      | 16,723 | 73.7 | 1.39 | <0.001 | 1.15 | 0.008  |
| Less than 3 days                                    | 25,122 | 68.1 | 1    | -      | 1    | -      |
| Total                                               | 41,845 | 70.2 | -    | -      | -    | -      |
| *Adjusted OR by level of education, gender, and age |        |      |      |        |      |        |
| **FLV: Fruits and vegetables consumption            |        |      |      |        |      |        |
| ***SES: Socioeconomic status                        |        |      |      |        |      |        |

**Table 3: Proportion (%) of individuals who reported both anthropometric measures during the interview and associations with health care utilization. PNS, 2013.**

| Variables            | Reported Weight and Height |      | Crude OR |         | Adjusted OR* |         |
|----------------------|----------------------------|------|----------|---------|--------------|---------|
|                      | N                          | %    | OR       | p-value | OR           | p-value |
| Medical Consultation |                            |      |          |         |              |         |
| Past 12 months       | 31,826                     | 72.2 | 1.92     | <0.001  | 1.06         | 0.778   |
| One year or more     | 9,775                      | 64.9 | 1.37     | 0.071   | 1.01         | 0.982   |

|                                                            |        |      |      |        |      |        |
|------------------------------------------------------------|--------|------|------|--------|------|--------|
| Never                                                      | 243    | 57.4 | 1    | -      | 1    | -      |
| Blood Pressure Measurement                                 |        |      |      |        |      |        |
| Past 12 months                                             | 35,166 | 73.2 | 2.82 | <0.001 | 2.18 | <0.001 |
| One year or more                                           | 5,804  | 59.2 | 1.49 | <0.001 | 1.28 | 0.014  |
| Never                                                      | 875    | 49.3 | 1    | -      | 1    | -      |
| Blood Glucose Test                                         |        |      |      |        |      |        |
| Past Year                                                  | 25,611 | 75.1 | 2.12 | <0.001 | 1.17 | 0.060  |
| One year or more                                           | 12,189 | 65.5 | 1.34 | <0.001 | 0.93 | 0.804  |
| Never                                                      | 4,045  | 41.4 | 1    | -      | 1    | -      |
| Cholesterol Test                                           |        |      |      |        |      |        |
| Past Year                                                  | 24,721 | 75.3 | 2.15 | <0.001 | 1.50 | <0.001 |
| One year ago, or more                                      | 12,131 | 66.5 | 1.40 | <0.001 | 1.31 | <0.001 |
| Never                                                      | 4,993  | 58.6 | 1    | -      | 1    | -      |
| Total                                                      | 42,278 | 70.2 | -    | -      | -    | -      |
| *Adjusted OR by degree of education, gender and age group. |        |      |      |        |      |        |

**Table 4: Obesity prevalence estimates with measured and self-reported weight and height according to sociodemographic, health care utilization and lifestyle indicators. PNS, 2013.**

\*Significant differences at the 5% level. \*\*FLV: Fruits and vegetables consumption; \*\*\*SES: socioeconomic status.

| Variables                    | Male     |            |               |            | Female   |            |               |            |
|------------------------------|----------|------------|---------------|------------|----------|------------|---------------|------------|
|                              | Measured |            | Self-reported |            | Measured |            | Self-reported |            |
|                              | %        | IC95%      | %             | IC95%      | %        | IC95%      | %             | IC95%      |
| Degree of Education          |          |            |               |            |          |            |               |            |
| Incomplete elementary school | 15.1     | 13.9- 16.3 | 16.2          | 14.7-17.8  | 28.7     | 27.3- 30.1 | 27.0          | 25.0- 29.0 |
| Incomplete high school       | 15.7     | 13.6- 18.0 | 16.6          | 14.3- 19.2 | 24.3     | 22.2- 26.5 | 21.0          | 18.7- 23.6 |
| Complete high school or more | 18.8     | 17.5- 20.2 | 17.5          | 16.1- 18.9 | 21.0     | 19.9- 22.2 | 17.3*         | 16.1- 18.6 |
| Age Group (Years old)        |          |            |               |            |          |            |               |            |
| 18 - 29                      | 10.6     | 9.2-12.2   | 10.8          | 9.1- 12.8  | 14.1     | 12.6- 15.8 | 11.7          | 10.1- 13.5 |
| 30 - 39                      | 17.1     | 15.6- 18.7 | 15.9          | 14.3- 17.6 | 23.7     | 22.0- 25.6 | 19.6*         | 17.6- 21.8 |
| 40 - 49                      | 20.8     | 18.9- 22.9 | 21.3          | 19.2- 23.5 | 28.1     | 26.2- 30.1 | 24.5          | 22.2- 26.9 |
| 50 - 59                      | 21.3     | 19.1- 23.8 | 23.5          | 20.9- 26.2 | 32.7     | 30.4- 35.1 | 26.3*         | 23.4- 29.4 |
| 60 - 69                      | 20.5     | 17.6- 23.8 | 17.6          | 14.9- 20.7 | 30.4     | 27.9- 33.0 | 26.6          | 23.4- 30.1 |
| 70+                          | 14.6     | 11.8- 17.9 | 13.5          | 10.2- 17.6 | 24.0     | 21.5- 26.6 | 21.7          | 17.9- 25.9 |
| SES***                       |          |            |               |            |          |            |               |            |
| A                            | 22.3     | 20.6- 24.2 | 20.5          | 18.8- 22.5 | 22.5     | 21.0- 24.1 | 17.6*         | 16.0- 19.3 |
| B                            | 16.8     | 15.6- 18.1 | 16.1          | 14.7- 17.6 | 26.7     | 25.5- 28   | 22.9*         | 21.4- 24.5 |
| C                            | 9.5      | 8.5- 10.6  | 11.2          | 9.8- 12.8  | 22.8     | 21.3- 24.4 | 21.3          | 18.7- 24   |
| Skin Color                   |          |            |               |            |          |            |               |            |

|                      |      |             |      |             |      |             |       |             |
|----------------------|------|-------------|------|-------------|------|-------------|-------|-------------|
| White                | 19.2 | 17.8- 20.6  | 18.8 | 17.3- 20.5  | 25   | 23.8- 26.2  | 20.4* | 19- 21.8    |
| Black                | 17.7 | 14.9- 20.9  | 14.6 | 12.1- 17.6  | 28.4 | 25.7- 31.2  | 24.4  | 20.8- 28.3  |
| Brown                | 14.2 | 13.2- 15.4  | 15.1 | 13.9- 16.4  | 23.2 | 22.0- 24.4  | 20.1* | 18.5- 21.8  |
| FLV**                |      |             |      |             |      |             |       |             |
| Yes                  | 18.3 | 16.7 - 20.1 | 17.1 | 15.3 - 19.1 | 23.9 | 22.5 - 25.4 | 19.5* | 17.9 - 21.1 |
| No                   | 16.2 | 15.3- 17.2  | 16.8 | 15.6- 18    | 24.7 | 23.7- 25.7  | 21.1* | 19.8- 22.4  |
| Physical Activity    |      |             |      |             |      |             |       |             |
| Yes                  | 14   | 12.3- 15.8  | 12.8 | 11.1- 14.7  | 21.3 | 19.3- 23.3  | 14.3* | 12.4- 16.4  |
| No                   | 17.6 | 16.6- 18.4  | 18.2 | 17- 19.4    | 24.9 | 24- 25.9    | 21.7* | 20.6- 22.9  |
| Meal Replacement     |      |             |      |             |      |             |       |             |
| 3 days or more       | 17.3 | 14.9- 20    | 18.4 | 15.6- 21.6  | 24.3 | 22.1- 26.7  | 20.6  | 18.1- 23.4  |
| Less than 3 days     | 16.7 | 15.8- 17.7  | 16.6 | 15.6- 17.8  | 24.5 | 23.6- 25.4  | 20.5* | 19.4- 21.6  |
| Sweet Consumption    |      |             |      |             |      |             |       |             |
| 3 days or more       | 15.8 | 14.5- 17.1  | 16.2 | 14.7- 17.9  | 21.3 | 19.9- 22.7  | 17.5* | 16- 19.1    |
| Less than 3 days     | 17.4 | 16.4- 18.6  | 17.3 | 16.1- 18.6  | 26.4 | 25.4- 27.4  | 22.6* | 21.3- 24.0  |
| Medical Consultation |      |             |      |             |      |             |       |             |
| Past Year            | 18.4 | 17.3- 19.3  | 18.1 | 16.9- 19.3  | 25.2 | 24.3- 26.2  | 21.4* | 20.3- 22.5  |
| One year or more     | 13.9 | 12.7- 15.3  | 14.4 | 12.9- 15.9  | 21.2 | 19.4- 23.1  | 16.2* | 13.8- 18.9  |
| Never                | 10.7 | 6.9- 16.1   | 13   | 6.4- 24.7   | 9.4  | 4.8- 17.8   | 5.1*  | 1.6- 15.2   |
| Total                | 16.8 | 15.9- 17,7  | 16.9 | 15.9- 17.9  | 24.4 | 23.6- 25.3  | 20.5* | 19.4- 21.6  |

In table 4, the obesity prevalence was estimated with measured and self-reported weight and height. Among women, the estimated obesity prevalence was 24.4%, nearly 4 percentage points higher than the prevalence calculated with self-reported weight and height (20.5%). The highest differences were found among women aged 50-59 years (6.4%), women of high socioeconomic status (4.9%), and among white women (4.6%). In relation to nutritional habits, the obesity prevalence estimated with measured weight and height was always higher than the obesity prevalence calculated with self-reported anthropometric measures, whether being a healthy or an unhealthy behavior. As to medical consultation in the past 12 months, a difference of 3.8 percentage points was found. Among men, no significant differences in the prevalence estimates were found.

## Discussion

This study showed that a considerable fraction of the Brazilian population did not report anthropometry during the interview, with only 70% informing both weight and height. Among people

most likely to report their anthropometric measurements, there is a predominance of men, young adults, people with higher educational level and socioeconomic status, and adequate health care utilization.

The findings indicated that height was the least self-reported measure corroborating results from previous national studies [13,26]. One possible explanation for reporting weight more frequently is that routine self-weighing is a usual practice, which has a positive influence on weight loss or weight gain prevention [27].

In this study, anthropometry missing information were more often found among people of low educational level and worse socioeconomic status. Evidence of the effects of socioeconomic status on unawareness of nutritional problems have been documented before, with results invariably unfavourable to the disadvantaged groups [28-30], probably due to difficulties in accessing preventive health measures and lack of information on the importance of monitoring weight [31]. Since awareness of weight problems is essential for prevention and treatment, new

health care approaches should be implemented in different social contexts focused on raising anthropometry awareness.

As to gender differences in self-reporting anthropometry, the losses were greater among women. The fact that women informed their weight and height less frequently may be associated with the dissatisfaction with their body image, mainly influenced by social and cultural factors [32]. In a study in the United States, women underestimated more than men on weight and men overestimated more than women on height [33]. In a review of studies that examined the accuracy of self-reported weight, all studies reported that women underestimated weight and a significant percentage of women in specific groups had large errors [10].

Our findings also show that the elderly report anthropometric measurements less frequently, corroborating previously documented result [34, 35]. In addition to the lower educational level among old Brazilian people, there is a natural aging process that leads to changes in body composition influencing the anthropometry awareness [36].

Regarding adequate health care utilization, all indicators considered in this study were associated with self-reported weight and height. The results of a recent study in Japan indicated that regular health examination results are positively associated with attitudes toward improving health habits and to acknowledge the obesity-related health risks [37]. In Brazil, population aging has come with the growth of the chronic non-communicable diseases (NCDs) and most public health efforts have focused on promoting health behaviors and reducing risk factors at primary health care. Routine height and weight measurements in primary health care services [38] have certainly increased the awareness of anthropometric measures and the rate of self-reporting anthropometry among those who use health care.

In the same context, our findings showed a positive association of healthy behavior adoption with self-reporting anthropometry during the interview. Paradoxically, however, population groups with unhealthy nutritional behaviors were also more likely to report their own weight and height. A recent Brazilian study shows a higher prevalence of some foods considered unhealthy, such as sweets, sandwiches, snacks, and pizzas, among the most favored social segments expressing the concomitance of healthy and unhealthy eating habits [39]. Thus, the more frequent report of the anthropometric measures among people with unhealthy nutrition habits is an example of reverse causation in cross-sectional studies, where the association between exposure and outcome is not due to direct causation [40].

The comparison of the obesity prevalence calculated with measured weight and height and self-reported anthropometric measures, among women, shows a large and significant difference of about 4 percentage points. The underlying determinants of these biases have been discussed before, placing special emphasis on the role played by social norms [18]. Our findings suggest that women of higher educational level and SES are less prone to

report their real weight and the lower self-reported weight may be reflecting the dissatisfaction with their body image [33]. The most pronounced difference, greater than 6 percentage points, was found among women aged 50-59 years old. This age-group is characterized by the menopause onset, reduction in metabolism, and increasing weight. The abrupt change in body mass is a possible explanatory factor for the underestimation of self-reported BMI due to discomfort with weight gain and physical changes related to menopause [41].

Different kind of problems were identified in the self-reported anthropometric measures in the Brazilian population. Firstly, BMI missing data are associated with unawareness of weight or height among people of low educational level and inadequate health care utilization. Secondly, underestimation of self-reported is related to dissatisfaction with their own body image. Finally, considering the progressive changes in the human body during life, missing anthropometric measures or incorrect self-reported information were found due to the lack of routine measurement of weight and height. As recommended by the Ministry of Health, food and nutrition surveillance should be part of the routine of health care services, especially in primary health care [38]. These routine health consultations are opportune not only for measuring weight and height, but also for promoting healthy behaviors [42, 43].

In conclusion, this study identified the main factors affecting the self-reporting of weight and height during the interview. The findings showed that missing anthropometry self-reported information is socially selective and unequal in the Brazilian population. Moreover, among people who reported weight and height during the interview, inaccurate measurements were found mainly among females, and caused significant inaccuracies in calculation of body mass index and obesity prevalence estimates [11]. Given that BMI is used as a guide for identifying persons at risk for diseases and for monitoring time-spatial trends in the population nutritional status, these findings indicate that direct measurement of height and weight should be performed whenever possible in Brazilian surveys to adequately support public health policies.

One of the limitations of this study is related to the quality of measured weight and height during fieldwork due to unevenness of the floor or walls of some sampled households. Other limitations stem from the cross-sectional design of the PNS, and bias in causal associations cannot be disregarded as the presence of risk factors and outcomes are measured simultaneously.

#### **CEP Identification / Approval Number**

PNS-2013 was approved in June 2013 by the National Ethics Commission for Research Involving Human Beings (Process No. 328.159).

#### **Individual Collaboration of Each Author in the Preparation of the Manuscript**

All authors contributed to the conception, analysis, interpretation

of data and writing of the article.

APSF, CLS, GND contributed to the conception and design of the study, analysis and interpretation of data, preparation of preliminary versions of the article and critical review, participation in the final writing and critical review of the article.

CSB, PRBSJ contributed to the analysis and interpretation of the data, participation in the final writing and review of the article.

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