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Accuracy of self-reported anthropometric measures in older Australian adults

ABSTRACT

Objective: To determine the accuracy of self-reported anthropometric measurements in older Australian adults 60-70 years.

Method: Self-reported anthropometric data from 103 community-dwelling participants (mean age 66 years) were compared with actual measurements. Difference and agreement were assessed using paired t-tests, correlation coefficients and Bland-Altman plots.

Results: Under-reporting occurred for weight and hip circumference, especially among males, whereas waist circumference was slightly over-reported, resulting in apparent under-estimations of body mass index (by 0.42 kg/m^2) but over-estimations of waist-to-hip ratio (WHR, by 0.02). Concordance correlation coefficients were generally high except for WHR. Self-reported circumference measures appeared to be more accurate than the derived WHR. The Bland-Altman plots revealed wide limits of agreement for all measures.

Conclusion: Self-reported values correlated well with measured values and average discrepancies were small. However, use of self-reported anthropometric data may be preferable in population studies for describing overall distribution than for monitoring changes at an individual level.

Key words: Hip circumference, height, self-report, waist circumference, weight

INTRODUCTION

Obesity is a major public health concern among older adults, with 79% of older Australians now considered overweight or obese [1]. Body mass index (BMI), derived from height and weight, is a popular measure of obesity [2], but it does not reflect the regional distribution of body fat. The negative health effects of abdominal/central obesity, independent of total body fat, have been well documented [3]. BMI, in conjunction with a measure of fat distribution such as waist circumference, can provide useful epidemiological information on obesity [4], whereas waist-to-hip ratio (WHR) is associated with cardiovascular disease risk [5] and all-cause mortality [6, 7]. Using additional measures is particularly appropriate when assessing obesity among the elderly, due to the age-related changes in body composition.

The ideal method for obtaining anthropometric data is via objective or direct measurements recorded by trained technicians. Researchers often collect anthropometric data using self-report methods (e.g. questionnaires) due to their low cost, ease of administration, practicality and minimal participant burden, allowing researchers to survey a large number of people [8], as well as improving recruitment and reducing attrition rates [9, 10]. However, factors such as gender, age, socioeconomic status and social desirability may introduce systematic and random biases [11, 12].

A review of 64 observational studies which compared direct and self-report anthropometric measures found a general tendency towards underestimating weight and BMI, and overestimating height [9]. Similarly, a review of studies on women revealed underestimation for weight but overestimation for height [13]. Such over- or under-estimation was more pronounced among older populations [14]. Average discrepancies between self-reported and

measured waist and hip circumferences are generally low, with a tendency towards under-reporting for waist circumference [15-19] and hip circumference [15-17].

Determining the accuracy of self-reported anthropometric measures among elderly is important, given the high levels of overweight and obesity and the steadily ageing population. There is limited research in the Australian context [20, 21], particularly with regard to measures of central obesity. This study aimed to investigate the accuracy of self-reported anthropometric data in Australian older adults aged 60-70 years.

METHODS

Participants and measures

Community-dwelling adults aged 60-70 years residing in low to medium socio-economic suburbs within metropolitan Perth were invited to participate in the Physical Activity and Nutrition for Seniors (PANS) program. Details of the recruitment procedure were extensively described elsewhere [22]. PANS was a 6-month, home-based physical activity and nutrition intervention consisting of written materials, supplemented by telephone advice and email contact from trained personnel [22]. Of the 248 intervention subjects recruited to the randomised controlled trial, a subgroup of 107 participants volunteered for the present cohort study. These participants were expected to be similar with respect to socioeconomic status.

In the self-administered mailed questionnaire delivered at baseline, participants were asked "what is your height in centimeters or feet/inches (without shoes)?" and "what is your weight in kilograms or pounds (without shoes)?" All participants received a tape measure and clearly written instructions on how to measure their waist and hip circumference, based on the national *Measure Up* campaign (www.measureup.gov.au). For waist circumference, the

instructions stated “measure halfway between your lowest rib and the top of your hipbone, roughly in line with your belly button”, and hip circumference was defined as “the point where the buttocks protrude the most”. They were requested to “measure directly against the skin”, “breathe out normally” and “make sure the tape is snug and not twisted, without compressing the skin”, before recording to the nearest 0.5 inch or centimetre.

The cohort was then invited to attend a group meeting facilitated by a technician according to residential location. Their height, weight, waist and hip circumferences were measured by 12 trained technicians who followed the same procedure and used the same instruments (calibrated electronic scale, stadiometer and tape) throughout the study. Only a single measure was taken for each anthropometric outcome. Height was measured to the nearest 0.1 cm with the participant standing barefoot and fully upright, using a portable stadiometer. Weight was measured to the nearest 0.01 kg using a portable electronic scale, with the participant wearing light-weight clothing and no shoes. A standard tape was used to measure waist and hip circumferences to the nearest 0.5 cm, with the participant standing upright. These measurements were taken within 2 weeks after their completed baseline questionnaires had been returned and before commencement of the PANS intervention. However, no qualitative data was collected at the group meeting on issues and difficulty concerning the self-report process.

The study was approved by the Curtin University Human Research Ethics Committee (approval number HR 186/2008). Informed consent was obtained from each participant during recruitment.

Statistical analysis

Four participants with missing anthropometric information were subsequently excluded from the analysis, resulting in a final sample size of 103. There were no significant differences between the included and excluded participants in terms of demographic variables. Values recorded in imperial scales were converted to metric values. BMI was calculated as weight (kg) divided by height (m) squared. WHR was calculated as waist circumference divided by hip circumference.

Demographic characteristics were summarised using descriptive statistics. Differences between self-reported and measured variables were examined using paired t-tests. Discrepancies were calculated as self-reported minus measured values, thus giving under-reported values a negative sign and over-reported values a positive sign. Agreement between self-reported and measured values was assessed using the concordance correlation coefficient [23] and the Pearson correlation coefficient. Comparison by gender was also performed. Statistical analyses were undertaken using the SPSS package version 20.

Bland-Altman plots were used to assess whether differences between self-reported and measured data were strongly associated with mean values [24]. For each anthropometric variable, the plot represents the discrepancies between self-reported and measured values against the mean of self-reported and measured values. Limits of agreement were computed as the mean difference ± 1.96 standard deviations, showing the range of discrepancies for 95% of the participants. These plots were generated using the BlandMedCalc version 12.3.0.

RESULTS

The sample comprised 43 male and 60 female participants with mean age 66 (SD 3) years. The majority of them were already retired (64%) and living with a partner (72%). The distribution of their education level was: primary school or lower (6.8%), high school or secondary school (42.7%), TAFE or trade certificate/diploma (29.1%), university or other tertiary education (21.4%).

Table 1 shows the mean discrepancies and correlations between self-reported and measured anthropometric values. Under-reporting occurred for weight (by 1.14 kg) and hip circumference (by 0.56 cm), especially among males, whereas waist circumference was slightly over-reported (by 0.66 cm). Females tended to under-report their height by about 1 cm on average, unlike their male counterparts. These apparently resulted in general under-estimations of BMI (by 0.42 kg/m^2) but over-estimations of WHR (by 0.02).

The correlations between self-reported and measured values ranged between 0.80 and 0.90, indicating moderate to substantial strength of agreement for the anthropometric variables, with the exception of height among males. Self-reported circumference measures appeared to be more accurate than the derived WHR, which exhibited an overall concordance coefficient of only 0.60 and even lower for each gender.

Figure 1 presents the Bland-Altman plots for height, weight and BMI, with 95% limits of agreement added as dashed lines. The plots corresponding to waist circumference, hip circumference and WHR are illustrated in Figure 2. Large systematic differences were evident for weight, BMI and WHR and wide limits of agreement for all anthropometric measures. However, there were no significant differences in demographic characteristics

between individuals who had poor agreement with the measured values and those who were within 2 standard deviations of the mean difference.

DISCUSSION

In this sample of older Australians, self-reported weight was significantly lower than actual measured weight, the overall mean discrepancy being 1.14 kg. The under-reporting of weight was common in the literature, particularly among overweight subgroups [25, 26]. Indeed, the observed under-reporting was comparable with another study in which weight was underestimated by 1.68 kg by men and 1.02 kg by women [20]. Correlations between self-reported and measured values for weight and BMI were found to be extremely high, again consistent with previous research involving older adults, with correlations generally above 0.90 [20, 25-27].

The discrepancies between height measurements were relatively small, with mean difference of 1.62 cm among males, when compared with previous studies involving elderly populations, which suggested over-reporting of male height from 2.1 cm to 4.3 cm [25, 28]. On the other hand, older women tended to underestimate their height. A study of mid-aged Australian women also found that height was underestimated, with social desirability towards being ‘petite’ an attributing factor [21]. The low correlation for male height was due to a few extreme values reported by the older men. It would be useful to collect qualitative data on social desirability and perceived health issues in future studies.

The Bland-Altman plots, however, revealed somewhat poor agreement between methods. The estimated limits of agreement suggest that a large proportion of individuals in this age group may over-report their weight by as much as 3.6 kg or under-report it by as much as 5.9

kg, and that height may vary within 10 cm. Similar variations have been reported for weight [27] and BMI [20].

Waist and hip circumferences did not differ significantly between methods, while correlations between self-reported and measured values were all high. A number of studies have also observed good agreement between self-reported and technician measurements for waist circumference [12, 18, 19, 29] and hip circumference [15, 19, 29]. The over-estimation of WHR in our sample and their weak correlations are consistent with the literature findings [15, 19, 29]. As WHR is derived from waist and hip circumferences, the corresponding errors are compounded in its calculation. Therefore, caution should be taken when applying the derived WHR to quantify central obesity and the health risk. In addition, the Bland-Altman plots indicated that individual differences in waist and hip circumferences could vary as much as 10 cm. Wide limits of agreement were also reported by other studies [12, 18, 30].

In this study, all older adults had been randomly selected from the community so they were representative of the target population. Nevertheless, replications using large population-based samples are recommended to confirm the observed findings. Selection bias could not be avoided because all participants took part voluntarily in the project. It was not feasible to enforce participants to record their anthropometric data at a particular time or date, but the inherent bias and measurement error should be small in view of the relatively short gap (< 2 weeks) between the self-report and actual measurements. Moreover, the same procedure and instruments were adopted by the trained technicians throughout the study to minimise intra- and inter- rater biases, but data on weight history and recent weight loss were not collected.

Self-reported anthropometric measures are commonly used to estimate the prevalence of overweight/obesity, to identify those at risk of developing obesity-related health problems, and in the evaluation of interventions. With rising obesity levels among older Australians, it is imperative to determine the validity of these widely used measures. The present study suggests that while self-reported anthropometric values are well correlated with measured values and average discrepancies are small, individual level differences between methods are often large. The use of self-reported anthropometric data may be suitable in population studies describing the distribution of obesity among the elderly, but they are not recommended to monitor changes at an individual level, particularly for WHR.

Finally, the issue of appropriate body weight is still controversial in the literature and there are no specific central obesity targets for the elderly. With regard to healthy weight for older adults, the Government of South Australia stated, “simply being overweight as an older adult may not mean that we need to lose weight – our general health can be more important. Weight loss is more often advised for those older adults who suffer from related health problems and would benefit from being in the healthy weight range” (www.sahealth.sa.gov.au).

Key points

- The use of self-reported anthropometric data is acceptable in population studies of older Australian adults when describing overall distribution of obesity.
- Self-reported anthropometrics should not be relied upon when monitoring changes at an individual level.
- Caution should be taken when using waist-to-hip ratio derived from self-reported data to measure obesity and assess health risk.

Figure legends

Figure 1: Bland-Altman plots of the discrepancy between self-reported and measured height, weight and BMI versus the mean of self-reported and measured data. Horizontal lines in each plot represent the mean discrepancy (solid line) and 95% limits of agreement (dashed lines).

Figure 2: Bland-Altman plots of the discrepancy between self-reported and measured waist circumference, hip circumference and WHR versus the mean of self-reported and measured data. Horizontal lines in each plot represent the mean discrepancy (solid line) and 95% limits of agreement (dashed lines).

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