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Validation of Anthropometric Measures Self-Reported in a Randomized Controlled Trial of a Web-Based Platform for Weight Loss

A. BELEIGOLI[1], A. ANDRADE[2], M. DINIZ[3], R. ALVARES[3], M. FERREIRA[3], L. SILVA[3], M. RODRIGUES[3], L. JACOMASSI[3], A. CERQUEIRA[3], A. RIBEIRO[3]
[1] *Flinders University, Adelaide, Australia*
[2] *University of South Australia, Adelaide South Australia, Australia*
[3] *Universidade Federal de Minas Gerais, Belo Horizonte Minas Gerais, Brazil*

Abstract. Introduction: A great number of weight loss interventions have been delivered through digital solutions. Analysis of the effectiveness in terms of weight loss is fundamental to understand the real potential of digital technologies as tools for delivery of weight loss interventions. For this, we need accurate and reliable anthropometric data. For reasons of convenience, self-reported weight and height often replace actual measurements in these interventions. This might lead to misclassification of BMI status during selection of participants and to bias in the assessment of the outcomes. Therefore, it is fundamental to have validation studies of self-reported web-based data. **Objectives:** We aimed to validate online self-reported height, weight and BMI in a POEmaS trial subsample. **Methods:** We included 12.5% of the POEmaS´ population (n=159). Anthropometric data reported on the web-platform were compared to measured data by paired T-tests. Agreement was assessed by Bland-Altman plots. Multinomial regression was used to investigate factors associated with self-reported weight validity. **Results:** There was no significant difference between reported and measured weight (0.4 kg, SD 1.7; p=0.13) and BMI (0.03 kg/m^2, SD 0.87; p=0.06). Reported height was on average 0.4 cm (SD 1.2) higher than the measured ones (p<0.001). For all anthropometric data, >=95% of the cases were within the limits of agreement. Higher measured BMI was the only factor associated with low accuracy of weight report. Each unit increase in BMI increased the odds that the reported weight was lower than the one measured (OR 1.13; 95%CI 1.01-1.26). **Discussion:** Self-reported weight and BMI change showed good agreement with measured ones. Since these are the primary outcomes of the POEmaS trial, the findings of the validation study suggest that the outcomes' accuracy is high and that it does not vary across gender, age, study group. These findings are relevant to digital health researchers and assessors and suggest that digital health interventions for weight loss might rely on self-reported assessment of outcomes. This might be particularly useful when other modes of assessment, such as anthropometry and e-scales, are not feasible or not available. However, we acknowledge that these results might not be applicable to low educated populations.

Keywords. Obesity, mobile health, validation

Introduction

The World Health Organization estimates that there are more than 600 million adults with obesity (Body mass index- BMI ≥ 30 kg/m^2) in the world [1]. Obesity has been associated with a serious burden due to high morbidity, mortality and impact in quality of life [2]. To tackle this epidemic, weight loss interventions via web have been increasingly more popular and have the potential benefits of allowing 24hours/7days accessibility and anonymity [3].

A great number of applications and websites are currently available and attract a large number of consumers who, correctly or not, consider themselves overweight and are willing to lose weight. Analysis of the effectiveness in terms of weight loss is fundamental to understand the real potential of digital technologies as solutions for delivery of weight loss interventions. For this, we need accurate and reliable data on anthropometry, which refers to systematic and standardised measures of body mass, such as weight, height, BMI, and body composition, such as waist circumference, hips circumference, waist-to-hips and waist-to-height.

For reasons of convenience, self-reported weight and height often replace actual measurements in these interventions [3]. This might lead to two main sources of bias in the assessment of digital interventions for weight loss: first, it is not possible to guarantee that the selected population for these interventions have obesity in fact, which can lead to misclassification of BMI status during the phase of recruitment. Secondly, discrepancies between measured and self-reported anthropometric data can affect weight loss trials biasing assessment of the outcomes. Therefore, it is fundamental to have validation studies of self-reported web-based data.

The aim of this study factors associated with agreement between self-reported weight data and measured weight in data collected via a web-platform for weight loss adult participants of the POEmaS (acronym of 'Online Platform for Healthy Weight Loss' in Portuguese) randomized controlled trial. Secondarily, we aimed to investigate whether age, gender, education level, BMI and study group were determinants of validity of self-reported online anthropometric data.

1. Methods

1.1. Population of the POEmaS Project

Students (current and past) and staff of the Federal University of Minas Gerais (UFMG), Belo Horizonte, in the southern Brazil, were recruited by physical and online advertising (flyers, University website, UFMG mailing list) for one month from the 25th September to 24th October, 2017. They were invited to access the project website www.poemasufmg.com.br, where they can watch a video with details of the project. Inclusion criteria were age between 18 and 60 years, self-reported BMI >=25 Kg/m2, intention to lose weight by changes in lifestyle habits, internet access. Subjects who reported comorbidities that demanded specific dietary or physical activity recommendations- diabetes, heart failure, coronary artery disease, kidney disease, hepatic disease, cancer, phenylketonuria, celiac disease, food allergies, bariatric surgery history; and were participants of other weight loss programs were excluded.

1,298 participants were randomized by a stratified randomized block design balanced by gender and category of body mass index (25 to < 30 or ≥ 30 kg/m^2) to one

of three groups: Group 1, control group which is submitted to an initial minimal intervention for 24 weeks and subsequently will have access to all the platform functionalities; Group 2 will follow a standard weight loss program delivered by the website platform for 24 weeks; Group 3 followed the standard weight loss program enhanced by personalized feedback by a dietitian based on lifestyle habits reported in the platform for 12 weeks and the standard weight loss program for the following 12 weeks.

The duration of the study was one year (until 24th Sep, 2018) with six months of intervention and six months of follow-up. A detailed protocol of the POEmaS project was reported elsewhere [4].

1.2. Population of the Validation Study

Although we had pre-defined a convenience sample for the validation study of 10% of the trial population [4], we were able to perform anthropometric measurements in 12.5% of the population between the 12th and the 24th week of the trial. This sample was randomly selected from the population. In order to be representative of the study population, the randomization process for the validation study was balanced across study groups. To minimise the effect of intra-individual weight variations over time on the agreement between self-reported and measured data, participants were instructed to report weight and height on the specific questionnaire on the web platform on the day of the face-to-face assessment.

1.3. Procedures

Anthropometric parameters were measured using standardized and calibrated instruments, according to the study protocol. Weight (kg) and height (cm) were measured with the participant barefoot, wearing light clothes, and standing straight with the head level, using Welmy scales (to the nearest 100 g) and a stadiometer (accuracy of 0.1 cm), respectively. BMI was calculated by the conventional formula [weight (kg)/height $(m)^2$].

1.4. Ethics

All participants signed both an informed consent form for the POEmaS trial and for the validation study. The Federal University of Minas Gerais (UFMG) Ethics Research Committee approved this study (CAAE: 73545717.5.0000.5149).

1.5. Statistical Analysis

Frequencies and mean (standard deviation; SD) were used to describe qualitative and continuous variables, respectively. A paired t-test was used to determine the differences between reported and measured weight, height and BMI.

To evaluate agreement between paired anthropometry the differences between reported and measured data were plotted against their mean value, according to the Bland–Altman method. Paired data is considered to have good agreement when 95% of the number of cases stay within the limits of the confidence interval.

To investigate the association of age, gender, education, BMI, and study group with the validity of self-reported weight, we performed ordinal logistic regression. The dependent variable was based on the following categories: -0.5 to 0.5kg difference (reference), <-0.5kg and >0.5kg difference. We used the SPSS software for statistical analysis (SPSS, IL).

2. Results

A total of 159 individuals predominantly females (129; 80.1%) and with graduation/post-graduation (120; 75%) participated in the validation study. Mean age was 36.5 years (11.1). Comparison between the POEmaS trial and the validation study populations are shown in Table 1.

Differences between weight and BMI were not statistically significant. However, reported height was 0.004 metres (SD 0.012) higher than measured height ($p<0.001$).

The Bland-Altman plots showed good agreement between reported and measured data for weight, height and BMI with less than 5% being out of the limits of the confidence interval (Figures 1 to 3).

BMI was the only characteristic associated with the accuracy of web-report. Each unit increase in BMI increased 13% the odds that the reported weight was lower than the one measured (OR 1.13; 95%CI 1.01-1.26).

3. Discussion

In this validation study with a sample of participants of a randomized controlled trial for weight loss enabled by an online platform, we found good agreement between measured and self-reported weight and height through the platform for weight loss. This led to a good agreement of calculated BMI.

In a web intervention, Harvey-Berino et al. [5] found significant underreporting of weight particularly in females, younger participants and those with higher BMI levels. Conversely, web-based surveys for epidemiological purposes with some showing high agreement between self-reported and measured anthropometric data [6].

These diverse results might be related to gender, age, literacy and body mass index (BMI) differences across studies. Overall, women tend to underestimate weight more than men, whereas men tend to overestimate height more than women. Overweight and obesity are associated with higher BMI underestimation when compared to normal weight [5]. In our study, however, age, gender, education, BMI, and study group did not affect the accuracy of self-reported anthropometry.

In conclusion, self-reported weight and BMI change showed good agreement with measured ones. Since these are the primary outcomes of the POEmaS trial, the findings of the validation study suggest that the accuracy of self-reported is comparable to measured anthropometry in studies that deliver weight loss interventions enabled by technologies. These findings are useful to inform assessors of Digital Health interventions on the validity of the outcomes reported through web platforms. Also, it is useful to inform researchers in Digital health interventions when other modes of anthropometry assessments, such as face-to-face or via e-scales, are not feasible or not available. However, it is important to highlight that our population was highly educated and that these results might not be applicable to less educated populations.

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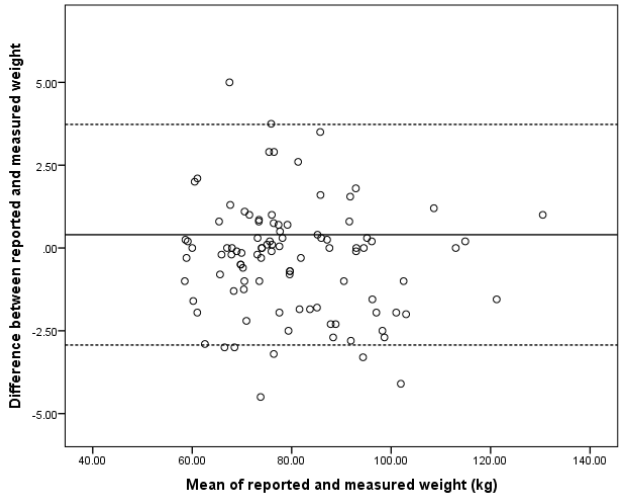

Figure 1. Bland-Altman plot for agreement between self-reported in measured weight (in kg).

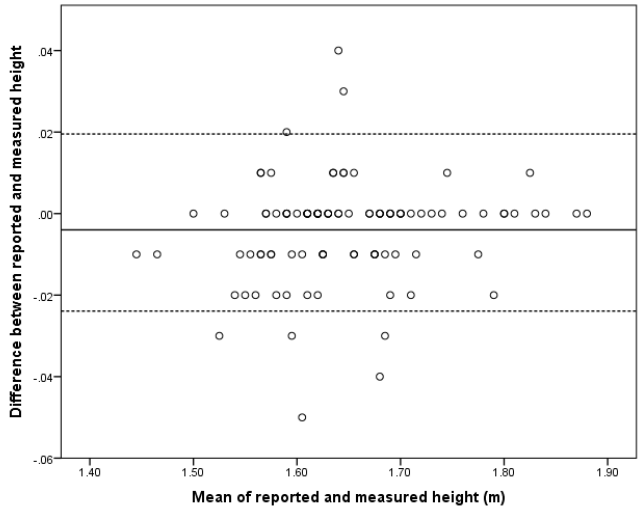

Figure 2. Bland-Altman plot for agreement between self-reported in measured height (in metres).

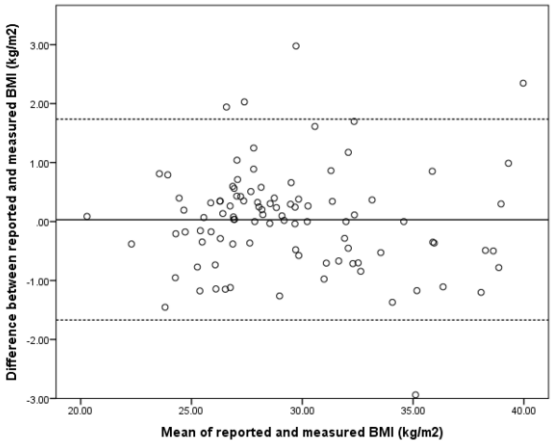

Figure 3. Bland-Altman plot for agreement between self-reported in measured body mass index (in kg/m2).

Table 1. Characteristics of the POEmaS trial population (at baseline) and the validation study population

Characteristic	POEmaS trial (n=1298)	Validation study (n=159)
Gender		
Female	996 (76.6)	128 (80.5)
Male	302 (23.4)	31 (19.5)
Age, years	33.6 (10.7)	36.5 (11.0)
BMI, kg/m2	29.9 (4.3)	29.4 (4.1)
Education*		
Undergraduate	99 (18.2)	39 (24.5)
Graduated/post graduated	445 (81.8)	120 (75.2)
Group		
Minimal intervention	470 (36.2)	59 (37.0)
Platform	420 (32.4)	42 (26.4)
Platform plus online dietitian	408 (31.4)	58 (36.6)

Table 2. Differences between reported and measured weight, height and body mass index (BMI)

	Weight (kg)			Height (m)			BMI (kg/m2)		
	Reported	Measured	Difference*	Reported	Measured	Difference**	Reported	Measured	Difference***
Mean (SD)	82.4 (15.7)	79.9 (14.2)	0.4 (1.7)	1.65 (0.08)	1.65 (0.08)	0.004 (0.01)	29.3 (4.1)	29.4 (4.1)	0.03 (0.87)

*p=0.13; **p<0.001; p=0.06

(1)

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