Truth Be Told: Evidence of Wheelchair Users' Accuracy in Reporting Their Height and Weight

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Abstract

Objectives—To examine whether wheelchair users' self-reports of height and weight differed significantly from direct measurements and whether weight category classifications differed substantially when based on self-reported or measured values.

Design—Single group, cross-sectional analysis. Analyses included paired *t* tests, chi-square test, analysis of variance, and Bland-Altman agreement analyses.

Setting—A university-based exercise lab.

Participants—Community-dwelling wheelchair users (N=125).

Interventions—Not applicable.

Main Outcome Measure—Participants' self-reported and measured height, weight, and body mass index.

Results—Paired *t* tests revealed that there were significant differences between wheelchair users' self-reported and measured values for height (difference of 3.1±7.6cm [1.2±3.0in]), weight (−1.7±6.5kg [−3.6±14.2lb]), and BMI (−1.6±3.3). These discrepancies also led to substantial misclassification into weight categories, with reliance on self-reported BMI underestimating the weight status of 20% of the sample.

Conclusions—Our findings suggest that similar to the general population, wheelchair users are prone to errors when reporting their height and weight and that these errors may exceed those noted in the general population.

Keywords

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The obesity epidemic in the United States and other industrialized nations[1,2] requires urgent action because of the increased risk for disease and early death. In the United States, several national surveys (Behavioral Risk Factor Surveillance System, National Health Interview Survey, and the National Health and Nutrition Examination Survey) track obesity prevalence using respondents' height and weight to calculate their body mass index (BMI) (weight in kg divided by height in m^2), which is then associated with a weight category (healthy, overweight, and obese following the National Heart, Lung, and Blood Institute designated cut points).[4] Use of BMI allows efficient and less expensive population-level data collection, because it typically relies on self-reported height and weight.[4,5]

Yet, people tend to overestimate their height and underestimate their weight,[5–7] which contributes to errors in calculating BMI when based on self-report,[7–9] and results in lower estimates of overweight and obesity prevalence. While the average reporting errors for height and weight across studies are typically small (height overestimates range, 0.6 –7.5cm; weight underestimates range, 0.6 –3.5kg), individuals with BMIs greater than 30 report greater discrepancies in weight (underestimated by 3– 6kg).[8,10] Further, discrepancies between measured and self-report values differ based on racial and demographic factors, such as age, BMI values, sex, and ethnicity/race.[11–13] Errors in reporting height and weight are not unique to U.S. residents, because reporting errors have also been documented among Dutch overweight working persons[14] and Canadian adults and adolescents.[15]

National data suggest that people with disabilities have significantly higher obesity rates than those observed in the general population,[16–18] and obesity rates are highest among those with lower extremity mobility impairment.[16] Notably, current prevalence estimates for people with disabilities derive exclusively from self-reported height and weight. Given consistent evidence of people's tendency to inaccurately report their height and weight, people with disabilities are likely to also be inaccurate reporters. However, to our knowledge, there have been no studies examining agreement between measured and self-reported height and weight for people with disabilities, including those with mobility impairments (eg, wheelchair users). Among factors associated with reporting accuracy in the general population, those who weigh themselves less often are less accurate at reporting weight.[14] This issue is particularly relevant for wheelchair users. Primary care practices have limited availability of wheelchair accessible scales[19] and such scales also are cost prohibitive for home use.

Evidence also suggests that wheelchair users overestimate their height,[20,21] likely because of the fact that many wheelchair users are unable to stand for measurement with a stadiometer. Given the strong association between obesity and health problems, it is important to identify whether wheelchair users similarly err in reporting their height and weight, and whether their discrepancies are larger than those observed among other groups. If people with disabilities in general, and wheelchair users in particular, are as prone to similar or greater reporting errors in height and weight as the general population,[9] obesity prevalence may be greater among people with disabilities than previously estimated.

Therefore, the purpose of this article is to compare self-reported height and weight with measured height and weight of wheelchair users to determine if there are discrepancies between the measurement methods and to determine whether BMI differs based on self-reported versus measured values.

METHODS

Data for this study were collected as part of a large randomized controlled trial designed to examine the effectiveness of a multicomponent behavioral program to promote exercise

adoption and maintenance by wheelchair users. The methods of participant recruitment for the larger trial were previously published,[22] but generally included disseminating study brochures through medical provider offices and through media venues such as direct mailing, radio, and newspapers. Interested participants called the study staff to learn about the study details and to be screened for eligibility, which included receipt of signed approval by the individuals' primary physician. Eligibility criteria included: mobility impairment for 6 months that necessitates manual or powered wheelchair use for mobility outside of the home; aged between 18 and 65 years; not currently physically active (report <150min of exercise a week); sufficient upper arm mobility for aerobic exercise; and physician consent to exercise.

Exclusion criteria included: BMI of 50; medical conditions such as chronic obstructive pulmonary disease, liver or kidney disease, or cardiac problems that their physician identifies as a contraindication for participating in unsupervised exercise; and pregnancy, or planning to become pregnant.

Assessments

Participants' height and weight were measured at the exercise lab of the General Clinical Research Center of the University of Kansas Medical Center. Participants were instructed to wear light, comfortable clothing. Participant weight was measured using a seca wheelchair accessible scale (seca #664).[a] After the initial weight was obtained, participants transferred from their wheelchair onto a mat table and their wheelchair was weighed. Participants' body weight was derived by subtracting the wheelchair weight from the combined weight of the body and wheelchair.

Based on a previous study of the most accurate method to measure height among wheelchair users,[20] we used participants' measured recumbent height to calculate BMI. Height was measured with the participant lying supine on a mat table using a custom-made anthropometer. The anthropometer components included 2 adjustable T squares,[23] 4 wooden blocks, and 2 metal plates. Wooden blocks secured the two 121.92cm (48-in) rulers with screws, permitting the ruler to slide open for measuring lengths between 121.92 and 215.9cm (48 – 85in), with a metal plate affixed to the inside edge at each end (fig 1). One metal plate of the anthropometer was placed against the top of the participant's head and the ruler ran along the right side of the participant's body. Participants were instructed to use their right hand to hold the metal plate against the top of their head to assure the plate remained in contact with the top of their head. With the right leg aligned with the hip, the edge of the tool was placed on the distal end of the calcaneous of the participant's right foot. For those with spasticity, contractures, or inability to lay flat or dorsiflex their ankle to 90°, staff manually assisted in extending the leg as far as possible or dorsiflexing the ankle. Height was recorded to the nearest 1/16 of an inch (reported in cm).

Analyses

Means and frequencies were calculated for demographic data, BMI, and weight categories. Chi-square analyses assessed whether there were significant differences across weight category distributions for BMI based on self-reported and measured values. Paired *t* tests examined whether there were significant differences between participants' self-reported and measured values for height, weight, and BMI. Analyses of variance (ANOVAs) assessed whether there were significant differences by weight category (under/healthy, overweight, or obese) in reporting errors for height and weight. Bland and Altman[24] agreement analyses were included to visually inspect the extent of agreement between self-reported and

measured height and weight. All results in the tables are presented in metric units, but to facilitate interpretation we included U.S. standard units in the text.

RESULTS

Participants' demographic characteristics are presented in table 1. The sample included nearly equal numbers of middle-aged, predominantly white men and women, who on average, had lived 22 years with their mobility impairment. The primary causes of disability were spinal cord/traumatic brain injury and spina bifida/cerebral palsy (~74% of the sample). Participants reported having their weight last measured over 1.5 years before, during a hospital (47.4%) or physician clinic visit (35.3%); only 6% reported being weighed at home. Chi-square analyses revealed significant differences in weight categories between measured and self-reported values ($\chi^2_{4,125}$=100.97, P=.000). Direct weight assessments indicated that 26% of the sample was overweight and 47% were obese, while self-reported measures indicated that 24% were overweight and 40% were obese. These data may underestimate the proportion of extreme (or morbid) obesity because of the exclusion criterion (BMI 50) for the parent study, as 14 individuals (of 323 screened) were excluded for this reason.

Measured values were compared with self-reported values for height and weight for the overall sample and by sex (table 2). Wheelchair users significantly overestimated their height and underestimated their weight, resulting in significantly lower BMIs when compared with measured values. Reporting errors varied by sex. Men significantly overestimated their height by 3.6±7.1cm (1.4±2.8in) (P=.000), but the difference between self-reported and measured weight in men (.54±7.4kg [−1.2±16.4lb]) was not statistically significant (P=.566). Women significantly overestimated their height by 2.6±8.1cm (1.0±3.1in) (P=.013) and significantly underestimated their weight 2.7±5.1kg (6.1±11.2lb) (P=.000).

The ANOVA results revealed that reporting errors for height did not differ by weight category for either men or women (table 3). In contrast, we observed significant differences between self-reported and measured weight across weight categories for both men (P=.020) and women (P=.025). Obese men and overweight and obese women underestimated their weight by averages of 2.9±6.0kg, 4.2±4.3kg, 3.5±6.1kg (6.1±13.3lb, 9.3±9.5lb, and 7.8±13.4lb), respectively, while healthy weight men overestimated their weight (3.2±9.1kg [7.0±20.1lb]) and healthy weight women and overweight men offered more accurate estimates (0.1±2.2kg [.23±4.8lb] and 0.2±6.2kg [−.47±13.6lb], respectively).

Bland-Altman agreement analyses (figs 2–5) revealed that a large proportion of participants overestimated their height (men=76.2%, women=64.5%) and underestimated their weight (men=61.9%, women=66.1%). Notably, the limits of agreement for height were wide for both men (−10.6 to 17.8cm [−4.1 to 6.9in]) and women (−13.5 to 18.7cm [−5.3 to 7.3in]), as were the limits of agreement for weight for both men (−15.4 to 14.3kg [−33.9 to 31.5lb]) and women (−13.0 to 7.4kg [−28.6 to 16.3lb]). Further, a sizeable portion of the sample (12.8%) made self-report errors for height that exceeded ±5%, with 11.2% overestimating their height an average of 17.6±10.8cm (6.9±4.2in). Self-report errors for weight exceeded ±5% for more than half the men (53.1%) and over one third (39.1%) of the women. Nearly one third of men and women (30.1% and 33.9%, respectively) underestimated their weight by at least 5%, with average weight underestimates of 7.7±3.3kg (16.9±7.3lb) for men and 8.5±3.8kg (18.7±8.4lb) for women.

DISCUSSION

National and international estimates of the prevalence of overweight and obesity are frequently based on BMI calculated from self-reported height and weight; however, evidence suggests the general population tends to inaccurately self-report their height and weight.[6,7,9,12] Prior to this study, the accuracy of wheelchairs users' self-reports of height and weight had not been evaluated, which may compromise estimates of overweight and obesity prevalence in this group. Our results suggest similar trends of reporting errors as observed in the general population.[7,8,12] Wheelchair users overestimate their height and underestimate their weight, resulting in significant differences between self-reported and measured BMI. We also observed a high level of individual variability in reporting errors for both height and weight, also found in the general population. For example, approximately one third of our sample underestimated their weight by an average of ~8kg (17.6lb), while 11% of the sample overestimated their height by as much as ~18cm (7.0in).

This sample of wheelchair users also made larger errors reporting their height, weight, and BMI than a nationally representative sample of over 15,000 people[12] who overestimated their height by less than 1cm (.39in) (vs 3.1cm [1.2in] for our full sample) and underestimated their weight by less than .75kg (1.65lb) (vs 1.7kg [3.7in] for our full sample). This reflects a BMI underestimation of .59 units for the general population versus 1.7 units for our sample. Although the magnitude of the discrepancy was greater for our wheelchair users, the trends observed were similar in both samples as reporting errors for weight were associated with BMI and sex. Similar to the national sample, men in our sample made larger height overestimates, while women made larger weight underestimates. The pattern of errors observed in our sample and the general population was also similar across weight categories. Among this sample of wheelchair users, weight was overestimated in nomal weight men (3.2kg [7.0lb]) and underestimated in obese men (2.9kg [6.3lb]), whereas in women, those with healthy weight reported their weight accurately, and overweight or obese women underreported weight by 4.2 and 3.5kg, respectively (9.3 and 7.8lb, respectively).

In terms of practical implications, 20% of our sample (n=25) would be categorized in a heavier weight category based on BMI derived from measured versus self-reported height and weight, while 5.6% (n=7) would be downgraded a weight category. This misclassification is notable given that current obesity estimates for people with disabilities derive exclusively from self-report. Consistent evidence shows that Americans with disabilities have significantly higher obesity rates than Americans without disabilities,[16–18] and recent estimates indicate that 32% of Americans with a disability are obese and 66% are overweight or obese.[18] Our study findings suggest that these current estimates may be lower than would be found if BMI was derived from a measured height and weight.

Furthermore, it is important to recognize that while BMI is extensively used for surveillance purposes to estimate obesity prevalence, it has been criticized as being an inaccurate predictor of body fat for some groups, including individuals with spinal cord injury (SCI).[25–28] Evidence reveals that individuals with SCI have significantly higher body fat than matched samples (matched on age, weight, and height) without impairment,[25,28] which has led to calls for lowering the BMI cut points for those with SCI.[26,27] Therefore, future research should investigate whether other mobility impaired groups who use wheelchairs also have significantly higher body fat than age, sex, and BMI matched individuals.

Study Limitations

The generalizability of these results may be limited because of the following issues: (1) the data were obtained from a relatively small sample of wheelchair users who had volunteered

to participate in an exercise intervention trial, (2) the study area was limited to the Midwest and therefore may not represent obesity rates in other regions, and (3) because of our exclusion criteria, those with BMIs 50 were ineligible to participate and thus results cannot be extended to those at the higher end of the BMI range.

CONCLUSIONS

It is important to track obesity prevalence among people with disabilities, as consistent evidence indicates this group has significantly higher obesity rates than the general population and that people with disabilities experience higher rates of obesity-related comorbid conditions such as hypertension, diabetes, and cardiovascular disease.[18,29,30] Notably, published national estimates of obesity prevalence in individuals with disabilities derive exclusively from self-reports, yet findings from this study argue for the need to obtain direct height and weight measures to more accurately track obesity prevalence among this group. The results suggest that wheelchair users are less accurate reporters of their weight and height than the general population, resulting in substantial misclassification of weight categories. These data, combined with evidence suggesting that the current BMI cut points for identifying overweight and obesity among those with SCI should be lowered, because these reference values do not adequately reflect body fat, and potentially compound the inaccurate assessment of disease risk for this group. Therefore, we recommend further study of this issue, because the impact of obesity may be even greater for the 54 million Americans who experience disability than it is in the general population in terms of negative consequences on health, function, and ability to maintain independence.

Acknowledgments

List of Abbreviations

ANOVA	analysis of variance
BMI	body mass index
SCI	spinal cord injury

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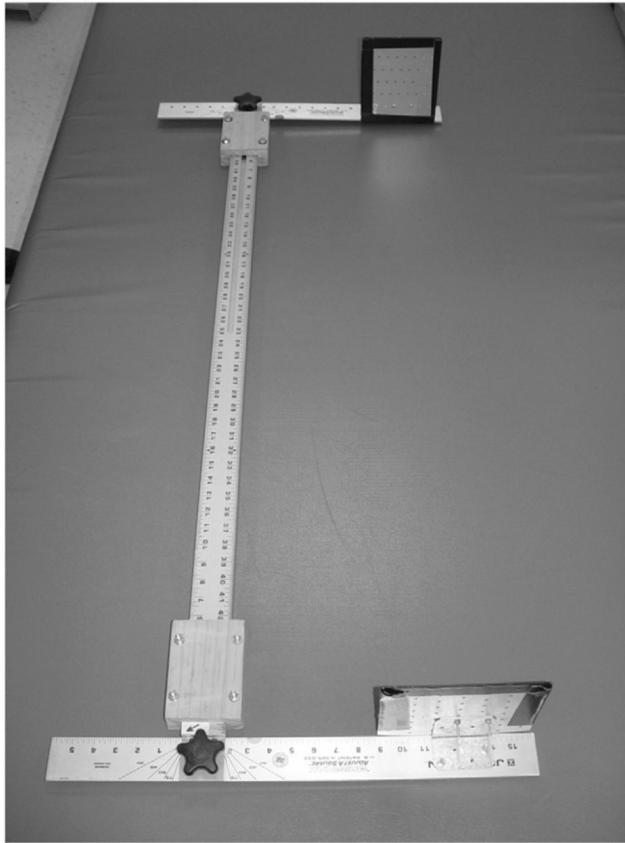
Fig. 1.
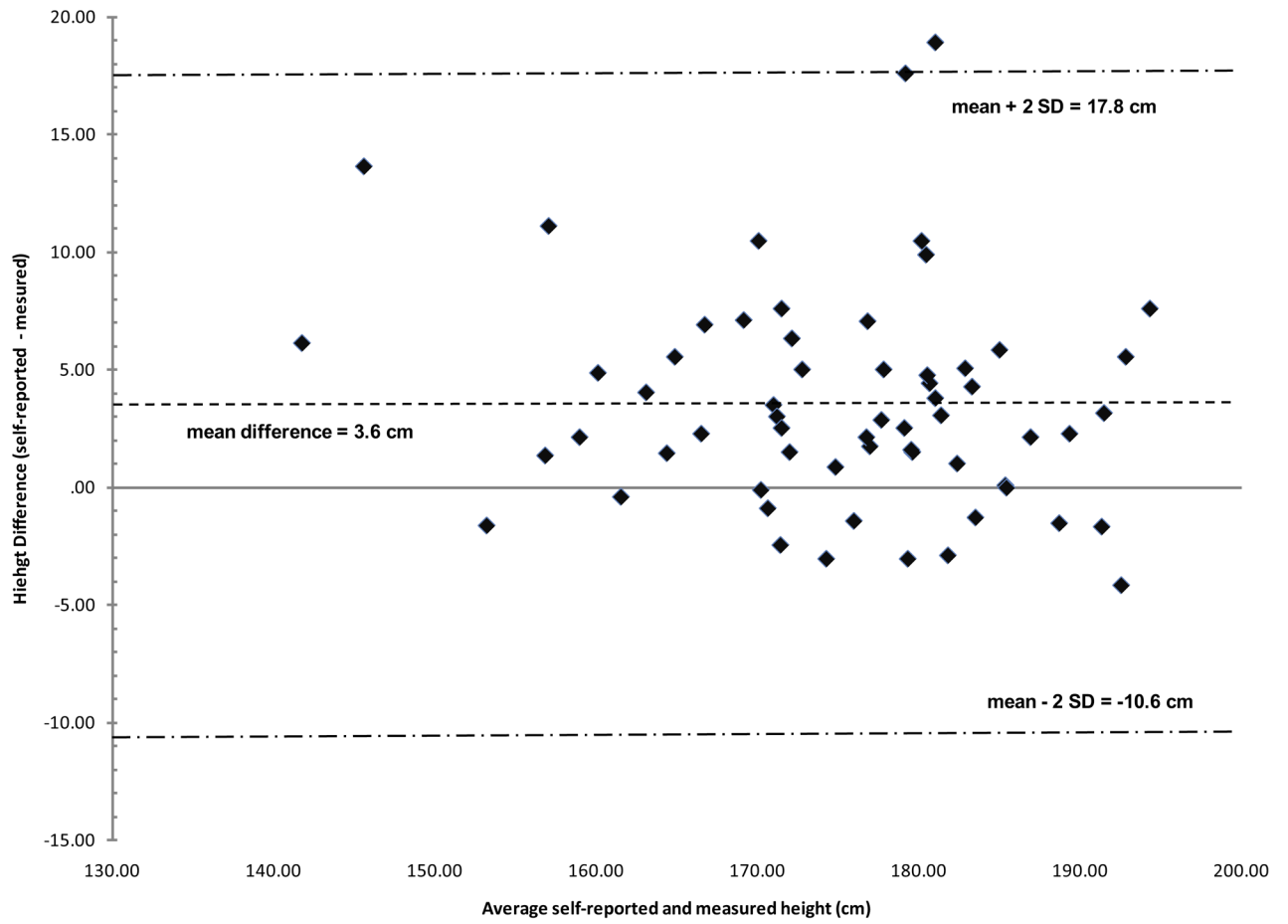Anthropometer built to measure recumbent height.

Fig. 2.
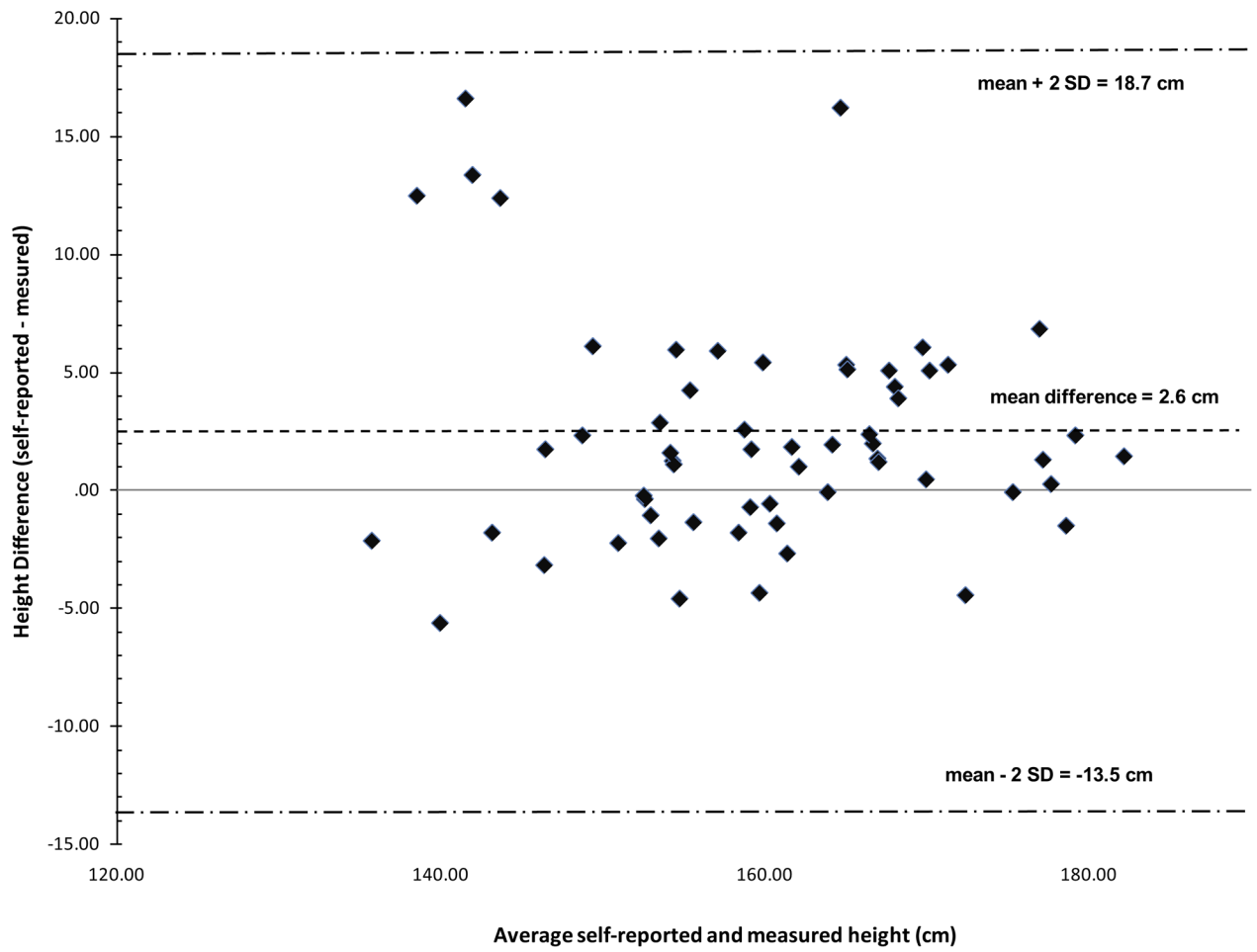Self-reported versus measured height in wheelchair users who are men (n=63).

Fig. 3.
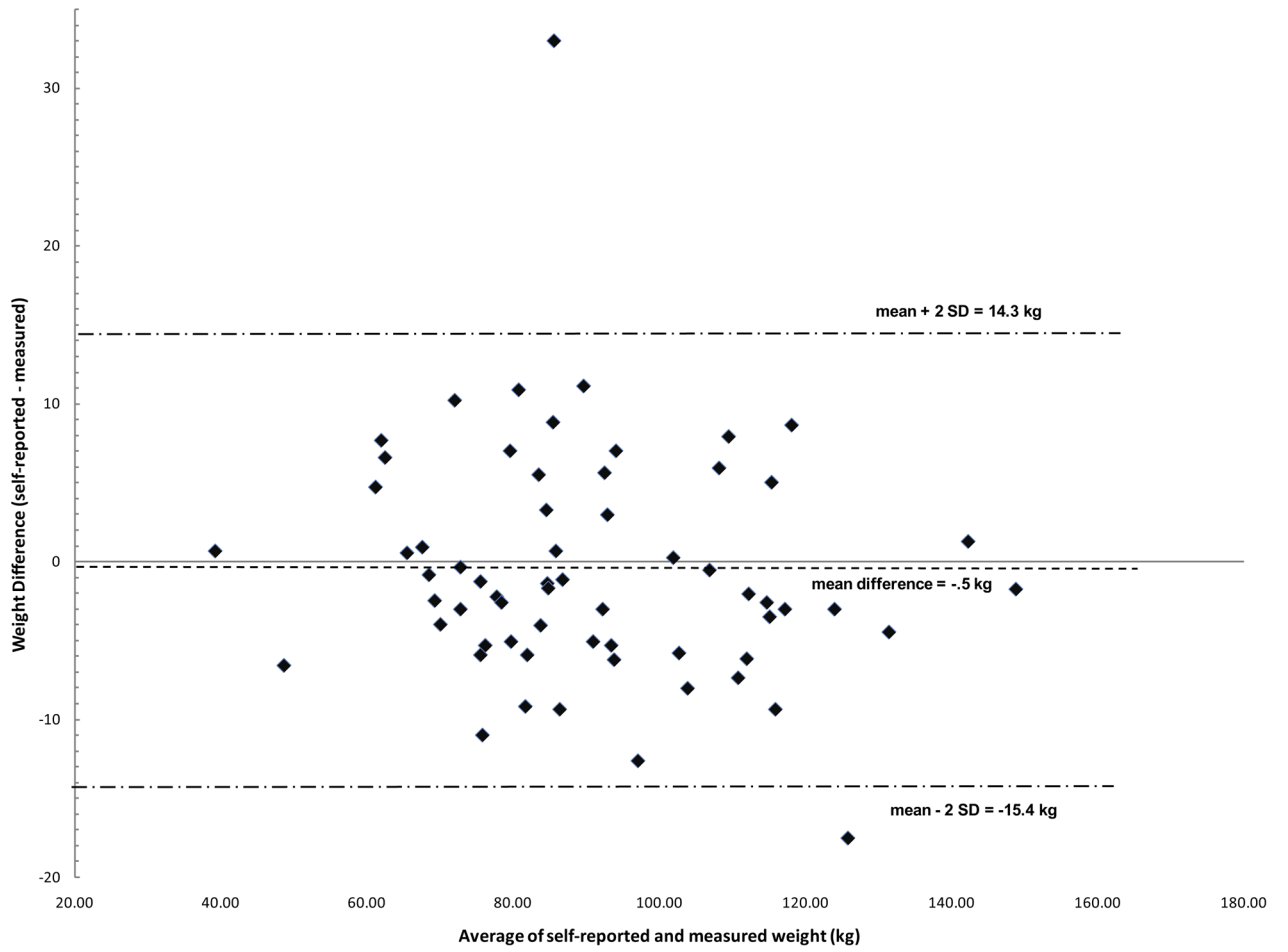Self-reported versus measured height in wheelchair users who are women (n=62).

Fig. 4.
Self-reported versus measured weight in wheelchair users who are men (n=63).
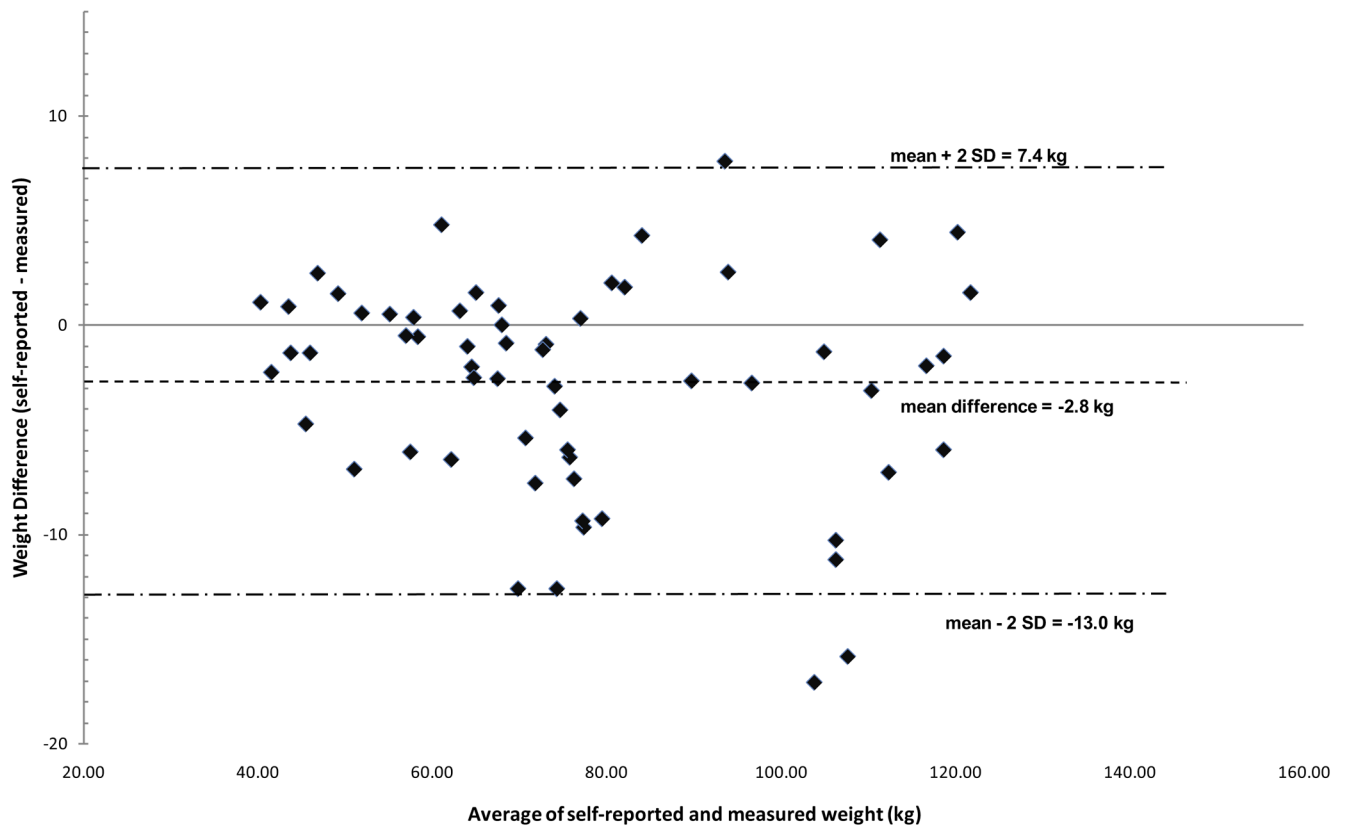
Fig. 5.
Self-reported versus measured weight in wheelchair users who are women (n=62).

Table 1

Demographic and Weight Data for Wheelchair Users (N=125)

Demographic Variables	Mean ± SD
Age (y)	43.6±12.9
Years live with disability	22.0±16.0
Time since last weighed (mo) (range, 0–264)	19.6±41.4

	n	%
Female sex	62	49.6
White	97	77.6
Black	17	13.6
Multiracial/other	11	8.8
Primary disabling condition		
Joint and connective tissue disease	5	4.0
Multiple sclerosis	10	8.0
SCI/traumatic brain injury	66	52.8
Spina bifida/cerebral palsy	26	20.8
Amputation	5	4.0
Other	13	10.4
BMI (kg/m^2)	30.7	75

	Measured		Self-reported		χ^{2*}
Weight Categories	n	%	n	%	
Under/healthy weight (BMI<18.5–24.9)	34	27.2	45	36.0	.000
Overweight (BMI 25–29.9)	32	25.6	30	24.0	
Obese (BMI 30)	59	47.2	50	40.0	
Mild obesity (BMI 30–34.9)	22	17.6	21	16.8	
Moderate obesity (BMI 35–39.9)	22	17.6	14	11.2	
Extreme obesity (BMI 40)	15	12.0	15	12.0	

*
Chi-square analyses were conducted with the 3 major weight categories (healthy, overweight, obese).

Table 2

Reporting Error for Height, Weight, and BMI in Individuals With Mobility Impairments Between Self-Reported and Measured Heights, Weights, and BMI

Measures	Total (N = 125)		Men (n = 63)		Women (n = 62)	
	Mean ± SD	P	Mean ± SD	P	Mean ± SD	P
Height (cm)						
Self-reported	168.6±14.1		176.6±11.2		160.5±12.1	
Measured	165.5±14.3		173.0±12.2		157.9±12.1	
Error	3.1±7.6	.000	3.6±7.1	.000	2.6±8.1	.013
Weight (kg)						
Self-reported	82.8±23.2		90.4±21.5		75.0±22.4	
Measured	84.4±23.7		91.0±22.5		77.8±23.2	
Error	−1.7±6.5	.033	−.54±7.4	.566	−2.7±5.1	.000
BMI (kg/m²)						
Self-reported	29.1±7.7		28.9±6.6		29.3±8.8	
Measured	30.7±7.5		30.5±7.2		31.0±7.8	
Error (kg/m²)	−1.6±3.3	.000	−1.5±3.0	.000	−1.7±3.7	.000

NOTE. Error refers to reporting error of self-reported-measures. Positive values represent overestimates, negative values underestimates.

Table 3

Reporting Error in Height and Weight by Sex and Weight Category in Individuals With Mobility Impairment

Variables	Male				Female			
	Healthy (n = 18)	Overweight (n = 14)	Obese (n = 31)		Healthy (n = 16)	Overweight (n = 18)	Obese (n = 28)	
	Mean ± SD	Mean ± SD	Mean ± SD	P	Mean ± SD	Mean ± SD	Mean ± SD	P
Height (cm)								
Self-reported	177.0±12.5	178.0±8.3	175.8±11.8		160.0±11.1	163.8±9.6	158.7±13.9	
Measured	175.2±12.8	173.3±7.1	171.6±13.8		157.3±11.1	157.9±13.4	158.3±12.3	
Error	1.8±7.9	4.7±5.0	4.2±7.3	.433	2.8±4.3	5.9±11.4	0.41±6.5	.077
Weight (kg)								
Self-reported	72.5±14.9	82.3±9.7	106.3±20.9		54.3±9.8	65.8±10.8	96.1±22.9	
Measured	69.3±12.3	82.5±7.6	109.6±21.9		54.2±9.8	70.0±11.2	99.5±22.4	
Error	3.2±9.1	−0.2±6.2	−2.9±6.0	.020	0.1±2.2	−4.2±4.3	−3.5±6.1	.025

NOTE. Error refers to reporting error of self-reported-measures. Positive values represent overestimates, negative values underestimates.