Regional differences in self-reported body dimensions

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Self-reported values of height and weight are used increasingly despite warnings that these data might be biased. The present study investigates whether differences between self-reported and measured values are the same for populations from different regions, and the influences of gender and age.
Differences between self-reported and measured weights and heights are compared for representative samples of the adult population of Italy, the Netherlands and North America.
In general, weight is under-reported (1.1 ± 2.6 kg for females and 0.4 ± 3.1 kg for males) and height over-reported (1.1 ± 2.2 cm for females and 1.7 ± 2.1 cm for males), in accordance with the literature.
Italy shows most over-reporting of height (2.6 ± 1.9 cm) and least under-reporting in weight (0.4 ± 2.4 kg). The Dutch show least over-reporting of height (1.0 ± 2.2 cm) and most under-reporting of weight (1.1 ± 3.2 kg). North America is in between with 1.2 ± 2.1 cm and 0.7 ± 2.9 kg. Furthermore, there are substantial differences between age groups (18-30, 31-45 or 46-65 years). Height is over-reported more by younger and (even more markedly) by older people, while older persons in Italy and the Netherlands under-report their weights more than the other age groups. Detailed inspection of the data also reveals differences between small and tall and between light and heavy weighted persons. Height is over-estimated most by small men and women and weight is under-reported most by heavy people ("light weights" even over-report their weights).
Apart from a general overestimation of height and underestimation of weight, substantial differences are observed between countries, between females and males, and between age groups. The supplied tables enable correction, based on country, gender, and age group, of self-reported values.

INTRODUCTION

Self-reported data on weight and height are much easier, simpler and inexpensive to obtain than measured values. Therefore in many cases self-reported data are used, but their validity may be questioned. Recent reviews (*e.g.* Engstrom *et al*., 2003, Connor Gorber *et al*., 2007) report a general trend to overestimate one's height and also to underestimate one's weight, especially by overweight or obese persons. These observations are confirmed for adolescents (Jansen *et al*., 2006). The self-reported data can substitute for measured data for most purposes, especially if only means are used, since the correlations between self-reported and measured heights and weights are high (Bostrom, G. 1997, Niedhammer, I. et al, 2000, Gunnel D., et. al., 2000, Spencer, E.A., 2002). However, for other applications such as health surveys (*e.g.* prevalence of obesity), clothing sizes, or input for ergonomic design, it is important to know how trustworthy the reported values are.

Many articles describe overall effects: over-reporting of height and under-reporting of weight. More specifically, a tendency towards the mean or 'flat slope syndrome' (Kuskowska-Wolk *et al*., 1989, 1992), meaning overestimation of lower values and underestimation of higher values, is also reported frequently (see for instance Rowland, 1990, Boström *et al*., 1997, Niedhammer *et al*., 2000, Spencer *et al*., 2002). Factors that are related to the accuracy of the self-reported data are gender, age (Rowland, 1990, Spencer *et al*., 2002) and weight status (underweighted – obese) (*e.g.* Boström *et al*., 1997, Gunnell *et al*., 2000).

The present study investigates whether also regional differences exist with respect to the errors in reporting weight and height. Our specific aim is to explore the effect of regional information in relation with gender, age and height or weight or obesity status on systematic errors in reporting weight and height. The data used have been assembled by identical procedures in three regions (Italy, the Netherlands, and North America), which we further refer to as 'countries'.

METHOD

Subjects

The data set contains data from the CAESAR project, an international co-operation to obtain anthropometric data from the populations of Europe and North America (Blackwell *et al.*, 2002). It consists of representative samples of the population of Italy, the Netherlands, and North America. All participants were measured in 1999 or 2000 when they came to one of the measurement sites. Procedures were the same at each of the sites. Data were collected in three ways. Participants first filled out a demographic questionnaire. In the questionnaire participants filled in gender, age, stature and weight. Thereafter they dressed in a special scanning garment over their underwear. The scanning garment for males was a short that covers from the waist to mid-thigh. Female's scanning garments consisted of a short supplemented with a sport bra top. Participants were then measured manually by trained specialists. Weight was determined using a calibrated weighing scale. Stature was determined while participants were standing with their feet approximately 10 cm apart at the heels.

4459 Participants were measured in the CAESAR project: 801 in Italy, 1266 in the Netherlands and 2391 in North America. Eight subjects were removed from the data because they were either below 18 or above 65 years old, 20 participants had missing data on age, height and/or weight, 5 persons were excluded from the data set because they were extreme outliers with respect to stature or weight and 23 participants were removed because they had extreme differences between reported and measured height (more than 20 cm) or weight (more than 25 kg). After excluding the outliers, total available data were

4403 participants, including 2327 females and 2076 males. Table 1 gives an overview, including the age distribution.

Table 1: Age characteristics of the data set

Females		Italy	Netherlands	North America	Total
N	Age 18 – 30	262	229	340	831
	Age 31 – 45	67	241	478	786
	Age 46 – 65	55	225	430	710
	Total	384	695	1248	2327
Age	Average	29.67	38.58	39.78	37.75
	S.D.	11.96	12.79	12.08	12.80
Males		Italy	Netherlands	North America	Total
N	Age 18 – 30	259	191	304	754
	Age 31 – 45	101	174	452	727
	Age 46 – 65	48	197	350	595
	Total	408	562	1106	2076
Age	Average	29.93	38.52	39.29	37.24
	S.D.	11.38	13.41	11.93	12.77

Variables and analysis

Gender, age, region (country), and self-reported height and weight from the questionnaire, and the manually measured stature and weight were included in further analysis. If necessary, reported values were converted to metric values. Difference scores were produced for height and weight. Differences between measured and self-reported values are always presented as [reported – measured], thus giving over-reported values a positive and under-reported values a negative sign. Because of the possible effect of age, the data were divided in three age groups: 18 – 30, 31 – 45 and 46 – 65 years. Weight and height deciles (10% parts of the ordered distributions of measured values) were also assigned to each of the participants for further analysis.

To investigate whether the regional differences exist with respect to the errors in reporting weight and height, in relation with gender, age and height or weight deciles, data analyses were done as follows: First, paired samples t-tests were performed to confirm the general trend of over or underestimate of reported values on each cell categorized by gender, age group and country. Second, separate ANOVA's were carried out with difference scores on weight or height as dependent variables with country, gender, age, height, and weight deciles as factors. This step examined the main effects of all six factors with interaction effects between country and all the other effects on difference scores. Because there were six main effects, the number of interaction terms in the full model became too high for practical application. Therefore, the model was reduced with all six main effects with two-way interaction terms associated with the country factor. When there were significant results that needed further analysis (post-hoc), Tukey HSD tests were done.

All statistical analyses were carried out with STATISTICA (StatSoft, 2007). Since the ANOVA's performed in this investigation were of unbalanced design, and had six factors with reduced interaction terms, the General Linear Model (GLM) procedure was used. Statistical significance was accepted for $p < 0.05$.

RESULTS

Differences between reported and measured weight

Table 2 gives the descriptive statistics of measured and reported values for weight and for the differences between reported and measured values, separately for the three countries. Weight was underestimated significantly in almost all cases. Paired samples t-tests on each cell categorized by gender, age, and country showed that reported weight was statistically smaller than measured weight in every case except for young and medium aged males from Italy and young males from the Netherlands. In other words, only younger males in the Netherlands and especially in Italy reported their weights more or less correctly.

Table 2: Descriptive statistics for weight (in kg) (* indicates a significant difference)

FEMALES									
	Italy			Netherlands			North America		
Age	measured	reported	difference	measured	reported	difference	measured	reported	difference
18- 30	55.6 ± 7.4	54.8 ± 6.7	-0.74* ± 2.23	68.1 ± 14.3	67.1 ± 13.6	-1.05* ± 2.72	64.4 ± 14.0	63.6 ± 13.3	-0.87* ± 2.32
31- 45	59.7 ± 10.8	58.7 ± 10.3	-0.98* ± 2.22	73.0 ± 14.7	71.5 ± 14.3	-1.51* ± 2.54	70.0 ± 18.3	69.0 ± 17.5	-1.01* ± 3.06
46- 65	64.0 ± 10.5	63.2 ± 10.3	-0.85* ± 2.11	77.8 ± 16.0	76.1 ± 15.5	-1.76* ± 2.63	70.9 ± 18.6	70.1 ± 18.9	-0.85* ± 2.71
all	57.5 ± 9.0	56.7 ± 8.5	-0.79* ± 2.21	73.0 ± 15.5	71.5 ± 14.9	-1.44* ± 2.64	68.8 ± 17.5	67.9 ± 17.1	-0.92* ± 2.75
MALES									
	Italy			Netherlands			North America		
Age	measured	reported	difference	measured	reported	difference	measured	reported	difference
18- 30	70.2 ± 9.4	70.4 ± 8.9	+0.24 ± 2.59	77.7 ± 11.9	77.6 ± 11.8	-0.09 ± 3.57	82.2 ± 17.1	81.8 ± 16.5	-0.41* ± 3.39
31- 45	76.4 ± 11.2	76.4 ± 10.7	-0.03 ± 2.17	86.8 ± 18.2	86.2 ± 15.8	-0.60* ± 4.01	86.1 ± 16.6	85.6 ± 16.1	-0.52* ± 2.86
46- 65	77.7 ± 9.7	77.0 ± 9.6	-0.73* ± 2.24	87.1 ± 16.0	86.0 ± 15.3	-1.09* ± 3.73	88.6 ± 18.2	88.2 ± 18.2	-0.50* ± 2.77
all	72.6 ± 10.4	72.7 ± 9.9	+0.06 ± 2.47	83.8 ± 16.1	83.2 ± 15.3	-0.60* ± 3.78	85.9 ± 17.4	85.4 ± 17.1	-0.48* ± 2.99

The ANOVA's on weight difference showed a significant main effect for country ($F_{2,4310} = 8.35$, $p < 0.001$), with all three countries being significantly different from each other. The Dutch underestimated their weight by 1.1 ± 3.2 kg, the North Americans by 0.7 ± 2.9 kg and the Italians by 0.4 ± 2.4 kg. The main effect of weight deciles ($F_{9,4310} = 1.68$, $p = 0.089$), shown in Figure 1, was approaching significance. No differences were found in height deciles ($F_{9,4310} = 1.29$, $p = 0.23$), meaning that smaller and taller people underestimate their weights equally.

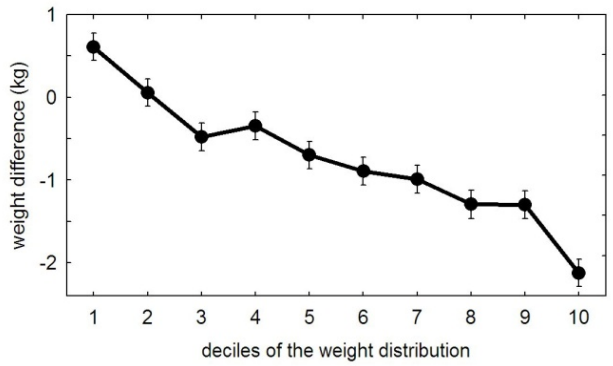

Figure 1: Differences between reported and measured values of weight for deciles of the weight distribution. Vertical bars denote +/- standard error.

There was also a significant main effect for gender ($F_{1,4310}$ = 60.23, p < 0.001), females (Mean (M) = -1.05 kg) underestimated their weight more than males (M = -0.41 kg), in general (Figure 2). Age was also an important factor ($F_{2,4310}$ = 7.37, p < 0.001). Out of three countries, Italians (M = -0.51 kg) underestimated their weight less than the other two countries. There were two significant interaction effects associated with the country factor: country and gender ($F_{2,4310}$ = 3.10, p = 0.045), and country and age groups ($F_{2,4310}$ = 2.92, p = 0.019). As shown in Figure 2, Netherlands females (M = -1.44 kg) underestimated their weight the most, while Italian males (M = 0.59 kg) did not underestimate, but reported more or less correctly. Depending on country, each age group reported weights were underestimated differently. The Americans (18-30 years M = -0.66 kg, 31-45 years M = -0.77 kg, 46-65 years M = -0.69 kg) underestimated their weight about the same across all age groups. But in both Italy and Netherlands, reported weight was underestimated more as people got older (Italy: 18-30 years M = -0.62 kg, 31-45 years M = -0.41 kg, 46-65 years M= - 0.79 kg, Netherlands: 18-30 years M = -0.62 kg, 31-45 years M = -1.131 kg, 46-65 years M = -1.44 kg).

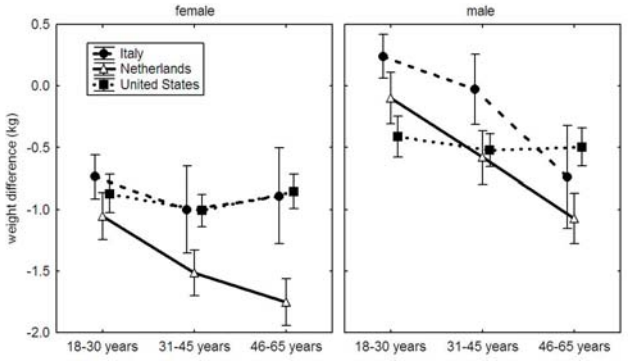

Figure 2: Differences between reported and measured values of weight. Vertical bars denote +/- standard error.

Differences between reported and measured height

Table 3 gives the descriptive statistics of measured and reported values for height and for the differences between reported and measured values, separately for the three countries. Paired samples t-tests on each cell showed that reported height was statistically greater than measured height in every case. In other words, on the average, reported height data are always overestimated.

Table 3: Descriptive statistics for height (in cm) (* indicates a significant difference)

FEMALES									
	Italy			Netherlands			North America		
Age	measured	reported	difference	measured	reported	difference	measured	reported	difference
18- 30	161.7 ± 6.1	164.6 ± 6.2	2.88* ± 2.02	170.4 ± 7.8	171.2 ± 7.8	0.83* ± 1.90	164.0 ± 7.2	165.1 ± 7.6	1.14* ± 1.98
31- 45	161.0 ± 6.0	163.6 ± 6.0	2.75* ± 1.51	168.7 ± 7.5	169.1 ± 7.5	0.46* ± 2.06	165.2 ± 7.4	165.7 ± 7.7	0.47* ± 2.20
46- 65	158.2 ± 6.3	161.3 ± 6.9	3.15* ± 2.37	164.9 ± 6.3	166.2 ± 6.5	1.32* ± 2.36	162.8 ± 6.9	163.7 ± 7.1	0.89* ± 1.72
all	161.1 ± 6.2	164.0 ± 6.4	2.86* ± 2.00	168.0 ± 7.6	168.9 ± 7.6	0.86* ± 2.14	164.0 ± 7.2	164.8 ± 7.5	0.80* ± 2.00
MALES									
	Italy			Netherlands			North America		
Age	measured	reported	difference	measured	reported	difference	measured	reported	difference
18- 30	174.5 ± 6.5	176.7 ± 6.4	2.21* ± 1.84	183.7 ± 7.1	185.1 ± 7.2	1.33* ± 1.9	177.9 ± 8.0	179.6 ± 8.2	1.70* ± 2.05
31- 45	173.1 ± 6.5	175.4 ± 6.1	2.29* ± 1.57	182.6 ± 8.8	183.6 ± 9.0	1.03* ± 2.47	178.2 ± 8.1	179.8 ± 8.2	1.58* ± 2.07
46- 65	169.9 ± 7.4	172.4 ± 7.3	2.44* ± 1.52	178.2 ± 8.9	179.6 ± 8.9	1.41* ± 2.24	177.1 ± 7.7	178.9 ± 8.0	1.83* ± 2.35
all	173.6 ± 6.8	175.8 ± 6.6	2.26* ± 1.74	181.4 ± 8.6	182.7 ± 8.7	1.26* ± 2.21	177.8 ± 7.9	179.5 ± 8.1	1.69* ± 2.16

Height was overestimated in all cases, but there were marked differences. The ANOVA's on height difference showed four significant main effects by country, gender, age groups, and height deciles. Regional difference affected the height difference values ($F_{2,4310}$ = 109.23, p < 0.001). Tukey HSD tests showed a further distinction among the three countries with the largest overestimations made in Italy (M = 2.6 cm, Standard Deviation (SD) = 1.9 cm), next North America (M = 1.2 cm, SD = 2.1 cm), and the smallest in the Netherlands (M = 1.0 cm, SD = 2.2 cm). For Gender effects ($F_{1,4310}$ = 11.30, p < 0.001) in general, males (M = 1.7 cm, SD = 2.1 cm) over-reported their heights more than females (M = 1.2 cm, SD = 2.2 cm). The height difference values were also affected by age ($F_{2,4310}$ = 9.82, p < 0.001). The three age groups were significantly different from one another based on Tukey HSD. This indicated that the youngest group (18-30 years, M = 1.7 cm, SD = 2.1 cm) overestimated the most, followed by the oldest group (46-65 years, M = 1.4 cm, SD = 2.2 cm), and finally the middle aged group overestimated the least (31-45 years, M = 1.1 cm, SD = 2.2 cm). The significant main effect of height deciles ($F_{,9,4310}$ = 2.00, p = 0.035) confirmed the general trend that the shorter people overestimate their height more. Tukey HSD test showed that people in the 10th percentile group overestimated more than other people, especially those who are taller than the 30th percentile. There was no other significant difference found in the height deciles groups, which means that an underestimation of height by the tall

group (above 90th percentile) was not found. Weight status or obesity status did not statistically affect the overestimation of height.

There were also two interaction effects associated with the country factor. One was the interaction between gender and country ($F_{2,4310} = 39.81$, $p < 0.001$). Depending on country, male and females overestimated their height differently. In general, males overestimated their heights, but for Italy the opposite was true as shown in Figure 3: Italian females overestimate their heights more than males. The other significant interaction was between country and weight status ($F_{2,4310} = 39.81$, $p < 0.001$). In all deciles, Italians overestimated their height more than the other two countries.

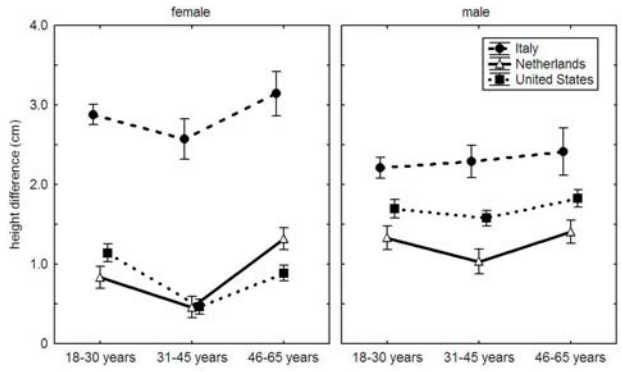

Figure 3: Differences between reported and measured values of height. Vertical bars denote +/- standard error.

DISCUSSION AND CONCLUSIONS

The expected average over-reporting of height and under-reporting of weight is present in our data. The underestimation was observed for men and women, for all three countries, and for all age groups. But there are clear differences when the data are inspected more closely.

Weight was underestimated more by females (M = 1.1 kg) than by males (M = 0.4 kg), more by the Dutch (M = -1.06 kg) than by Italians (M = -0.35 kg) and North Americans (M = -0.71 kg), more by middle-aged (M = -0.83 kg) and older persons (M = -0.94 kg) than by young ones (M = -0.51 kg) and more by heavier people than by persons with low weights. Probably the effect of the so-called "socially desirable `ideal' weight" plays an important role here (Larson, 2000).

Height is overestimated more by males (M = 1.7 cm) than by females (M = 1.5 cm) and much more by Italians (M = 2.6 cm) than by participants from the Netherlands (M = 1.0 cm) and the North America (M = 1.2 cm). Smaller persons overestimated their height more than taller ones (the so-called 'flat slope syndrome', Kuskowska-Wolk *et al.*, 1989, 1992), possibly because of "wishful thinking" (Larson, 2000). The effect of age was significant but hard to explain since both the younger (18-30 years) and the older group (46-65 years) show a larger overestimation of height than the intermediate group (31-45 years). For the oldest group a probable explanation is the seemingly unawareness of the well-documented phenomenon that people shrink with age (Rowland, 1990, Sorkin *et al*., 1999).

We have found considerable differences between countries, but region might not be the only explanation. It is feasible that cultural or ethnic differences (*e.g.* Cornelisse-Vermaat and Maassen van den Brink, 2007) also play a role, *e.g.* because quite different attitudes exist towards preferred values for height and weight. Fairly large differences, for instance, are reported in under- or overestimation of height and weight between children from different ethnic backgrounds within the Netherlands (Jansen *et al*., 2006).

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