The Determinants of Misreporting Weight and Height: The Role of Social Norms*

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Abstract

This paper uses a combination of the 2006 Catalan Health and Health & Examination Surveys to compute the size of weight and height self-reporting biases. The underlying determinants of these self-reporting biases are also analysed, placing special emphasis on examining the role played by social norms. Our findings show that social norms have a dual impact on these self-reporting biases: the higher the distance between individuals' measured weight (height) and that of their average reference group, the higher (lower) the weight (height) bias or more (less) inclined they are to misreport their weight (height). This evidence confirms the influence of group-specific factors or social norms on self-reports of attributes. Finally, the relationship found between the measured and self-reported anthropometric data in our merged database was applied to the Spanish National Health Survey (NHS) to correct its self-reported information. Interestingly, after correcting for self-reporting errors, both the BMI and the prevalence of obesity were significantly underestimated; the increase was higher among women.

Keywords: Self-reported weight, height, BMI; Anthropometric biases; Social-norms
JEL Classification: I10; I12.

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Resumen

Este artículo calcula, en primer lugar, la magnitud de los sesgos en los datos declarados de peso y altura por medio de utilizar una muestra de individuos obtenidos a partir de la combinación de la Encuesta Catalana de Salud y el Examen de Salud de Cataluña del 2006. En segundo lugar, se examina empíricamente cuáles son los determinantes de estos sesgos prestando una especial atención al impacto que puedan ejercer los denominados "social norms". Nuestros resultados evidencian que las 'normas sociales' ejercen un impacto dual y significativo sobre esos sesgos en los datos declarados: cuanto mayor (menor) es la distancia entre el peso (altura) medido individual y el del promedio del grupo de referencia, mayor (menor) es el sesgo en el peso (altura) declarado o más (menos) inclinado están los individuos a declarar erróneamente su peso (altura). Esta evidencia empírica confirma cómo los factores específicos de grupos o las normas sociales influyen en la declaración de datos sobre atributos individuales. Finalmente, la relación hallada entre los datos antropométricos medidos y declarados en nuestra base de datos combinada de Cataluña, se trasladó a la Encuesta Nacional de Salud (ENS) de 2006 para corregir los datos autodeclarados de peso y altura. Como se esperaba, tanto el BMI como la prevalencia de la obesidad en España (basada en datos declarados) están fuertemente subestimadas, siendo ésta mayor entre las mujeres.

1. Introduction

The recent rapid increase in the prevalence of obesity is widely recognized as constituting a major public health concern in economically developed countries. Obesity is considered to be responsible for an increasing portion of total health care expenditure, as it is associated with a number of co-morbidities (e.g., heart disease, diabetes, certain cancers, arteriosclerosis, or apnoea), and for generating other socio-economic costs (e.g., labour incapacity, absenteeism, wage and promotion discrimination, stigma and social exclusion or mental disorders). Moreover, the fact cannot be ignored that the obesity epidemic is more prevalent among low income families.

The relevance of the epidemic has been tested mainly by means of self-reported anthropometric information. However, data of this kind are known to be biased and so weight and height information need to be corrected to achieve a more accurate measurement of obesity. Access to reliable information is crucial for health policy makers attempting to deal with this pandemic problem. The present paper examines the magnitude of these biases by examining the latest available Catalan Health & Examination surveys. No database for the entire Spanish population is currently available.

In contrast to previous research which considered only a few individual characteristics to describe misreporting behaviour,[1] in this paper we emphasize the role played in this phenomenon by social norms. This factor is particularly relevant since, when answering anthropometric questions in health questionnaires, individuals have a reference group in mind. For instance, being shorter or fatter than average in a reference group is assumed to affect self-reported data, since the ideal body image conditions self-declared weight and height responses. That is, individuals' utility functions are defined according to relative weight (height) and people rationally select a weight (height) mirroring that of their peers (Burke and Heiland, 2007; Etilé, 2007 and Oswald and Powdthavee, 2007). Our approach considers social norms proxied by levels of weight and height measured for a reference group defined by educational attainment, gender, and age.

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[1] See Danubio et al. (2007) for a survey of bias magnitudes for OECD countries.

In the last stage of our study, following Cawley and Burkhauser's (2008) approach we extrapolate our results to the Spanish case by correcting self-reported weight and height data presented in the latest edition of the Spanish health survey in order to achieve a more accurate measurement of both BMI and obesity rates. This correction was implemented using the estimation of conversion formulas provided by our merged Catalan database. Instead of using general conversion formulas from other countries, we preferred to use Catalan data since weight and height corrections are sensitive to the presence of dissimilar cultural and environmental patterns.

Our findings corroborated the existence of significant biases in self-reported weight and height for the Catalan sample. The biases followed the expected pattern based on gender, age, education and health status, among other factors. By using a SURE procedure to account for the presence of common unobservable effects, we found evidence confirming that social norms had a dual effect on weight and height biases. First, peers' characteristics conditioned misreporting behaviour; second, anthropometric biases were also explained by some other covariates (i.e., the BMI, waist-to-hip ratio, age, gender, nationality, education and health and health-care variables. Finally, we found that both self-declared BMI and the obesity rate of the Spanish population were significantly underestimated (18.5% instead of 15%), the misreporting being higher among women.

The remainder of this paper is structured as follows. In section 2 we measure and quantify the magnitude of bias in self-declared anthropometric data for the Catalan case. Section 3 outlines the econometric methodology, discusses the underlying determinants of the misreporting behaviour, and presents empirical evidence. Section 4 corrects the anthropometric data for Spain as a whole and the final section summarizes the main results.

2. Bias in Anthropometric Data

2.1 Data Description

To assess and quantify the magnitude of bias in self-reported data on weight, height and BMI, we combined the 2006 editions of the Catalan Health Survey (CHS) and the Catalan Health Examination Survey (CHES), both produced by the Catalan government's Department of Health. These surveys provide valuable information on self-reports and clinical

measurements.[2] We used this combined dataset because there is no standard examination survey covering the entire Spanish population (Aromaa *et al.*, 2003).[3]

The CHS-2006, which is representative of the resident and non-institutionalized Catalan population, gathers information on aspects such as self-perceived health status, healthcare utilization, consumption of medicines, chronic conditions, mental health and social support, preventive medicine, life styles, self-reported anthropometric data, and socioeconomic characteristics. The survey was carried out using computer-assisted personal interviews and was structured in three questionnaires following a complex multistage sampling procedure. The initial sample comprised 18,126 individuals (15,926 adults aged 15+ and 2,200 children) with information collected between December 2005 and July 2006. Almost at the same time, a voluntary health examination survey was undertaken on a representative (by health regions, gender and age groups) subsample of interviewed individuals, aged 6 and over, obtained from the CHS-2006, to complement the information provided by the health survey and to improve the understanding of the distribution of CVD risk factors (diabetes, arterial hypertension or obesity) among the Catalan population. Like other examination surveys, the CHES-2006 includes physical (height, weight, waist and hip circumference, blood pressure and heart rate) and biological (glucose and cholesterol tests) explorations and a short list of questions on food disorders.[4] The measurements were conducted by highly qualified, trained personnel and carried out at individuals' homes during 2006. From a theoretical subsample of 4,000 respondents extracted from the health survey, the CHES-2006 finally contained 2,119 individuals, a response rate of 55.5%.

After merging the two samples by the identification number and removing the data relating to subjects aged below 15 and above 65, we ended up with a sample comprising 1,568 observations (49.7% men and 50.3% women) for whom we had both self-reported and measured anthropometric data along with socioeconomic and health information.[5]

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[2] Catalonia is the second most populated region in Spain, with 16% of the country's total population and 18.8% of the Gross Domestic Product.

[3] The exceptions are a couple of regional surveys covering their respective populations: the 'Nutrition and Health Examination Survey 1994" of the Region of Valencia, and the 2002 and 2006 editions of the CHES.

[4] Weight and height measurements were taken with shoes off and subjects clad only in a light robe or undergarments and rounded to the nearest 0.5 cm. Waist and hip circumferences were measured using a flexible, inelastic measuring tape with the subject in standing position. The tape was placed horizontally (parallel to the floor) around the abdomen at the level of the navel (waist circumference) and around the maximal circumference at the level of the trochanter (hip circumference). In both cases measures are recorded to the nearest 0.5 cm.

[5] We excluded the elderly population from the sample to reduce the incidence of their higher morbidity on the self-report of weight and height.

2.2 Bias Magnitudes

Table 1 reported the estimation of self-reported and measured weight, height and BMI (Body Mass Index) average values according to different population subgroups by using the dataset described above. The table also provides the measurement of the bias or gap, computed simply as the difference between each reported anthropometric value and the corresponding measurement and the share of the bias in percentage terms. As usual, the BMI indicator was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). The following categories adopted by the WHO (2000) are considered: (1) underweight: BMI <18.5; (2) normal-weight: BMI 18.5-24.9; (3) overweight: BMI 25-29.9 and (4) obese: BMI ≥30. The estimations excluded the influence of multiple outliers detected by applying the Hadi (1992) procedure for multivariate data.[6]

As a criterion of validity, Pearson correlation coefficients between self-reported and measured weight and height were computed. All were statistically significant ($p<0.001$) using Bonferroni-adjusted significance levels for all age groups within each gender. Specifically, correlation coefficients between self-reported and measured weight for all age groups and both genders ranged between 0.90-0.96,whereas correlations for height and the same population subgroups were somewhat lower, ranging between 0.80-0.91. Despite these strong correlations, our data confirmed that individuals tended to commit systematic errors when reporting anthropometric data.

Our estimations showed that the mean difference between self-reported and measured weight was -1.42 kg (95% CI: -1.63 to -1.21), confirming the well-known underestimation of weight. As in most literature reports, this underestimation to be larger for women than for men (-1.45 kg vs. -1.38 kg). For instance, using data from Sweden, Boström and Diderichsen (1997) reported that adult women tended to underestimate their weight significantly more than men (-1.64 kg vs. -0.74 kg). Similar results were found by Niedhammer *et al.* (2000) for a sample of middle-age French subjects (-0.85 kg for women, -0.54 kg for men); Bolton-Smith *et al.* (2000) based on a sample of Scottish adults (-0.95 kg for women, -.63 kg for men) or Quiles and Vioque (1996) using data from participants of the 'Survey of Nutrition and Health, 1994' from the Autonomous Community of Valencia (-1.81 kg. for women, -1.21 kg for men).

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[6] We excluded 20 (15) outliers for self-reported weight (height) and just 13 outliers for self-reported BMI.

However, other studies reported a more pronounced underestimation of weight among the male population (Gunnell *et al.,* 2000; Spencer *et al.*, 2002). As for height, the mean difference between self-reported and measured height was estimated to be 0.64 cm (95% CI: 0.47 to 0.81) clearly suggesting that height was overestimated. Interestingly, this gap or bias was substantially higher among Catalan adult women (0.92 cm) than among men (0.36 cm), suggesting perhaps a larger dissatisfaction with height among women. The literature reports were again rather mixed: while some papers reported a higher overestimation in self-reported height among females (Quiles and Vioque, 1996, Boström and Diderichsen, 1997; Paccaud *et al.* 2001), others presented larger overestimation among males (Gunnell *et al.*, 2000; Kuczmarski *et al.*, 2001; Spencer *et al.*, 2002).

At this point, it is worth stressing the differentials found in the biases computed based on covariates. Reflecting previous results for a region of Spain (Quiles and Vioque, 1996), Table 1 shows that over-reporting of height or height bias increased with age, in accordance with other literature (e.g., Boström and Diderichsen, 1997, Kuczmarski *et al.*, 2001). Hence, the oldest adult group (aged 56-65) tended to over-report their height significantly more (1.42 cm) than any other age group.[7] However, this finding could not be corroborated totally for weight since the greatest bias was found for the 25-35 age group. Next, educational attainment played a notable role in the generation of biases. Interestingly, the lower the individual educational attainment, the greater the bias in height, but the lower the bias in weight. So our data indicate that skilled individuals seemed to be more worried about reporting their real height than their weight.[8] Self-assessed health status also showed a pattern of misreporting. Both the weight and height biases were larger among those with better self-perceived health status, which could be interpreted as a consequence of being more dissatisfied with their own body size. Finally, as expected, our estimations evidenced that obese individuals under-reported their weight (-3.54 kg) and over-reported their height (1.88 cm) more significantly than their counterparts, the misreporting also being higher in relative terms.

[Insert Table about 1 here]

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[7] Reductions in stature and body weight in old age have been reported; this would ultimately explain why older adults are in general more unaware of their current height.

[8] Similarly, according to Boström and Diderichsen (1997) manual workers overestimated (underestimated) their height (weight) more (less) than non-manual workers. See also Niedhammer *et al.* (2000).

As these biases between self-declared and measured weight (height) may not be consistently evidenced for the whole distribution, we estimated kernel density functions to observe misreporting patterns throughout the anthropometric distributions (Figure 1). Two findings deserve particular mention. First, the height bias distribution displayed significant dissimilarities only for heights 2.5 centimetres above the average level. Second, the weight bias distribution was more skewed. That is, stronger dissimilarities in the shape of the distribution were evidenced for the weight bias, indicating that individuals misreported weight more than height. Therefore, bearing in mind the above comments, determinants of the misreporting of height and weight cannot be estimated jointly through the use of a single measure, that is, the BMI indicator.

[Insert Figure 1 about here]

The difference between the average BMI calculated from self-reported and measured data was -0.72 kg/m^2 (95% CI: -0.81 to -0.63), revealing a systematic underestimation error when computing the BMI indicator using self-reports (Table 1). Indeed, the BMI was underestimated much more among women (-0.87 kg/m^2) than among men (-0.57 kg/m^2) and also in the oldest age group considered (-1.09 kg/m^2 among those aged 56-65). Interestingly, as a consequence of the evidence presented above, the negative BMI bias was roughly the same among individuals with the lowest education attainment (-0.70 kg/m^2) and those who achieved a university degree (-0.68 kg/m^2). A similar pattern was found among those who reported healthy vs. bad self-assessed health status. As expected, the category measuring obese individuals underestimated BMI (-1.96 kg/m^2) much more significantly than any other body weight subgroup.

3. Determinants of Misreporting Behaviour

3.1 Methods

We now examine the factors underlying the misreporting behaviour for both weight and height. Nevertheless, to simplify the interpretation of the results we define the biases in terms of positive values. Thus, the dependent variables are, on the one hand, the weight bias or difference between measured and self-reported weights and, on the other hand, the height bias

or difference between self-reported and measured heights. That is, $bias_w = w_m - w_d$ denotes the bias or gap in weight whilst $bias_h = h_d - h_m$ represents the bias in height. Since the self-reported and measured anthropometric information are collected in different surveys (CHS and CHES) we initially wondered whether the voluntary nature of participation in the CHES-2006 might have caused a sample selection problem. It is plausible that individuals refuse to participate in the examination survey because they feel uncomfortable or simply as a consequence of their weight. Thus, gap measurements would be biased and, consequently, would under-represent a fraction of the overweight and obese population. However, the reverse effect might also be expected: individuals feeling comfortable with their body shape might refuse to participate in a second interview due to work or family commitments. Thus, in this second case, normal or healthy weight population would be under-represented.

We carried out two alternative specifications to examine the presence of this selection problem. Both models aim to explain why individuals are more likely to participate in the examination survey. First, we estimated the determinants of weight and height bias through the use of a bivariate sample selection model.[9] In both cases our estimations showed that the error terms of the participation and outcome equation were uncorrelated [Wald test =0.34 (p=0.56) for the weight bias and a Wald test=0.92 (p=0.34) for the height bias]. Similarly, the estimated coefficients of the inverse Mills ratio were not statistically significant. Second, we adjusted a two-part regression model specification or "hurdle model" assuming two separate processes underlying the censoring mechanism and the analysed outcome. Again, our data confirmed that the coefficient of the participation regressor was not statistically significant. We therefore concluded that sample selection was not a problem in our data and hence OLS regression led to consistent parameter estimates of the bias equations.

We estimated the two gaps separately by means of an OLS procedure. At this point, we wondered whether common unobserved factors might affect both biases in weight and height. We therefore re-calculated our equations through the use of a Seemingly Unrelated Regression (SURE) estimation since all regressors could be considered exogenous. Note that

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[9] We introduced further covariates in the participation equation for identification reasons. Specifically, we included the year and month of the examination, health region, labour status, civil servant, type of labour contract, pregnancy, interviewer perceptions regarding the ease of obtaining responses and response sincerity, individuals reporting being the head of the family, and household size. Results are available from the authors upon request.

this approach is useful when both residual terms are correlated although the gain in efficiency is only considerable when this correlation is high.

$$bias_{w,i} = x_i^{'}\beta + z_i^{'}\gamma + \lambda_1 S_w + \varepsilon_{1,i}$$
$$bias_{h,i} = x_i^{'}\delta + z_i^{'}\gamma + \lambda_2 S_h + \varepsilon_{2,i}$$

(1)

These gap measures are conditioned to x_i which is composed by the *k*-vector of explanatory variables, z_i denoted a vector of anthropometric measures and β, γ, δ and λ_1 and λ_2 are the *k*-vectors of unknown parameters and, finally, $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ represent the random error terms which are assumed to be correlated. Finally, S_w and S_h represent the influence of social norms or distance to a reference group. As this is one of the main paper's goals, these covariates deserve a further explanation which will be given in section 3.3. A χ^2 test reporting statistical significance of this correlation (Cov($\varepsilon_{1,i}$, $\varepsilon_{2,i}$)≠0) confirms the validity of this kind of estimation although the gain in efficiency will be small since the correlation is not very high. For this reason, we present only SURE estimations throughout the empirical evidence section.

3.2 Factors Influencing Misreporting

According to the above evidence and certain references in the literature, we assumed that the misreporting behaviour depended on individual characteristics such as gender, age and age squared, marital status and ethnicity/nationality since it is well established that the over- and underestimation of height and weight vary according to these demographic attributes (Boström and Diderichsen, 1997; Bolton-Smith *et al.*, 2000, Gillum and Sempos, 2005 or Danubio *et al.*, 2008). We hypothesized, however, that some other factors would also be accounted for. Table 2 reports the set of covariates included in the regression analysis of the determinants of the height and weight bias in our dataset.

[Insert Table 2 about here]

Firstly, a socioeconomic gradient may be underlying the misreporting behaviour. That is, poorer people might be expected to overestimate their height and underreport their weight more than their richer counterparts. In this regard, previous studies have shown that manual workers tend in general to overestimate their height more than non-manual workers, while

non-manual workers tend to underestimate their weight (Boström and Diderichsen, 1997, Niedhammer *et al.*, 2000). However, in the present study, given the existence of many missing values in our income variable, we constructed an index of individual deprivation based on housing characteristics as a proxy.[10]

Secondly, the existence of a reporting bias or error could simply be a consequence of knowledge or educational level rather than of a wealth effect. In principle, lower accuracy when self-declaring weight and/or height would be expected among those with a lower educational level. However, highly educated individuals might be more aware or informed of their real weight and height and might deviate more when self-reporting this information. In some sense, when reporting their anthropometric features individuals take their ideal measures into account.

Thirdly, several health-related covariates were also assumed to affect the misreporting of weight and height. In our regressions we included self-assessed health status, number of chronic conditions, proxies of health care utilization (e.g., control of cholesterol levels and medical visits) and a mental health index (based on a GHQ-12) intended to measure current psychiatric morbidity.[11] Two additional weight-related features were included to measure the potential impact of distorted information regarding one's own body mass on the reporting behaviour. To do so, we first considered whether interviewees had experienced a rapid and considerable weight loss and, second, whether they perceived themselves as being fat although others saw them as thin. Moreover, since reporting bias behaviour is contingent on the particular weight and height levels achieved by each individual (Boström and Diderichsen, 1997) we also considered as additional regressors the BMI measured (including a non-linear effect), the well-known waist to-hip-ratio (WHR) and the waist circumference. While BMI measures overall obesity, both WHR and waist circumference are proxy indicators of abdominal-visceral fat (central adiposity)[12] and are estimated to be better predictors of the risk of several chronic diseases and death.[13]

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[10] This index ranges from 0 to 1 and is calculated averaging whether the individual's home is equipped with bath and/or bathtub, hot water, heating, washing-machine, dish-washer and air-conditioning.

[11] The mental health index was defined from the answers to a set of 12 questions about the individual's feelings during the past four weeks.

[12] Both measures of abdominal fat were included, since it is still debated which indicator is the most appropriate adiposity marker, although waist circumference is easier to compute (NIH, 1998, Pischon et al., 2008).

[13] See Pischon et al. (2008) for an analysis of the association between central and general adiposity with the risk of death in Europe.

As controls in the econometric specification we incorporated the CHS interview length, the number of months between the first CHS interview and the examination survey (CHES)[14] and the well-known rounding effect or tendency to round one's weight and height to the nearest '0' and '5' value (see Table 2).

3.3 The Role of Social Norms

The present paper also analysed the determinants of misreporting weight and height as a consequence of social norms. We hypothesized that declared weight and height were conditioned by the extent to which individuals' anthropometric measures deviate from the values attributed to a reference or social group. We assumed that the act of reporting anthropometric measures depended either on individual-specific or on group-specific-factors (Blume and Durlauf, 2006). According to recent literature (Burke and Heiland, 2007; Etilé, 2007; Oswald and Powdthavee, 2007; and Blanchflower et al., 2008), social norms are present when people choose their ideal attributes. Hence, subjects' utility function was based on relative standards. Indeed, this kind of analysis relates to the extensive recent literature considering the role of social interactions in economic behaviour. This idea is based on the Brock and Durlauf (2001) model in which individuals choose between actions (such as misreporting either their weight or height); the utility of performing an action depends on a baseline utility, which is common across individuals in the same reference group, and on the distance between their action and the average expected action in that population. In short, an individual's expectations depend on shared expectations in his/her social group. This means that we should consider the social group to which each individual self-assigns. An interesting research question would then be to know whether individuals were equally influenced by group-specific factors when reporting weight and height respectively.

As for the specific reference group, note that there is a long list of possible candidates: among others, parents, friends, classmates or schoolmates, work colleagues or neighbours. However, given the limitations of our dataset, at this juncture we used Etilé (2007)'s analysis when defining a proxy measure of social norms regarding the ideal BMI measure.[15] We included real measurements of weight and height for the reference group instead of using an average

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[14] During this period (approximately four months) individuals could increase or decrease their weight.

[15] Etilé (2007) considered gender, age group and occupational status as the characteristics for defining the proximity or identification to a reference group.

ideal measure. Our study thus took the interaction group as given and slightly modified these references considering three individual characteristics: i) gender, ii) individual age and iii) educational attainment for defining the reference group. Hence, we defined S_w (S_h) as the distance in kg (cm) between real or measured individual weight (height) and the average measured weight (height) of the reference group (see Table 2). We preferred educational attainment to job occupation since the latter might suffer mismatch consequences. This was thought to be particularly important in the Spanish case since, in recent decades, the share of highly-educated workers has increased notably. Nonetheless, this increase has not been matched by an equal increase in the supply of skilled jobs, thus resulting in over-education. Nonetheless, to explore the sensitivity of our results to the definition of the reference group, we considered two additional groups. First, following Etilé (2007)'s proposal, we dropped the educational attainment level as a reference characteristic. Second, we took into account gender and geographical residence (according to health region) of individuals when defining the reference group.

3.4 Empirical Evidence

Tables 3a and 3b display the SURE results for the determinants of the weight and height biases respectively.[16] Whilst the first column in each table presented the biases' determinants excluding social norms, the rest of columns show the effects accounting for our alternative social norm definitions. The estimated correlation coefficients between the error terms of the weight bias and the height bias are low (between -0.11 and -0.14) but statistically significant in all cases. These correlation coefficients show that there may be unobservable factors which are negatively related to misreporting weight and height. Note that weight and height biases were defined in opposite ways. The goodness of fit was reasonable (R^2 ranged from 0.15 to 0.23) given the microeconometric nature of our data.

[Insert Tables 3a and 3b about here]

Besides the presence of other expected covariate effects, the most interesting result is the effect of social norms on individuals' reporting behaviour regarding anthropometric measures. Interestingly, we find that social norms concerning weight (see Table 3a) exerted a

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[16] Very similar results were obtained after considering the whole sample of adult individuals.

positive, statistically significant effect on the weight bias equation (around 0.11). That is, the greater the distance between the measured weight and the average of the reference group, the higher the weight bias. This result was statistically significant after controlling for the influence of the various anthropometric measures. In a similar way, Table 3b indicates that social norms regarding height also exerted a negative, statistically significant impact on the height bias (around -0.10). This means that the greater the distance between one's measured height and that of the average reference group, the lower the height bias, or the less inclined individuals are to misreport their height. Overall, this evidence confirms that group-specific factors or social norms regarding an average/ideal (weight and height) level have an influence when individuals report their attributes (Etilé, 2007). Therefore, an estimation of the misreporting behaviour should account for this particular effect. Note that the effects of social norms were quite similar regardless of the alternative definitions of the reference group.

The impact of the anthropometric measures on reporting behaviour provided other interesting results. As expected and in accordance with the literature, the non-linear BMI effect corroborated our assumption of a positive effect on either the weight or the height bias. Thus, the higher weight to height ratio, the more likely individuals were to over-report their height and under-report their weight. Likewise, abdominal-visceral fat, proxied by the waist-to-hip ratio, was found to exert a negative influence on height reporting bias, possibly showing that those with more central adiposity were tall individuals who otherwise tended to report a lower bias. The reverse effect was found on the weight bias although this effect disappeared after controlling for the non-linear BMI effect. This is a consequence of the fact that waist-to-hip ratio captures high BMI level effects (severe obesity).

Regarding the effects of other covariates, Tables 3a and 3b show the existence of a clear-cut pattern according to age and gender. Our findings revealed a statistically significant non-linear age effect on the weight and height reporting bias; also, men tend to misreport both weight and height significantly less than women, once we controlled for the effects of other determinant covariates. As for education, we found that low educated individuals were much more accurate when self-reporting their weight and height than their more highly educated counterparts. This may be a consequence of being less aware either of the negative effects of being fat or having a disappointing body image. As expected, nationality again played a notable role in the self-reporting behaviour: Asian (European) individuals tended to over-report (under-report) significantly their height. Likewise, African-born individuals tended to

misreport less their weight than Spaniards. Furthermore, health covariates (reporting a fair health status, number of chronic diseases, cholesterol checks and having visited a physician) seemed to play a significant role when explaining the bias magnitudes.

4. Assessing the Correction of Self-Reported Data

Although several studies have documented the existence of substantial errors in self-reports of weight, height and BMI in developed countries, so far the issue has not been investigated, as far as we know, in Spain's main health survey. Datasets of this kind usually lack measurements of weight and height or more accurate measures of fatness (e.g., waist circumference, hip circumference or WHR), and typically include only self-reported values. This section has two aims: first, to quantify the magnitude of this reporting error or bias and to assess the degree of accuracy of self-reported anthropometric data in the latest Spanish National Heath Survey carried out in 2006; second, to provide conversion formulas based on our merged dataset to enable social science researchers to use these estimations to calculate more accurate measures of weight and height when using their habitual datasets. The method we use for correcting reporting bias has been applied by many economists studying obesity (e.g., Cawley 2000, 2004; Lakdawalla and Philipson, 2002; Chou *et al.*, 2004 and Cawley and Burkhauser, 2008). Nonetheless, according to Plankey *et al.* (1997) correcting the reporting errors does not completely eliminate the errors obtained by the use of linear regression models; as a result, measured variables are preferable when available.

In the first stage, Table 4 reports the results of the regressions of measured weight, height and waist circumference by gender based on self-reported anthropometric data, age and their corresponding squared terms (i.e., data commonly available in social science datasets) using our merged sample of adults from the CHS-CHES, 2006 (section 2.1).[17] The R-squared scores of measured weight and height equations were relatively high (ranging from 0.73 to 0.88) indicating that the quadratic specification would fit the data quite well. Less valid was the adjustment of the waist circumference (R-squared of 0.6 for males, 0.72 for females). The addition of more covariates such as education or civil status to these econometric specifications barely improved the goodness of fit of the weight and height measurements.

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[17] We deliberately excluded individuals aged 15 and under from the combined dataset since the adult sample of the SNHS 2006 started at the age of 16.

[Insert Table 4 about here]

In the second step, the coefficients from these regressions were transferred to the adults'
sample of the SNHS 2006 and, after multiplying them by the self-report values, we obtained
measures of weight and height corrected for reporting error.[18] Of course, this correcting
approach assumes data 'transferability', that is, that the relationship between true and declared
values is the same in both datasets (Cawley and Burkhauser, 2008). Table 5 shows the impact
of this correcting procedure on the BMI. The second column displays the average BMI based
on actual self-reporting information on weight and height, and the third column shows the
estimated average BMI based on weight and height corrected for self-reporting. Interestingly,
our results suggest that self-reported BMI values calculated using the latest available health
survey (SNHS-2006) were underestimated for both genders, although the underestimation
was much more pronounced for women. The differences between self-reported and corrected
mean BMI were statistically significant at the 1% level.

[Insert Table 5 about here]

For purely comparative purposes, the fourth column shows the corrected BMI values if we
apply the Cawley and Burkhauser (2008) estimated conversion coefficients for weight and
height corresponding to the white male and female populations.[19] The correction figures
suggested by these authors produced lower BMI values than our own method based on a
Catalan sample (third column), which would suggest that the direct transfer of their
estimations to the SNHS-2006 underestimates the BMI indicator.[20] Unfortunately, the SNHS
2006 did not include measurements to assess the validity of our BMI values corrected for self-
reporting errors. While the sizes of the BMI differentials were relatively small, Table 5
showed that the correction of self-reports could have a significant impact on estimated obesity
prevalence rates (columns 5-7). That is, correcting for reporting error would result in an
increase in the Spanish obesity prevalence of 3.5 percentage points (from 15% to 18.5%),
while with the Cawley-Burkhauser (2008) approach the prevalence rose slightly less (17.6%).

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[18] Details about the SNHS 2006, in which data are also collected in face-to-face interviews may be accessed at
http:///www.ine.es
[19] Cf. Tables 6 and 7 of Cawley and Burkhauser (2008). Their values in pounds and inches were converted into
kilograms and centimetres (1 lb = 0.4536 kg; 1 in = 2.54 cm).
[20] Again, the differences between mean BMI values of column third and fourth were statistically significant at
the 1% level.

As expected, the findings indicated that the obesity prevalence rate for women would be underestimated much more if only self-reports on weight and height was used.

[Insert Table 6 about here]

Finally, given that the fit of the measured waist circumference equation in Table 4 (panel C) was relatively weak, Table 6 tentatively shows the estimation of this more complete measure of fatness (central adiposity) for the Spanish adult population (aged 16 and over). Interestingly, average waist circumference was higher in males than in females (96.29 vs. 86.74). Using the US National Institutes of Health's (NIH) threshold levels of 102 cm (40 inches) for men or 88 cm (35 inches) for women, it was estimated that 14.4% of the Spanish adult male population and 21.2% of the adult female population were at relatively "high risk" of suffering type II diabetes, hypertension, and cardiovascular diseases.

5. Concluding Remarks

As is well known, the use of social science databases containing declared or reported information on, among other items, individuals' weight and height suffers from a serious problem: the existence of bias which may raise doubts about the calculations of the BMI and, hence, the assessment of obesity. This is one of the reasons why the medical profession has generally preferred alternative and more accurate proxies (e.g. the waist and hip circumference or the waist-to-hip ratio) to calculate the prevalence of obesity. Provided these alternative indicators are obtained through physical explorations, they are not conditioned by the same kind of biases as the ones using self-declared weight and height information. However, the high cost of gathering a more complete set of information for large population samples explains the use of self-reported data by social science scientists.

Firstly, this paper has examined the size of the self-reported weight and height biases taking advantage of the combination of a health and examination survey of the Catalan population (Catalan Health Survey 2006 and Catalan Health and Examination Survey, 2006), given the inexistence of similar data for the Spanish population as a whole. Interestingly, we found that women, university graduates, subjects with a healthy self-assessed health status and the obese tended to underestimate their weight much more significantly than their counterparts, whereas height was overestimated specially among women, older age groups, lower educated

individuals, those with healthy self-assessed health status and obese individuals. BMI was to a large extent underestimated by women, the older age groups and the obese. Ultimately, these results suggest that the self-reporting anthropometric data pattern found in our data resembles that found in the literature for other developed countries.

Secondly, we believe that this paper is also the first to investigate the underlying determinants of the biases in weight and height reporting behaviour, and, among other covariates, the role played by social norms (Burke and Heiland, 2007; Etilé, 2007; Oswald and Powdthavee, 2007; and Blanchflower et al., 2008). Interestingly, we found a dual effect of social norms on these biases. Specifically, after taking into account the existence of sample selection problems, SURE estimations showed that social norms concerning weight (height) exerted a positive (negative) and statistically significant effect on the weight (height) bias equation, even after controlling for several anthropometric measures. In other words, the greater the distance between the measured weight (height) and that of the average reference group, the higher (lower) the weight (height) bias or the more (less) inclined individuals were to misreport their weight (height). Mirroring the results of Etilé (2007), our evidence seemed to confirm that group-specific factors or social norms regarding an average or ideal weight and height level might have an influence on individuals' reports of their attributes. As expected, we also found that other covariates (i.e., the BMI, waist-to-hip ratio, age, gender, nationality, education and health and health-care variables) significantly affected self-reported weight and height biases.

Finally, this paper is the first to present empirical evidence of the degree of underestimation of both the mean BMI and the prevalence of obesity incurred, after correction of the self-declared anthropometric data (from the leading Spanish health survey) by using conversion formulas provided by our merged Catalan database. Undoubtedly, to achieve an adequate measurement of individuals' body mass and the prevalence of obesity it is crucial to obtain a proper diagnosis. This paper shows that both self-declared BMI and the obesity rate of the Spanish population were significantly underestimated, and that the misreporting was higher among women. Correcting for self-reporting error would increase the Spanish obesity rate by 3.5 percentage points (from 15% to 18.5%). For comparative purposes, the picture would not be exactly the same if we had applied the Cawley-Burkhauser (2008) conversion approach since we had inferred a rather lower obesity rate for the entire Spanish population (17.6%).

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Figure 1. Distributions of Weight and Height bias
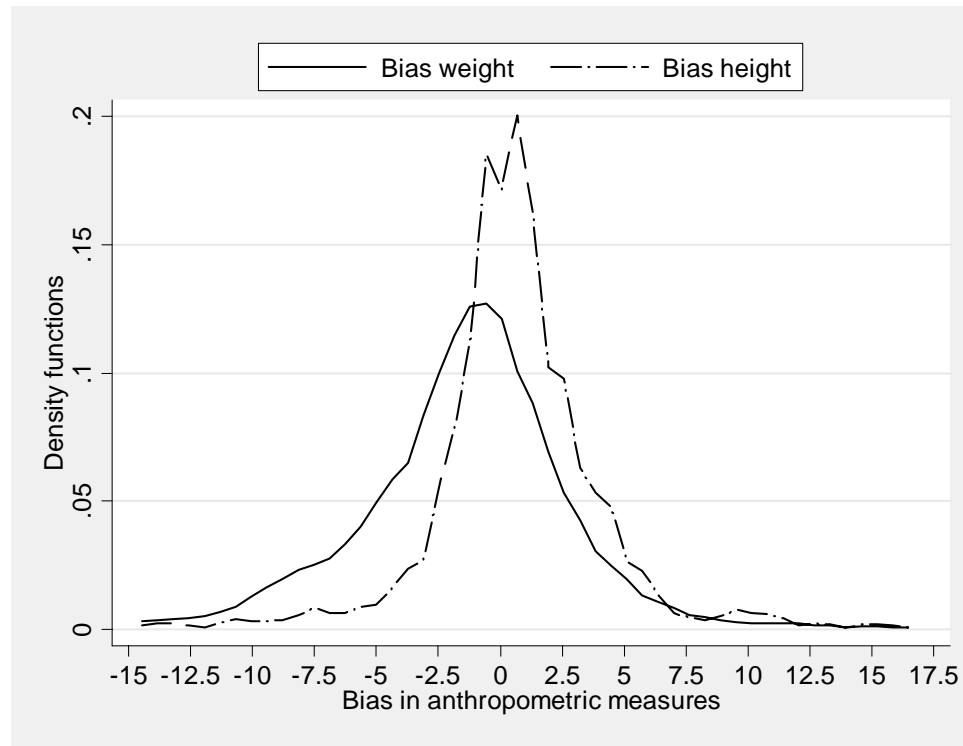
Table 1. Self-Reported and Measured Mean Height (cm), Weight (kg) and BMI (CHS & CHES, 2006)

	Female	Male	Age 15-24	Age 25-35	Age 36-45	Age 46-55	Age 56-65	Low Educ.	Second. Educ.	University Educ.
Weight:										
Self-Reported	62.56	78.14	63.95	68.64	72.00	72.73	73.57	72.48	69.04	71.17
	(11.08)	(12.90)	(12.13)	(14.11)	(14.10)	(14.99)	(13.89)	(13.39)	(14.70)	(14.00)
Measured	64.00	79.53	65.10	70.35	73.27	74.02	75.05	73.70	70.54	72.59
	(11.61)	(13.94)	(12.60)	(15.02)	(14.82)	(15.64)	(14.28)	(13.70)	(15.59)	(14.40)
Bias/Gap	**-1.45**	**-1.38**	**-1.15**	**-1.71**	**-1.27**	**-1.29**	**-1.48**	**-1.22**	**-1.50**	**-1.42**
	(4.12)	(4.34)	(4.29)	(4.57)	(3.90)	(4.03)	(4.21)	(4.44)	(4.08)	(4.34)
Bias (%)	2.3%	1.7%	1.8%	2.4%	1.7%	1.7%	2.0%	1.7%	2.1%	2.0%
Height:										
Self-Reported	161.26	173.82	169.93	169.19	167.69	165.36	164.34	164.91	167.44	170.45
	(6.57)	(7.51)	(9.44)	(9.21)	(9.16)	(9.74)	(8.60)	(8.83)	(9.32)	(9.59)
Measured	160.34	173.47	169.45	168.79	167.20	164.63	162.92	164.21	166.82	169.79
	(6.59)	(7.57)	(9.21)	(9.22)	(9.40)	(9.90)	(9.30)	(9.91)	(9.24)	(9.91)
Bias/Gap	**0.92**	**0.36**	0.48	**0.40**	**0.48**	**0.73**	**1.42**	**0.69**	**0.61**	**0.66**
	(3.30)	(3.42)	(3.58)	(3.34)	(3.40)	(2.91)	(3.59)	(3.64)	(3.36)	(3.09)
Bias (%)	0.6%	0.2%	0.3%	0.2%	0.3%	0.4%	0.9%	0.4%	0.4%	0.4%
BMI:										
Self-Reported	24.12	25.83	22.00	23.84	25.50	26.50	27.16	26.66	24.50	24.37
	(4.40)	(3.87)	(3.00)	(3.72)	(3.89)	(4.51)	(4.08)	(4.53)	(4.16)	(3.54)
Measured	24.99	26.39	22.58	24.57	26.11	27.14	28.26	27.36	25.23	25.05
	(4.77)	(4.24)	(3.40)	(4.16)	(4.21)	(4.61)	(4.53)	(4.77)	(4.54)	(3.94)
Bias/Gap	**-0.87**	**-0.56**	**-0.58**	**-0.73**	**-0.61**	**-0.64**	**-1.09**	**-0.70**	**-0.74**	**-0.68**
	(1.90)	(1.74)	(1.65)	(1.92)	(1.68)	(1.85)	(1.96)	(1.95)	(1.78)	(1.80)
Bias (%)	3.5%	2.1%	2.6%	3.0%	2.3%	2.4%	3.9%	2.6%	2.9%	2.7%

Table 1. Self-Reported and Measured Mean Height (cm), Weight (kg) and BMI (CHS & CHES, 2006) (continued)

	SAH 1	SAH 2	SAH 3	Measured Obese	Measured Overweight	Measured Normal weight	Measured Underweight
Weight:							
Self-Rep.	69.85	71.47	74.78	88.70	76.84	61.85	51.40
	(13.98)	(14.90)	(17.81)	(13.40)	(9.33)	(9.07)	(8.42)
Measured	71.32	72.66	76.13	92.24	78.29	62.21	49.80
	(14.49)	(15.14)	(19.10)	(13.91)	(10.35)	(8.71)	(6.74)
Bias/Gap	**-1.47**	**-1.18**	-1.35	**-3.54**	**-1.45**	**-0.36**	**1.60**
	(4.16)	(4.40)	(5.62)	(4.82)	(4.31)	(3.60)	(4.17)
Bias (%)	2.1%	1.6%	1.8%	3.8%	1.9%	0.6%	-3.2%
Height:							
Self-Rep.	168.17	165.11	163.74	167.65	168.24	167.29	167.46
	(9.46)	(8.75)	(9.75)	(9.26)	(9.35)	(9.00)	(11.64)
Measured	167.52	164.52	162.98	165.78	167.72	166.96	168.17
	(9.68)	(8.93)	(10.25)	(10.16)	(9.78)	(9.09)	(10.89)
Bias/Gap	**0.65**	**0.59**	0.76	**1.88**	**0.52**	**0.33**	-0.72
	(3.29)	(4.04)	(4.68)	(3.59)	(3.62)	(3.11)	(2.71)
Bias (%)	0.4%	0.4%	0.5%	1.1%	0.3%	0.2%	-0.4%
BMI:							
Self-Rep.	24.58	26.21	28.03	31.47	27.07	22.03	18.23
	(3.89)	(4.87)	(5.65)	(3.74)	(1.40)	(2.05)	(1.45)
Measured	25.32	26.80	28.79	33.44	27.76	22.22	17.53
	(4.26)	(5.21)	(5.93)	(3.31)	(2.38)	(1.73)	(0.67)
Bias/Gap	**-0.74**	**-0.59**	**-0.75**	**-1.96**	**-0.69**	**-0.20**	**0.70**
	(1.75)	(2.09)	(2.17)	(2.18)	(1.94)	(1.42)	(1.46)
Bias (%)	2.9%	2.2%	2.6%	5.9%	2.5%	0.9%	-4.0%

Note: Estimates performed using sampling weights and excluding outliers following Hadi (1992). Standard deviations are reported in brackets. SAH 1: good/very good and excellent, SAH 2: fair, SAH 3: poor self-assessed health status. Biases statistically significant at 5% are in bold typeface. Source: Catalan Health Survey (CHS) 2006 and Catalan Health Examination Survey (CHES) 2006.

Table 2. Variable Definition and Descriptive Statistics

Variable	Definition	Mean	SD
Demographics and Civil Status			
Male	= 1 if male; 0 female	0.485	0.50
Age	Age of the individual	45.26	17.78
Single	=1 if single	0.298	0.46
Widow	= 1 if widow	0.059	0.24
Divorced-Separated	= 1 if separated/divorced	0.050	0.22
Nationality			
African	= 1 if African nationality	0.020	0.14
Latin-American	= 1 if Latin America or Caribbean nationality	0.062	0.24
Asian	= 1 if Asian nationality	0.003	0.06
European	= 1 if European or other developed countries	0.018	0.13
Education & Wealth proxy			
Low Educ.	= 1 if low education	0.316	0.47
Secondary Educ.	= 1 if secondary education	0.497	0.50
Non Deprivation	= Index of individual deprivation (*)	0.753	0.18
Health Variables			
Fair Health	= 1 if fair self-assessed health status	0.212	0.41
Bad Health	= 1 if bad self-assessed health status	0.061	0.24
Chronic Diseases	Number of chronic conditions suffered by the individual	2.04	2.14
Checking Cholesterol	=1 if cholesterol is controlled habitually	0.525	0.50
Medical Visit	=1 if medical visit during last 15 days	0.264	0.44
Mental Health	Mental health index based on a GHQ-12	1.19	2.26
Weight Loss	= 1 if the individual has lost more than 6kg in the last 3 months	0.063	0.24
Fat Perception	= 1 if perceived as fat although others say subject is very thin	0.131	0.34
BMI and Fatness			
Measured BMI	Measured Body Mass Index (Kg/m^2)	26.14	4.69
WHR	Waist-to-hip ratio (waist circumference divided by hip circumference)	0.903	0.14
Waist Circumference	Measured waist circumference	90.41	14.42
Controls			
Interview Duration	Number of minutes of interview duration	44.53	13.24
Time Lag	Number of months between interview and examination	3.99	2.49
Height Rounding	= 1 if rounding one's height to the nearest '0' and '5' value		
Weight Rounding	= 1 if rounding one's weight to the nearest '0' and '5' value	0.384	0.49
Social Norms			
Social Norms on Height	Distance (cm) from one's measured height to an average reference group (**)	-0.030	6.63
Social Norms on Weight	Distance (kg) from one's measured weight to an average reference group (**)	-0.045	12.34

Note: (*) Defined by assigning one if the home is equipped with bath and/or bathtub, hot water, heating, washing machine, dish-washer and air-conditioning. (**) The considered reference group is defined in terms of gender, age group and educational attainment level. Means computed using sampling weights and excluding outliers for weight and height following Hadi (1992).

Table 3a. SURE Estimation of the Weight Bias (CHS & CHES, 2006)

	(1) Without social norms	(2) Social norms (age, gender & education)	(3) Social norms (zone & gender)	(4) Social norms (age & gender)
Social Norms on Weight		0.1012 (0.02)***	0.1059 (0.02)***	0.1113 (0.02)***
Measured BMI	0.6434 (0.14)***	0.4198 (0.15)***	0.4018 (0.15)***	0.4012 (0.15)***
Squared Measured BMI	-0.0047 (0.00)**	-0.0043 (0.00)*	-0.0042 (0.00)*	-0.0043 (0.00)*
Waist-to-hip Ratio	0.6424 (0.91)	1.3940 (0.90)	1.4593 (0.91)	1.4541 (0.90)
Waist Circumference	0.0081 (0.01)	-0.0213 (0.02)	-0.0224 (0.02)	-0.0256 (0.02)
Male	-0.8412 (0.24)***	-0.3337 (0.25)	-0.4474 (0.24)*	-0.2791 (0.25)
Age	-0.2103 (0.06)***	-0.1704 (0.06)***	-0.2108 (0.06)***	-0.1700 (0.06)***
Squared age	0.1942 (0.07)***	0.1826 (0.07)***	0.2148 (0.07)***	0.1867 (0.07)***
Single	-0.3302 (0.30)	-0.2979 (0.29)	-0.2976 (0.29)	-0.3050 (0.29)
Widow	-1.2469 (0.92)	-1.1223 (0.90)	-1.2583 (0.90)	-1.0755 (0.90)
Divorced-Separated	0.5517 (0.47)	0.7192 (0.47)	0.7098 (0.47)	0.7093 (0.46)
African	-1.6098 (0.67)**	-1.5032 (0.66)**	-1.5230 (0.66)**	-1.5805 (0.66)**
Latin-American	-0.6057 (0.46)	-0.5260 (0.45)	-0.5342 (0.45)	-0.5277 (0.45)
Asian	0.8409 (2.18)	0.9604 (2.15)	0.8697 (2.15)	1.0768 (2.15)
European-HIC	-0.7008 (0.65)	-0.7021 (0.64)	-0.6832 (0.64)	-0.6525 (0.64)
Low Education	-0.7953 (0.34)**	-0.5363 (0.34)	-0.6025 (0.34)*	-0.5219 (0.34)
Secondary Education	-0.3084 (0.27)	-0.2052 (0.27)	-0.1978 (0.27)	-0.1175 (0.27)
Non Deprivation	-0.3698 (0.66)	-0.5593 (0.66)	-0.6084 (0.66)	-0.5669 (0.66)
Fair Health	-0.8042 (0.31)***	-0.7529 (0.30)**	-0.7533 (0.30)**	-0.7568 (0.30)**
Bad Health	0.1042 (0.65)	0.0891 (0.64)	0.1181 (0.64)	0.0705 (0.64)
Chronic Diseases	-0.1854 (0.08)**	-0.1881 (0.08)**	-0.1927 (0.08)**	-0.1879 (0.08)**
Checking Cholesterol	0.3801 (0.22)*	0.3736 (0.21)*	0.3701 (0.21)*	0.3724 (0.21)*
Medical Visit	0.6921 (0.25)***	0.6193 (0.25)**	0.6391 (0.25)**	0.6156 (0.25)**
Mental Health	0.0347 (0.06)	0.0364 (0.06)	0.0315 (0.06)	0.0344 (0.05)
Weight Loss	-2.6077 (0.44)***	-2.6575 (0.43)***	-2.6989 (0.43)***	-2.6707 (0.43)***
Fat Perception	-0.5193 (0.32)	-0.4635 (0.32)	-0.4574 (0.32)	-0.4702 (0.32)
Time Duration	0.0112 (0.01)	0.0109 (0.01)	0.0106 (0.01)	0.0108 (0.01)
Time Lag	0.0411 (0.04)	0.0493 (0.04)	0.0469 (0.04)	0.0484 (0.04)
Weight Rounding	0.2359 (0.21)	0.1582 (0.21)	0.1670 (0.21)	0.1749 (0.21)
Constant term	-7.7617 (2.33)***	-1.9656 (2.50)	-0.3162 (2.63)	-1.2563 (2.51)
N	1,409	1,409	1,409	1,409
F -test	10.20 (0.00)	11.13 (0.00)	11.06 (0.00)	11.28 (0.00)
R-squared	0.2113	0.2313	0.2300	0.2340
Root MSE	3.78	3.73	3.74	3.73
$\rho(e_{1,i}, e_{2,i})$	-0.14	-0.11	-0.11	-0.11
$\chi 2$ Breusch-Pagan test	26.48 (0.00)	17.31 (0.00)	17.18 (0.00)	16.88 (0.00)

Note: Weight bias is defined as the difference between measured and self-reported weight. Estimations performed excluding multivariate outliers. These estimations included dummies for health sanitary regions. Standard errors in brackets. *** ($p<0.01$); ** ($p<0.05$); * ($p<0.1$).

Table 3b. SURE Estimation of the Height Bias (CHS & CHES, 2006)

	(1) Without social norms	(2) Social norms (age, gender & education)	(3) Social norms (zone & gender)	(4) Social norms (age & gender)
Social Norms on Height		-0.1017 (0.01)***	-0.1046 (0.01)***	-0.1002 (0.01)***
Measured BMI	0.4653 (0.12)***	0.3681 (0.11)***	0.3601 (0.11)***	0.3747 (0.11)***
Squared Measured BMI	-0.0043 (0.00)**	-0.0040 (0.00)**	-0.0039 (0.00)**	-0.0041 (0.00)**
Waist-to-hip Ratio	-2.1606 (0.73)***	-3.1749 (0.73)***	-3.1789 (0.73)***	-3.1771 (0.73)***
Waist Circumference	-0.0328 (0.01)***	0.0015 (0.01)	0.0023 (0.01)	0.0012 (0.01)
Male	-0.2559 (0.19)	-0.3903 (0.19)**	-0.3953 (0.19)**	-0.3840 (0.19)**
Age	-0.0711 (0.05)	-0.0836 (0.05)*	-0.0759 (0.05)*	-0.0899 (0.05)**
Squared age	0.0971 (0.05)*	0.1081 (0.05)**	0.0802 (0.05)	0.1194 (0.05)**
Single	-0.1860 (0.24)	-0.2159 (0.23)	-0.2079 (0.23)	-0.2143 (0.23)
Widow	1.9246 (0.74)***	2.0578 (0.72)***	2.0936 (0.72)***	2.0890 (0.72)***
Divorced-Separated	-0.2568 (0.38)	-0.4338 (0.37)	-0.4409 (0.37)	-0.4367 (0.37)
African	-0.0062 (0.54)	-0.0084 (0.53)	-0.0211 (0.53)	0.0058 (0.53)
Latin-American	-0.2418 (0.37)	-0.3440 (0.36)	-0.3183 (0.36)	-0.3164 (0.36)
Asian	4.5744 (1.75)***	4.6209 (1.72)***	4.6169 (1.72)***	4.6303 (1.72)***
European-HIC	-1.6758 (0.52)***	-1.6922 (0.51)***	-1.7013 (0.51)***	-1.6855 (0.51)***
Low Education	-0.6160 (0.27)**	-0.4371 (0.27)	-0.8147 (0.27)***	-0.7966 (0.27)***
Secondary Education	-0.0875 (0.22)	-0.0451 (0.22)	-0.2156 (0.22)	-0.2059 (0.22)
Non Deprivation	-0.1196 (0.53)	0.1875 (0.53)	0.1653 (0.52)	0.1915 (0.53)
Fair Health	-0.3953 (0.25)	-0.4372 (0.24)*	-0.4495 (0.24)*	-0.4376 (0.24)*
Bad Health	-0.7237 (0.52)	-0.7446 (0.51)	-0.7598 (0.51)	-0.7374 (0.51)
Chronic Diseases	0.0687 (0.06)	0.0729 (0.06)	0.0793 (0.06)	0.0721 (0.06)
Checking Cholesterol	-0.3742 (0.17)**	-0.3651 (0.17)**	-0.3702 (0.17)**	-0.3642 (0.17)**
Medical Visit	-0.3402 (0.20)*	-0.2697 (0.20)	-0.2810 (0.20)	-0.2748 (0.20)
Mental Health	-0.0181 (0.04)	-0.0105 (0.04)	-0.0111 (0.04)	-0.0105 (0.04)
Weight Loss	0.4152 (0.35)	0.5342 (0.35)	0.5427 (0.35)	0.5462 (0.35)
Fat Perception	-0.2376 (0.26)	-0.3347 (0.26)	-0.3210 (0.26)	-0.3268 (0.26)
Time Duration	0.0012 (0.01)	0.0019 (0.01)	0.0019 (0.01)	0.0019 (0.01)
Time Lag	0.0422 (0.03)	0.0340 (0.03)	0.0339 (0.03)	0.0336 (0.03)
Height Rounding	0.0113 (0.17)	-0.0043 (0.17)	-0.0018 (0.17)	-0.0106 (0.17)
Constant term	-1.8990 (1.87)	-1.6790 (1.84)	-1.0537 (1.84)	-1.5088 (1.84)
N	1,409	1,409	1,409	1,409
F -test	4.65 (0.00)	6.31 (0.00)	6.37 (0.00)	6.28 (0.00)
R-squared	0.1089	0.1451	0.1463	0.1442
Root MSE	3.04	2.98	2.98	2.98
$\rho(e_{1,i}, e_{2,i})$	-0.14	-0.11	-0.11	-0.11
$\chi2$ Breusch-Pagan test	26.48 (0.00)	17.31 (0.00)	17.18 (0.00)	16.88 (0.00)

Note: Height bias is defined as the difference between self-reported and measured weight. Estimations performed excluding multivariate outliers. These estimations included dummies for health sanitary regions. Standard errors in brackets. *** (p<0.01); ** (p<0.05); * (p<0.1).

Table 4. Prediction of Measured Anthropometric Data

A) Regression of Measured Weight on Self-Reported Weight (CHS & CHES, 2006)

	MALE	FEMALE
Self-Reported Weight (kg.)	1.8156***	0.9559***
Self-Reported Weight (kg.) Squared	-0.0050	0.0004
Age (years)	0.0482	0.0508
Age (years) Squared	-0.0005	-0.0007*
Constant	-31.73	2.0064
No. of Observations	947	967
R-squared	0.82	0.88

Note: The sample is formed by individuals aged 16 and over. Statistical inference based on robust standard errors. *** ($p<0.01$), ** ($p<0.05$), * ($p<0.1$).

B) Regression of Measured Height on Self-Reported Height (CHS & CHES, 2006)

	MALE	FEMALE
Self-Reported Height (cm.)	1.1036*	-1.4495
Self-Reported Height (cm.) Squared	-0.0006	0.0070**
Age (years)	0.0852*	0.0913**
Age (years) Squared	-0.0012**	-0.0019***
Constant	-0.1311	211.77**
No. of Observations	936	957
R-squared	0.77	0.73

Note: The sample is formed by individuals aged 16 and over. Statistical inference based on robust standard errors. *** ($p<0.01$), ** ($p<0.05$), * ($p<0.1$).

C) Regression of Measured Waist Circumference on Self-Reported Weight and Height (CHS & CHES, 2006)

	MALE	FEMALE
Self-Reported Weight (cm.)	1.4529***	1.4089***
Self-Rep. Weight Squared	-0.0041*	-0.0036**
Self-Reported Height	-2.3858*	0.0389
Self-Reported Height Squared	0.0059	-0.0009
Age	0.3159***	-0.0041
Age Squared	-0.0011	0.0022***
Constant	232.26**	23.09
No. of Observations	941	961
R-squared	0.60	0.72

Note: The sample is formed by individuals aged 16 and over. Statistical inference based on robust standard errors. *** ($p<0.01$), ** ($p<0.05$), * ($p<0.1$).

Table 5. Actual and Corrected Mean BMI and Obesity Rate (SNHS-2006)

	N	Actual BMI based on Self-Reports	Corrected BMI for Self-Reporting	Corrected BMI Cawley-Burkhauser (2008)	Actual Obesity based on Self-Reports	Corrected Obesity for Self-Reporting	Corrected Obesity Cawley-Burkhauser (2008)
MALE	10,894	26.28 (3.97)	26.59 (3.86)	26.38 (4.05)	15.19% (0.36)	17.48% (0.38)	15.97% (0.37)
FEMALE	15,310	25.08 (4.71)	26.06 (4.88)	25.85 (5.04)	14.85% (0.36)	19.60% (0.37)	19.36% (0.40)
TOTAL	26,204	25.69 (4.39)	26.32 (4.40)	26.12 (4.57)	15.02% (0.36)	18.53% (0.40)	17.65% (0.38)

Note: Estimated means computed using sampling weights. Standard deviations are reported in brackets.

Table 6. Estimated Mean Waist Circumference (SNHS -2006)

	MALE	FEMALE
Waist Circumference (cm)	96.29 (10.40)	86.74 (12.15)
"High Risk" [WC >= 102 cm (88 cm) in males (females)]	14.37%	21.21%
No. of Observations	10,894	15,310

Note: Estimated means computed using sampling weights. Standard deviations are reported in brackets.