Does BMI generated by self-reported height and weight measure up in older adults? Associations between self-report and measurement in six middle income countries from the Study on Global AGEing and Adult Health (SAGE)

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INTRODUCTION

Individuals often overestimate their height while concomitantly underestimating their weight; this results in lower obesity prevalence rates when self-report data are used to calculate BMI, a pattern that has been observed in both sexes (Gorber et al., 2007; Nyholm et al., 2007). This misclassification of obesity due to inaccurate self-reported (SR) BMI values has considerable public health implications, especially given that global obesity levels have reached epidemic-proportions. Thus, accurately identifying obese individuals, in particular, is crucial to the interpretation of lifestyle factors that increase obesity risk (Flegal et al., 2013).

Individual characteristics, such as true (measured) weight and age, also appear to influence the accuracy of SR BMI values. It appears that actual body weight may influence the extent to which an individual underestimates their weight. For example, Hill and Roberts (1998) documented a ~0.1 increase in BMI underestimation for every unit increase in measured BMI. Furthermore, previous research has documented that the overestimation of height and underestimation of weight significantly increases with age, leading to the increased misclassification of overweight and obese older individuals (Lawlor et al., 2002; Dahl et al., 2010). This misclassification may preclude enrollment in weight reduction programs designed to reduce the health complications associated with obesity, thereby putting these older individuals at risk.

Still, studies assessing the accuracy of SR BMI have largely been restricted to wealthier nations. The few studies examining these relationships in lower income countries have produced conflicting results. Weight underestimation and height overestimation (similar to Western populations) has been documented in Mexico, Thailand, and China (Santillan and Camargo, 2003; Lim et al., 2009; Zhou et al., 2010), while studies in Brazil and Mexico have observed no significant difference between self-report and measured BMI (Osuna-Ramírez et al., 2006; Rech et al., 2008). Thus, further work is required to determine if the discrepancies between SR and measured BMI are shared or differ by culture.

The present study assesses whether SR and measured BMI values differ cross-culturally in older adults using data from World Health Organization's Study on global AGEing and adult health (SAGE) Wave 1 (Kowal et al., 2012). Data from six middle income countries (China, Ghana, India, Mexico, the Russian Federation, and South Africa) are used to examine how discrepancies in SR and actual BMI among older adults varies cross-culturally. Three hypotheses are tested. First, BMI calculated from SR height and weight will significantly differ from BMI calculated from height and weight measured by SAGE interviewers. Second, heavier individuals will be more likely to underreport their weight, decreasing their SR BMI value and resulting in a negative difference between SR and measured BMI. Third, age will be inversely correlated with discrepancies in SR and measured BMI (calculated by subtracting measured BMI from SR BMI); thus, older adults will be more likely to misreport their height and weight).

METHODS

Study Design and Participants

Nationally-representative samples of older adults (≥50 years old) and comparative samples of younger adults (18-49 years old) were drawn from each SAGE country. Face-to-face interviews were used to collect household and individual level data (Kowal et al., 2012).

BMI Variables

Participants were asked to report their height and weight during the face-to-face interview; these values were then used to calculate SR BMI as a ratio of weight divided by height squared (kg/m^2). In addition, trained SAGE researchers obtained participant height and weight measurements using standard procedures, and these values were used to calculate measured BMI.

Socio-demographic and health behavior variables

Sex and age were collected as part of the interview. Participants were also asked about their highest level of education attained, and this variable was dummy coded using less than primary school as the reference group. Physical activity level (PAL) was calculated from interview data. Participants were asked to report the number of hours during a typical day they spent in vigorous-intensity activities as part of their work, in moderate-intensity activities as part of their work, in vigorous-intensity activities during leisure time, and in moderate-intensity activities during leisure time. Time spent in vigorous or moderate exercise for both work and leisure were averaged together to create a composite PAL measure. Tobacco and alcohol consumption patterns were sorted into frequency categories. Smoking categories were defined as "not at all," "occasionally," and "daily," while drinking categories included "not at all," "occasionally," (<3 days per month) and "moderate/heavy drinker" (>1 days per week). The smoking and drinking variables were then dummy coded using the "not at all" category as the reference group. Finally, following standard procedures (Nyholm et al., 2007), responses to an overall self-rated general health questionnaire item (5-point scale from very good to very bad) were dummy coded using the lowest health rating as the reference group.

Statistical Analyses

Paired t-tests were used to assess whether a significant difference between SR and measured BMI values was evident in different age groups by sex and country. Specifically, differences between self-report and measured BMI were evaluated in older men (≥50 years or older), older women, younger men (18-49 years old), and younger women in each country.

A series of linear regressions were then conducted to determine the relative contribution of measured weight and age to the discrepancy between SR and measured BMI. The education dummy variable was entered in the first step to control for the contribution of education to variation in BMI. Sex and age were also entered in the first step. The total PAL variable was then entered in the second step of the regression. The smoking and drinking dummy codes were also entered in the second step of the regression to control for behavior that might contribute to variation in BMI. The self-rated health dummy codes were entered in the third step of the regression to control for the influence of perceived health on reported body measures. Measured body weight was then entered in the final step.

A second linear regression was then run to examine if age contributed to discrepancies between SR and measured BMI values. Sex and the education dummy codes were entered in the first step of the regression. Total PAL, smoking frequency, and drinking frequency were entered in the second step of the regression. The self-rated health dummy codes were entered in the third step of the regression and age (as a continuous variable) was entered in the final step of the regression. All regressions were conducted separately by country.

RESULTS

Differences between reported and measured BMI by age group

The results of the paired t-tests indicated that significant differences exist between self-reported and measured BMI values; however, these differences are not uniform and vary by country, sex, and age group. Significant differences between SR and measured BMI in older men (≥ 50 years old) were observed in Ghana, India, South Africa, and Russia ($p < 0.05$). More specifically, mean SR BMI was significantly higher than mean measured BMI in Ghana, India, and South Africa; however, mean SR BMI was lower than mean measured BMI in Russia. Similarly, significant differences between SR and measured BMI in older women were observed in Mexico, Ghana, India, and Russia ($p < 0.01$). Mean SR BMI in older women was significantly higher than mean measured BMI in Ghana and India; however, mean SR BMI was lower than mean measured BMI in Mexico and Russia.

Significant differences were also observed among younger adults (18-49 years old) of both sexes in some countries. Among younger men, mean SR BMI was significantly higher than mean measured BMI in India ($p < 0.001$). Among younger women significant differences were evident in India, China, and Russia ($p < 0.05$). Mean SR BMI was significantly higher than mean measured BMI in India; however, mean SR BMI was significantly lower than mean measured BMI in China and Russia.

Measured Body Weight and the Discrepancy between Reported and Measured BMI

A linear regression was used to assess the contribution of measured body weight to variation in the discrepancy between self-report and measured BMI in each country while controlling for several confounding demographic and health variables. When controlling for potential confounders, there were not enough individuals in Ghana with SR BMI values to run a regression in this country, but all other countries had adequate sample sizes. Measured weight significantly contributed to the discrepancy between reported and measured BMI in China and Russia. In China, measured weight explained a significant 2.0% of the variance in BMI discrepancy ($p < 0.001$), while in Russia measured weight explained 2.8% of additional variance ($p < 0.001$). Specifically, for each unit increase in measured body weight the discrepancy between SR and measured BMI became more negative (B = -0.055 in China and B = -0.063 in Russia).

Age and the Discrepancy between Reported and Measured BMI

A second linear regression was used to examine the contribution of age to variation in the discrepancy between self-report and measured BMI in each country while controlling for several confounders. When controlling for potential confounders, there were not enough individuals in Ghana with SR BMI to run a regression in this country, but all other countries had adequate sample sizes. In all countries, age contributed an insignificant amount to variation in BMI discrepancy.

Discussion

The present study found mixed support for two of the three hypotheses. Significant differences between SR and measured BMI values were observed in some countries, but the direction of these divergences varied by country. Measured body weight contributed to variation in SR and measured BMI differences in only two of the six countries (China and Russia); although in both cases it does appear that individuals with higher body weight are more likely to underestimate their BMI, as expected. Finally, age did not significantly contribute to BMI discrepancy variation in any of the populations examined.

Older men in Ghana, India, and South Africa reported significantly higher SR BMI values than those calculated using measured height and weight. These findings fail to support the typical pattern observed in wealthier nations (where individuals are more likely to underestimate their BMI); only in Russia did older men significantly underestimate their BMI. Similarly, older women in Ghana and India overestimated their BMI, and only older women in Mexico and Russia underestimated their BMI as expected. These mixed findings were also apparent among younger adults. Younger men significantly overestimated their BMI in India, but in no country did younger men exhibit the expected pattern of underestimating their BMI. Younger women in India also significantly overestimated their BMI; however, younger women China and Russia underestimated their BMI as anticipated. Interestingly, at all ages, both men and women overestimate their BMI in India. Similarly, in all age groups (except young men) both men and women significantly underestimated their BMI in Russia. These findings seem to suggest that cultural differences influence the accuracy of SR BMI values. For instance, among the six countries examined, the prevalence of underweight by measured BMI is highest in India; these individuals are therefore more likely to have a lower BMI than participants living the other SAGE countries, and may subsequently overestimate their BMI. Conversely, more developed nations (like Russia) may exhibit diet, activity patterns, and body composition more similar to wealthier nations, and consequently underestimate their BMI as has been observed in upper income populations.

The results of linear regression assessing the contribution of measured body weight to the difference between reported and measured BMI also lend credence to the hypothesis that national level of economic development may influence the accuracy of SR BMI. Specifically, older adults in China and Russia, highly developed countries, were the only populations in which increased measured body weight significantly contributed to the difference between SR and measured BMI as expected (e.g., via heavier adults underestimating their BMI). Future research should assess whether economic factors, such as household income or dwelling location (urban or rural), significantly contribute to variation in the difference between SR and measured BMI.

In conclusion, this study documented significant differences in SR and measured BMI that vary by country and sex, but not age, and often contradict findings from more affluent countries. These results suggest that SR BMI may not accurately reflect measured BMI in middle income countries, but the direction of this discrepancy varies by country. This cultural variation in reported BMI has international public health implications, and suggests obesity interventions reliant on BMI data must carefully assess the validity of SR BMI values based on country and population. Thus, differences in reported BMI at different levels of economic development in distinctive cultures should be considered in future public health interventions and epidemiological studies aimed at decreasing obesity prevalence.

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