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Accuracy of Self-Reported Versus Measured Weight Over Adolescence and Young Adulthood: Findings From the National Longitudinal Study of Adolescent Health, 1996–2008

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Many studies rely on self-reports to capture population trends and trajectories in weight gain over adulthood, but the validity of self-reports is often considered a limitation. The purpose of this work was to examine long-term trajectories of self-reporting bias in a national sample of American youth. With 3 waves of data from the National Longitudinal Study of Adolescent Health (1996–2008), we used growth curve models to examine self-reporting bias in trajectories of weight gain across adolescence and early adulthood (ages 13–32 years). We investigated whether self-reporting bias is constant over time, or whether adolescents become more accurate in reporting their weight as they move into young adulthood, and we examined differences in self-reporting bias by sex, race/ethnicity, and attained education. Adolescent girls underreported their weight by 0.86 kg on average, and this rate of underreporting increased over early adulthood. In contrast, we found no evidence that boys underreported their weight either in adolescence or over the early adult years. For young men, self-reports of weight were unbiased estimates of measured weight among all racial/ethnic and educational subpopulations over adolescence and early adulthood.

adolescence; bias; measurement; self-report; trajectories; weight; youth

Abbreviation: Add Health, National Longitudinal Study of Adolescent Health.

Although some population-based surveys use direct anthropomorphic measurements to track trends in obesity (1), many studies rely on self-reported measures of weight and height (2). Objective measurement of weight and height can be prohibitively expensive in large population-based surveys, and even impossible for studies that rely on telephone or mail surveys. Self-reported data are easy and relatively inexpensive to collect (3), but the validity of self-reports has been questioned. Although biases in self-reported height are generally small (4–7), differences between self-reported and measured weight are more marked. A number of studies have investigated bias in self-reported weight in adult populations and have generally found self-reports to be similar to measured weight (Pearson's $r = 0.77$–0.99) (8–11). Nevertheless, self-reports of weight are consistently lower than measured weight and also vary by individual characteristics, with women and younger adults tending to underreport their weight more than men and older adults (8, 9, 12).

There is comparatively less research examining self-reported weight in adolescence and young adulthood—critical periods of the life course for research on obesity (13). Although some studies suggest that adolescents' reports of weight are valid and reliable (14–16), others have raised concerns (17–21). However, most of this research has been limited to select, geographically defined samples. The National Longitudinal Study of Adolescent Health (Add Health) provides a unique opportunity to examine reporting bias during youth, because it includes measures of both self-reported and measured weight in a nationally representative sample of American adolescents followed repeatedly into their young-adult years (4 waves of data from 1994 to 2008). Goodman et al. (22) compared self-reported and measured weight using data from more than 10,000 adolescents in the second wave (in 1996) of Add Health (the first wave for which measured weight data are available). They found a strong correlation between measured and self-reported weight ($r = 0.95$),

Table 1. Growth Curve Model of Weight by Age for Female Subjects Aged 13–32 Years in the National Longitudinal Study of Adolescent Health, Waves 2–4, 1996–2008

Variable	Unstandardized Regression Coefficients				
	Model A: Unconditional Linear Growth	Model B: Plus Quadratic Term	Model C: Plus Self-Report	Model D: Plus Covariates	Model E: Plus Covariates Over Time
Weight at Baseline (kg at age 13 years)					
Intercept	58.02[a]	54.82[a]	55.23[a]	53.01[a]	54.63[a]
By self-report[b]			−0.86[a]	−0.72[a]	−0.73[a]
By race/ethnicity[c]					
Hispanic				−0.84	−0.36
Non-Hispanic black				4.63[a]	3.39[a]
Asian				−8.06[a]	−6.16[a]
Other race				−0.23	−0.78
By attained education[d]					
Less than high school				3.43[a]	0.67
High school				3.17[a]	0.08
Some college				2.71[a]	0.84
Self-report × race/ethnicity[c]					
Self × Hispanic				0.25	0.25
Self × black				−0.25	−0.25
Self × Asian				0.95[a]	0.95[a]
Self × other				0.33	0.33
Self-report × education[d]					
Self × less than high school				−0.06	−0.07
Self × high school				−0.27	−0.27
Self × some college				−0.29[a]	−0.29[a]
Rate of Weight Change (kg/year of age)					
Age	1.22[a]	2.03[a]	2.10[a]	2.07[a]	1.68[a]
Age^2		−0.04[a]	−0.04[a]	−0.04[a]	−0.04[a]
By self-report					
Age × self-report			−0.12[a]	−0.12[a]	−0.12[a]
Age^2 × self-report			0.01[a]	0.01[a]	0.01[a]

Table continues

and they found no evidence of self-reporting bias by race, parental education, or household income. However, they did find that adolescent girls tended to underreport their weight to a greater degree than adolescent boys.

More recently, Field et al. (23) extended this work to examine differences in self-reported and measured weight change across 2 waves (in 1996–2001) of Add Health data, when subjects were aged 16–26 years. They found that both males and females slightly underreported their weight at both time points, but because underreporting was fairly consistent, a measure of weight change was not biased by self-report. However, to our knowledge, no research has examined long-term trajectories of self-reporting bias in a national sample of youth.

We used 11 years of data (3 waves, in 1996–2008) from Add Health participants aged 13–32 years. We investigated whether self-reporting bias is constant over time, or whether adolescents become more accurate in reporting their weight as they move into young adulthood, and we examined differences in self-reporting bias by sex, race/ethnicity, and attained education.

METHODS

In 1994–1995, Add Health administered an in-school questionnaire to more than 90,000 students from a nationally representative sample of schools (24). A stratified random sample of 20,745 adolescents was then interviewed in their homes in 1995, constituting the baseline survey (wave 1) of the longitudinal cohort. These adolescents were followed 1 year later in 1996 (wave 2, $n = 14{,}738$, 88.2% response rate), 5 years later in 2001–2002 (wave 3, $n = 15{,}197$, 77.4% response rate), and most recently in 2007–2008 (wave 4, $n = 15{,}701$, 80.3% response rate). Nonresponse analysis conducted by the Add Health study team suggests there is no significant bias to Add Health estimates from attrition across

Table 1. Continued

Variable	Unstandardized Regression Coefficients				
	Model A: Unconditional Linear Growth	Model B: Plus Quadratic Term	Model C: Plus Self-Report	Model D: Plus Covariates	Model E: Plus Covariates Over Time
By race/ethnicity					
Age × Hispanic					−0.12
Age^2 × Hispanic					0.01
Age × black					0.22
Age^2 × black					0.01
Age × Asian					−0.32
Age^2 × Asian					0.01
Age × other race					0.16
Age^2 × other race					−0.001
By education					
Age × less than high school					0.84[a]
Age^2 × less than high school					−0.04[a]
Age × high school					0.78[a]
Age^2 × high school					−0.02[a]
Age × some college					0.45[a]
Age^2 × some college					−0.01
	Variance Components				
Intercept	16.81[a]	18.23[a]	18.26[a]	15.57[a]	15.50[a]
Age	1.28[a]	4.05[a]	4.05[a]	3.43[a]	3.41[a]
Age^2		0.20[a]	0.20[a]	0.17[a]	0.17[a]

[a] $P < 0.05$ (2-tailed tests).
[b] Reference group is measured weight (time varying).
[c] Reference group is white.
[d] Reference group is college degree.

waves (25). Because measured weight data are only available beginning in wave 2, we restricted our analyses to 19,238 respondents who participated in any wave after wave 1. Thus, respondents contributed anywhere from 1 to 3 observations to the analyses. Secondary analysis of Add Health data for this project was approved by the institutional review board at the University of Michigan (Ann Arbor, Michigan).

Measures

Respondents were first asked to self-report their weight in pounds at each interview (which was converted to kilograms for analyses). Following the computer-assisted interview, respondents were asked to remove their shoes and any items from their pockets, and weight was measured to the nearest 0.1 kg using a Health O Meter 844KL high-capacity digital scale (Jarden Corp., Rye, New York) (26). Thus, we have 2 measurements of weight at each wave in which a respondent was interviewed, generating up to 6 observations per person across all 3 waves. (Data were excluded for respondents who were pregnant at the time of interview.) A dummy variable was used to distinguish between measured and self-reported weight in the data, and in the analysis, it captures the difference between the 2 (e.g., underreporting) over time.

Time-invariant covariates included sex and race/ethnicity (captured using 4 dummy variables contrasting non-Hispanic black, Hispanic, Asian, and other race/ethnicity (e.g., Native American) with white respondents). Attained education was modeled using 3 dummy variables comparing those who did not complete high school, those with a high school diploma, and those with some college versus those with a college degree or higher. Missing data on attained education by wave 4 ($n = 1{,}381$, 7.2%) was multiply imputed using SAS, version 9.2, software (SAS Institute, Inc., Cary, North Carolina) using data on sociodemographic covariates, educational performance (grades and history of skipping or being suspended from school), college aspirations, family income, parents' education, parents' occupation, and parents' marital status from prior waves (27, 28).

Statistical analyses

We used growth curve models to estimate trajectories of weight gain over adolescence and early adulthood (29). Age (centered at 13 years) was used as the indicator of time. To address nonlinearity in weight gain trajectories, we fitted and tested quadratic terms. All models were estimated in Stata, version 12, software (StataCorp LP, College Station, Texas) using full information maximum likelihood assuming

Table 2. Growth Curve Models of Weight by Age for Male Subjects Aged 13–32 Years in the National Longitudinal Study of Adolescent Health, Waves 2–4, 1996–2008

Variable	Unstandardized Regression Coefficients				
	Model A: Unconditional Linear Growth	Model B: Plus Quadratic Term	Model C: Plus Self-Report	Model D: Plus Covariates	Model E: Plus Covariates Over Time
Weight at Baseline (kg at age 13 years)					
Intercept	67.74[a]	62.02[a]	62.15[a]	61.83[a]	61.34[a]
By self-report[b]			−0.28	−0.38	−0.38
By race/ethnicity[c]					
Hispanic				−1.52[a]	−2.53[a]
Non-Hispanic black				0.08	0.07
Asian				−6.39[a]	−5.65[a]
Other race				3.08[a]	2.48
By attained education[d]					
Less than high school				−0.77	1.17
High school				0.44	1.65
Some college				1.47[a]	1.78[a]
Self-report × race/ethnicity[c]					
Self × Hispanic				−0.16	−0.15
Self × black				0.25	0.25
Self × Asian				−0.21	−0.22
Self × other				−0.22	−0.22
Self-report × education[d]					
Self × less than high school				0.24	0.25
Self × high school				0.16	0.16
Self × some college				0.08	0.07
Rate of Weight Change (kg/year of age)					
Age	1.53[a]	3.07[a]	3.08[a]	3.14[a]	3.36[a]
Age^2		−0.08[a]	−0.08[a]	−0.08[a]	−0.10[a]
By self-report					
Age × self-report			−0.02	−0.02	−0.02
Age^2 × self-report			−0.0001	−0.0001	−0.0001

Table continues

normally distributed residuals. Maximum likelihood produces unbiased coefficients under the assumption that the attrition process is conditional on observed variables in our models (30–32). All data and analyses were weighted by time-varying cross-sectional weights (waves 2 through 4) to account for the unequal probability of selection into the Add Health sample, as well as differential nonresponse. Because of the consistent evidence for sex differences in self-reporting bias (7), we ran separate models for males and females.

RESULTS

The sample was equally divided by sex ($n = 9{,}864$ females, $n = 9{,}374$ males). Almost two-thirds of the sample was white and less than one-fifth was African American. Hispanics made up approximately 12% of the sample, whereas Asians and other racial/ethnic groups constituted a smaller minority (4%). By the fourth wave of Add Health (when adolescents had reached ages 24–32 years), the majority (44%) had obtained some college education.

Trajectories of weight gain among young women

Results from the unconditional growth model are presented in model A (Table 1) for women. Coefficients represent the association between the independent variables and weight in kilograms at baseline (intercept) and kilograms per year of age (rate of change). Girls weighed 58 kg on average at age 13 years, and they gained weight at an average rate of 1.2 kg per year to age 32 years. There was significant variation in weight between girls at age 13 years and significant variation in the rate of weight gain over time (variance components). Model B indicates a significant quadratic term, where weight increased rapidly early in adolescence and then attenuated with age. Adolescent girls underreported their weight by 0.86 kg on average at age 13 years (model C), and this rate of underreporting increased with age.

Table 2. Continued

Variable	Unstandardized Regression Coefficients				
	Model A: Unconditional Linear Growth	Model B: Plus Quadratic Term	Model C: Plus Self-Report	Model D: Plus Covariates	Model E: Plus Covariates Over Time
By race/ethnicity					
Age × Hispanic					0.15
Age^2 × Hispanic					0.01
Age × black					−0.01
Age^2 × black					0.01
Age × Asian					−0.15
Age^2 × Asian					0.01
Age × other race					0.20
Age^2 × other race					−0.01
By education					
Age × less than high school					−0.55[a]
Age^2 × less than high school					0.03[a]
Age × high school					−0.44[a]
Age^2 × high school					0.03[a]
Age × some college					−0.21
Age^2 × some college					0.02[a]
	Variance Components				
Intercept	17.84[a]	21.72[a]	21.72[a]	19.28[a]	19.26[a]
Age	1.29[a]	4.28[a]	4.28[a]	3.73[a]	3.71[a]
Age^2		0.21[a]	0.21[a]	0.18[a]	0.18[a]

[a] $P < 0.05$ (2-tailed tests).
[b] Reference group is measured weight (time varying).
[c] Reference group is white.
[d] Reference group is college degree.

In terms of racial/ethnic differences, the measured weight of non-Hispanic black women was 4.63 kg more than that of white women, but African American women underreported their weight at similar levels to white women at age 13 years (model D). There was no evidence of differential rates of weight gain by race/ethnicity over time (model E), nor was there any indication that self-reporting bias varied by race/ethnicity over time (models not shown). Asian women weighed, on average, 8.06 kg less than white women (model D) and showed no evidence of self-report bias ($\hat{\beta}$ for self report = $-0.72 + 0.95 = 0.23$ kg, which was not statistically different from 0 in posthoc tests).

There was a strong educational gradient in measured weight among females. In adolescence, young women who do not eventually graduate from college weigh significantly more than those who do and exhibit a more rapid rate of weight gain over early adulthood (model E). For example, compared with women with a college degree, women with a high school education gained 0.78 kg more per year of age, although this was attenuated at later ages as a function of the age^2 term ($\beta = -0.02$). There was also evidence of differential underreporting of weight by attained education; young women with only some college education underreported their weight by 0.29 kg more than college graduates (models D and E).

Trajectories of weight gain among young men

Table 2 presents a similar set of models for young men. In early adolescence, boys weighed 67.7 kg on average, which was 9.7 kg more than girls at the same age. Boys also gained weight more rapidly than girls, gaining 1.5 kg per year of age (model A). Similar to the results for females, there was evidence of a quadratic form to the model, with more rapid weight gain early in adolescence that tapered off with increasing age (model B). Model C in Table 2 adds the binary indicator for self-report. Unlike girls, early-adolescent boys did not underreport their weight at age 13 years and showed no evidence of any reporting bias with increasing age.

There was no evidence of differential rates of measured weight gain by race/ethnicity over time (model E), nor was there any indication that self-reporting bias varied by race/ethnicity over time (models not shown). There was no significant difference in the measured weight of non-Hispanic black and white adolescent males, but Hispanic males weighed 1.5 kg less than white males, on average (model D). Similar to the results for women, Asian males weighed 6.4 kg less than white males and showed no evidence of self-reporting bias. Adolescent boys who did not go on to graduate from college weighed more than those who did ($\beta = 1.47$, model D). There

were no differences in self-reporting bias among young men by education.

DISCUSSION

The use of self-reported body weight to monitor population trends in obesity is controversial. Although some consider self-reports to be valid and reliable (12, 15, 22), others urge caution on the basis of findings that suggest a consistent underreporting of weight, especially among adolescent girls (7). Although most of the existing research has used cross-sectional data (or data from 2 time points (23)), this study examined trajectories of self-reporting bias in weight over adolescence and young adulthood using multiple, repeated observations from a nationally representative sample over a 13-year period.

Consistent with previous research (7), we found notable differences in self-reporting bias by sex. Adolescent girls underreported their weight, and underreporting increased over early adulthood. The rate of underreporting was the same for African American, white, and Hispanic young women, but Asian women showed no evidence of self-reporting bias. In contrast, we found no evidence that boys underreported their weight either in adolescence or over the early adult years. Nor did we find any evidence of self-report bias among young men by racial/ethnic group or attained education.

Many researchers urge caution when interpreting population trends in obesity and overweight on the basis of self-reported weight data (4, 16, 20) and even apply a correction factor to empirically adjust for self-report bias (33–35). Our findings suggest that adolescent boys are accurate in reporting their weight and remain consistently accurate throughout the transition to young adulthood. Any correction for self-report should, therefore, be reserved for young women. However, such a correction factor should not be applied to young Asian women, who were consistently accurate in reporting their weight over time. Underreporting of weight in this study may have been minimized because respondents were interviewed in person. This study was also unable to explore the role of other factors, such as social norms, which have been shown to affect misreporting of weight (36) but are not available in the Add Health data.

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Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth).

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