Research Article

Weight Underestimation as a Potential Contributor to US Obesity

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Abstract

Introduction: There has been a significant increase in obesity in the US in recent decades. There is research indicating that weight underestimation reduces weight loss behaviors, which may contribute to the change in obesity. Our objective was to identify personality traits associated with weight underestimation present in the sample and to study if a change in those traits over time can be associated to a change in underestimation in the MIDUS cohort of English-speaking US Adults randomly sampled and longitudinally surveyed 3 times from 1995 to 2014.

Methods: The MIDUS study began with 3602 participants with BMI's >= 25.0 with 1794 remaining by the end of the study. General linear mixed models were used to evaluate change in weight underestimation over time in association with demographic and personality trait variables.

Results: Weight underestimation increased from 1995 to 2014, OR = 2.15 (95% CI = 1.85-2.49, p<.000). Blacks were more likely to underestimate when compared to Whites OR = 2.16 (95% CI = 1.67-2.81, p<.000). Education was inversely related to underestimation with those who have Graduate Degrees being less likely than those with Less Than High School OR = 0.39 (95% CI = 0.30-0.51, p<.000). Those who rated themselves against the question Caring Describes Me as "A Lot" were less likely to underestimate when compared to all other responses (less caring) OR = 0.86 (95% CI = 0.77, 0.96, p<.011). Optimism was not found to be significantly associated with weight underestimation. Self-reported levels of Caring and Optimism did not change over time.

Conclusions: MIDUS Participants who rated themselves as most caring were more likely to have a realistic perception of their weight status. A change in personality traits over time was not demonstrated and did not contribute to a change in underestimation, although there was a significant change in underestimation.

Introduction

The US population has become increasingly overweight and obese as measured by Body Mass Index (BMI); over 40 years from 1998-2014, the proportion of the population with a BMI >=25.0 has risen from 57% to 68% [1]. There is evidence that not all persons with BMI's >=25.0 perceive themselves to be overweight, decreasing the likelihood that they will participate in weight change behaviors [2,3]. Personality traits including agreeableness, caring and optimism have been implicated in various ways in perception of weight. Sutin finds that optimism correlates with dissonance between perceived and actual body weight with those scoring higher in optimism being more likely to report a weight 5 lbs. less than their actual weight (OR = 1.06, 95% CI = 1.02-1.10) [3]. Social normative pressures to maintain a healthy weight are correlated to agreeableness (inclusive of caring) [4].

This study examines whether Americans have generally become more caring, optimistic or agreeable and how these personality variables relate to the likelihood of the weight underestimation, as well as how the change over time in underestimation correlated with these variables. This study uses longitudinal data from the Midlife in the United States survey (MIDUS) with data collected between 1995 and 2014 containing information about personality, weight perception and anthropometric measurements for English speaking adults in the US [5-7].

Materials and Methods
Study Population

Participants in the three MIDUS surveys are a random sample of adults in major US metropolitan areas aged 20 to 75 years during the initial survey period. The longitudinal survey data is from the same participants of the cohort in three waves: MIDUS I (N=7,108 from 1995-'96), MIDUS II (N=4,963 from 2004-'06) and MIDUS III (N=3,294 from 2013-'14). The survey was conducted using both telephone and paper surveys for each respondent [5,8].

Body Mass Index

BMI Measures are calculated from self-reported anthropometric data using survey provided instructions and measurement materials. The World Health Organization defines BMI as

weight (in kilograms) divided by height squared (in meters) with BMIs greater than or equal to 25.0 considered overweight and BMI greater than or equal to 30 as obese [9].

Self-Perception of Weight

Weight perception is recorded using the question: "Which of the following do you consider yourself?" Very Overweight, Somewhat Overweight, About the Right Weight, Somewhat Underweight, Very Underweight, or Don't Know [5]. For the purposes of this study Underestimation refers to those who have a BMI >= 25.0 and respond to the perception question with About the Right Weight, Somewhat Underweight or Very Underweight or those who have a BMI>= 30.0 and respond with Somewhat Overweight, About the Right Weight, Somewhat Underweight or Very Underweight.

Statistical Analysis

General linear mixed models analyse with binary logistic regression on underestimation were used for evaluation of effects of caring and optimism on weight underestimation for the three survey periods. The variable for agreeableness was not included to reduce the effects of multicollinearity – the R2 for caring as a predictor for agreeableness is 0.627 (p<.000). Models were analyzed with and without demographic and socioeconomic covariates: gender (male, female or unknown), race (White, Black or Other), highest level of education completed, household income in thousands, and age summarized by decade as well as with and without the variables for caring and optimism to provide data about the association of these self-reported personality trait variables to the change in underestimation.

Results

Table 1 shows the demographic characteristics of those in the sample with BMIs >=25.0 who underestimate their weight compared to those who do underestimate their weight. While the distribution of males and females was approximately equal among those participants who are overweight or obese,

Table 1: Demographic and Socioeconomic Characteristics of MIDUS Participants with BMI>25.0 [6-8].

	All Participants with BMI >= 25.0			Underestimates Weight Status			Does Not Underestimate Weight Status		
	1995-'96	2004-'06	2013-'14	1995-'96	2004-'06	2013-'14	1995-'96	2004-'06	2013-'14
Participants with BMI >=25.0	3602	2581	1794	1088	884	683	2514	1697	1111
Gender (Year: p <.000, Gender: p <.000, Year × Gender: p <.882)									
Male	1986 (55.1%)	1317 (51%)	876 (48.8%)	765 (70.3%)	593 (67.1%)	425 (62.2%)	1221 (48.6%)	724 (42.7%)	451 (40.6%)
Female	1616 (44.9%)	1264 (49%)	918 (51.2%)	323 (29.7%)	291 (32.9%)	258 (37.8%)	1293 (51.4%)	973 (57.3%)	660 (59.4%)
Race (Year: p <.000, Race: p <.007, Year × Race: p <.192)									
White	3166 (87.9%)	2355 (91.2%)	1604 (89.4%)	935 (85.9%)	791 (89.5%)	595 (87.1%)	2231 (88.7%)	1564 (92.2%)	1009 (90.8%)
Black	214 (5.9%)	105 (4.1%)	65 (3.6%)	95 (8.7%)	45 (5.1%)	35 (5.1%)	119 (4.7%)	60 (3.5%)	30 (2.7%)
Other	222 (6.2%)	121 (4.7%)	125 (7%)	58 (5.3%)	48 (5.4%)	53 (7.8%)	164 (6.5%)	73 (4.3%)	72 (6.5%)
Highest Level of Education (Year: p <.000, Education: p <.027, Year × Education: p <.718)									
Less than High School	354 (9.8%)	164 (6.4%)	97 (5.4%)	135 (12.4%)	66 (7.5%)	45 (6.6%)	219 (8.7%)	98 (5.8%)	52 (4.7%)
High School/ GED	1929 (53.6%)	1260 (48.8%)	797 (44.4%)	589 (54.1%)	429 (48.5%)	312 (45.7%)	1340 (53.3%)	831 (49%)	485 (43.7%)
Two or Four Year Degree	956 (26.5%)	779 (30.2%)	607 (33.8%)	281 (25.8%)	284 (32.1%)	240 (35.1%)	675 (26.8%)	495 (29.2%)	367 (33%)
Graduate Degree	353 (9.8%)	375 (14.5%)	290 (16.2%)	80 (7.4%)	105 (11.9%)	86 (12.6%)	273 (10.9%)	270 (15.9%)	204 (18.4%)
Unknown	10 (0.3%)	3 (0.1%)	3 (0.2%)	3 (0.3%)	0 (0%)	0 (0%)	7 (0.3%)	3 (0.2%)	3 (0.3%)
Mean Age by Race in Years (Year: p <.522, Race: p <.297, Age: p <.173, Year × Race: p <.130, Year × Age: p <.584, Race × Age: p <.329, Year × Race × Age: p <.308)									
White	48.4	56.5	64.2	46.4	56	64.7	49.3	56.8	63.8
Black	45.4	53.9	61	45.5	54.7	60.2	45.3	53.4	61.9
Other	44.9	54.1	64.5	45.9	51.1	65	44.2	56.1	63.9
All	48	56.3	64.1	46.3	55.7	64.5	48.8	56.6	63.8
Mean Income in Thousands by Race (Year: p <.000, Income: p <.729, Year × Race: p <.474, Year × Income: p <.718, Race × Income: p <.585, Year × Race × Income: p <.487)									
White	72.4	71.9	87.3	71.5	72.7	84.4	72.6	71.5	88.7
Black	46.4	53.7	58.7	43.5	57.3	54.7	48.4	51.5	64.2
Other	62.8	66.2	79.9	57.6	71.4	79.9	65.8	62.9	80.7
All	70.3	70.9	85.8	68.4	71.8	82.5	71.1	70.5	87.6

the number of participants underestimating their weight is skewed toward males and gender is significantly associated with weight underestimation. Race, Education and Age are all significantly associated with weight underestimation, further discussion of these associations accompanies the analysis displayed in **Table 3**. Household Income was not significantly associated with weight underestimation. Two-way interactions of each demographic found no significant interactions with time for any combination of demographic variables with time.

Table 2 contains the distribution across variables of caring and agreeableness. Response of A lot were compared to all other responses that were less caring or optimistic than the response A lot inclusive of Somewhat, A little, and not at all. Gender was significantly associated to responses to "Caring Describes Me" with females being more likely to respond A lot to the question. Gender was not significantly associated with "Optimistic Describes Me."

Race was significantly associated with responses to "Caring Describes Me" with Blacks being most likely to respond A lot to the question and Whites least likely to respond A lot, Race was not significantly associated with "Optimistic Describes Me." Survey year was not significantly associated to either caring or optimism. Caring and optimism responses had less than a 1% change in any period for either variable.

Table 2: Participants with BMI >=25.0 (Chi Square significance shown for each category).

Gender	All	Male	Female
Caring Describes Me			
p <.000			
A lot	5117 (64.1%)	2240 (53.6%)	2877 (75.8%)
All other responses	2798 (35.9%)	1907 (46.4%)	891 (24.2%)
Optimistic Describes Me			
p=.310			
A lot	3582 (44.9%)	1854 (44.4%)	1728 (45.5%)
All other responses	4379 (55.1%)	2317 (55.6%)	2062 (54.5%)
Race	White	Black	Other
Caring Describes Me			
p <.000			
A lot	4513 (63.3%)	284 (74%)	320 (68.4%)
All other responses	2570 (36.7%)	90 (26.0%)	138 (31.6%)
Optimistic Describes Me			
p=.839			
A lot	3208 (45.0%)	172 (44.8%)	202 (43.2%)
All other responses	3908 (55.0%)	210 (55.2%)	261 (56.8%)
Survey year	1995-'96	2004-'06	2013-'14
Caring Describes Me			
p <.410			
A lot	2337 (64.9%)	1637 (63.4%)	1143 (63.7%)
All other responses	1236 (35.1%)	929 (36.6%)	633 (36.3%)
Optimistic Describes Me			
p=.780			
A lot	1604 (44.5%)	1174 (45.5%)	804 (44.8%)
All other responses	1986 (55.5%)	1403 (54.5%)	990 (55.2%)

The likelihood of underestimation is shown in Table 3 with results expressed as Odds Ratios (OR) comparing groups. After adjusting for covariates, participants were more than twice as likely to underestimate in 2013-'14 as compared to 1995-'96 suggesting that shifting demographics partially mask the magnitude of the change within groups. The association expected between caring/optimism and the likelihood to underestimate was partially demonstrated in the dataset. Those who respond to the survey item "Caring describes me" as A lot (most caring) were more likely than those who respond with any other answer (less caring) to underestimate their weight.

The likelihood of underestimation was significantly different among demographic groups with Blacks most likely to underestimate their weight. Males were more likely to underestimate. Education level was inversely associated to underestimation of weight. Age of participant was generally inversely associated with underestimation, with youngest participants having the greatest likelihood of underestimating. Decade of birth (generational age) showed no significant association to underestimation.

The 2-way interaction of race and caring is shown in **Figure 1**. This interaction shows that Whites who regarded themselves as most caring (responses of A lot) had less of an increase in underestimation from 1994-'96 to 2013-'14 than Whites who regarded themselves as less caring. The association for whites is significant. Blacks who regarded themselves as most caring (responses of A lot) had less of an increase in underestimation than Blacks who regarded themselves as less caring. Blacks who were most caring were more likely to underestimate in 1995-'96, but by 2004-'06 were less likely. The association between was not significant for Blacks.

Blacks were more likely than Whites to underestimate at all time points and across all levels of caring, consistent with the main effect shown in **Table 3**. The 2-way interaction of race and optimism shows no significant findings for either race or gender. Main effects for all variables can be seen in **Table 3**. The interaction of gender and caring was not significantly associated with underestimation (F=0.023, p<=.880). Gender and optimism were also not significantly association with weight underestimation (F=3.741, p<=.053).
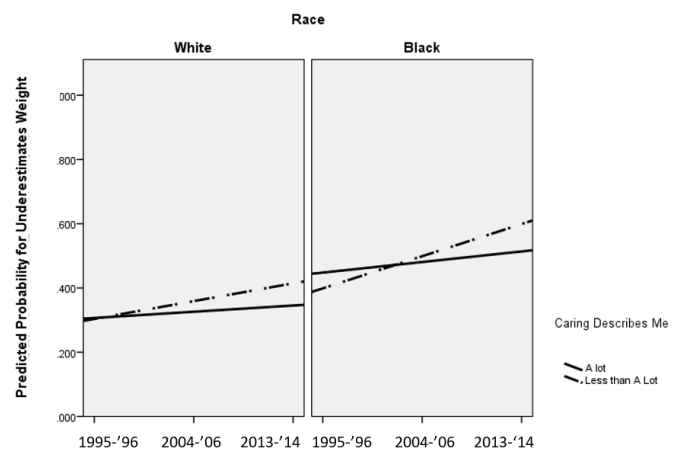

Figure 1: *Predicted Probability for Underestimation of Weight among MIDUS participants with BMI >=25.0 (Adjusted for Gender, Age, Decade of Birth, Household Income and Education). 2 Way Interactions Interaction of Time × Caring Describes Me for each race: White (F=4.702, p=<.030), Black (F=0.425, p=<.515).*

Table 3: Odds Ratios for Underestimation of Weight among MIDUS participants with BMI >=25.0 (Adjusted for Gender, Race, Age, Decade of Birth, Household Income and Education).

	OR with 95% CI	p			OR with 95% CI	p
Gender				Education (Highest Level Completed)		
Male	1.0 (Reference)			Less than High School	1.0 (Reference)	
Female	0.31 (0.27, 0.35)	<0.000		High School/GED	0.67 (0.54, 0.82)	0.001
				2- or 4-Year Degree	0.63 (0.50, 0.79)	
Time				Graduate Degree	0.39 (0.30, 0.51)	<0.000
MIDUS 1 (1995-'96)	1.0 (Reference)					
MIDUS 2 (2004-'06)	1.52 (1.35, 1.71)	<0.000		Age		
MIDUS 3 (2013-'14)	2.15 (1.85, 2.49)	<0.000		20-29	1.0 (Reference)	
				30-39	0.88 (0.63, 1.22)	0.439
Caring Describes Me				40-49	0.68 (0.47, 0.99)	0.046
All other responses	1.0 (Reference)			50-59	0.53 (0.34, 0.82)	0.005
A lot	0.86 (0.77, 0.96)	0.011		60-69	0.47 (0.28, 0.79)	0.004
				70+	0.51 (0.27, 0.94)	0.031
Optimistic Describes Me						
All other responses	1.0 (Reference)			Decade of Birth		
A lot	0.94 (0.84, 1.03)	0.367		1920's	1.0 (Reference)	
				1930's	1.07 (0.81, 1.40)	0.653
Race				1940's	0.92 (0.66, 1.30)	0.645
White	1.0 (Reference)			1950's	0.97 (0.64, 1.48)	0.894
Black	2.16 (1.67, 2.81)	<0.000		1960's	0.91 (0.55, 1.50)	0.714
Other	1.06 (0.82, 1.36)	0.677		1970's	1.88 (0.76, 4.62)	0.17

Discussion

While the participants in this dataset did not become more caring or more optimistic over the 30 years of the survey period as seen in **Table 2**, we can only draw conclusions about generations represented in this dataset. It's possible that generations outside this dataset, those born after 1975, have significantly different rates of caring or optimism that associates with weight estimation. While we did not see a change in the incidence of caring and optimism over time, we are able to see changes over time in weight underestimation related to caring and optimism at their relatively constant rates. While other studies, such as the one by Sutin,3 draw a link between a behavioral attribute such as optimism or pessimism and weight estimation, they are not looking for a change over time with regard to that association. This work does not contradict their work as there are differences in underestimation found in association with variables of caring and optimism. What was expected and not found is an association with a change in caring or optimism over time that is associated to a change in underestimation (see **Table 2**).

The data suggests that the change shown in weight estimation is not related to a change in those behavioral attributes. While those attributes have held constant in this population, the tendency to underestimate has increased significantly and at different rates for those who are more caring or more optimistic.

The dataset contained enough White participants to analyze smaller subgroups such as survey period, self-reported optimism and caring with relatively narrow confidence intervals. Whites made up between 85.9% and 87.1% of those underestimating their weight and had sample sizes 10-20x larger than Black and other races. It's likely that additional conclusions could be drawn about Black and other races for the smaller subsets of data if a larger sample were available. The conclusions for Blacks and other races are most meaningful at the interaction of time and race level, where enough participants can be summarized together to highlight a trend.

One of the founding theories of this research was that those who were most caring would have a greater change over time, as they may have a higher likelihood of an erroneous positive body image, similar to the effect that was seen for optimism. The data presented here finds the opposite effect with those who are more caring being less likely to underestimate. McPherson and Turnbull provide an alternate hypothesis that suggests that males are simply more satisfied with their body proportions and adiposity. They support this with a sample of Scottish men that report high body satisfaction in spite of their overweight status [10]. This is consistent with data in MIDUS showing males make up a larger proportion of those underestimating weight overall **(Table 1)**. Males are also less likely to be in the group responding caring describes me A lot. The subset of most caring is 44.7% male, while the subset of less caring is 68.6% male. If more had been known about the demographic composition of the MIDUS participants in advance of the research, perhaps different forecasts could have been made. This is only a partial explanation for the directional difference in the association of caring with weight underestimation, as those who are less caring have the largest increase in weight underestimation even after controlling for gender. Robinson and Kirkham found that exposure to obesity makes it more difficult to recognize obesity as the perception of a normal weight changes11. It's possible that those who are less caring are more susceptible the effects of societal weight norms on their perception.

We are able to determine that there is not a change in caring or optimism associated with the change in underestimation, as those changes were not demonstrated. Although it's clear that caring and optimism are associated with weight underestimation, caring and optimism were not associated with the change. The problem of weight underestimation has increased within the MIDUS sample over time. This research lends support to an investment in further research into the effects of underestimation, as well as ways to reduce those effects in this group.

This research confirms that behavioral attributes of caring and optimism are associated with perception of weight and also provide an avenue for future research to determine if there are 3-way interactions that were outside the scope of this study that caused a directional change in the association between caring and weight underestimation. Within the MIDUS datasets there are other attributes and behaviors that can be part of a future research design, including weight loss behaviors and family variables. Expanding research to include future generations for comparison across groups may inform clinical practice for our younger adult population. A longitudinal study design that incorporates new generations into each survey population could provide an ongoing source of data for future research.

Conflict of Interest: The authors declare no conflict of interest.

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