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Is Being Underweight as Bad for Your Health as Being Obese? Evidence from the 2012 Behavioral Risk Factor Surveillance System

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Abstract

Background: Although there are indications that being underweight can compromise health status, most studies examine the health effects of obesity. A clearer understanding of the differential health effects of being underweight or obese could provide avenues for targeted, effective interventions.

Objectives: The main study question was: *Is being underweight as bad for your health as being obese*? Related questions are: Relative to individuals with healthy body weights, what is the health status of those who are underweight? Relative to the health status of individuals who are obese, what is the health status of those who are underweight?

Method: To address the study questions, we analyzed data from the 2012 Behavioral Risk Factor Surveillance System (BRFSS) of the US Centers for Disease Control and Prevention (CDC). We defined the following body weight groups: BMI ≤ 18.5 as underweight; healthy body weight as18.5 ≤ BMI < 25; overweight as 25 < BMI < 30; Class1 obese as 30 ≤ BMI < 35; Class2 obese as 35 ≤ BMI< 40; and Class3 obese as 40 ≤ BMI. We conduct $\chi 2$ - and t-tests of health status differences across these body weight classes. Applying a health production framework from health economics we conducted a multivariate analysis to examine the effects of body-weight classes on the likelihood of self-assessed good health status.

Results: Relative to individuals with healthy body weights, those who were underweight had poorer health, higher probability of poor health and prevalence of diagnosed chronic health conditions. We found significant ($p < 0.000$) differences in health status, across the four bodyweight classes (underweight, obese classes 1-3). Being underweight has similar negative health effects as being obese.

Conclusion: Differences across the four body-weight classes warrant closer examination to determine appropriate interventions. It is also very important to address being underweight and its effects on health.

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Introduction

Evidence about the health effects of being underweight is inconclusive and often contradictory. Being underweight is associated with higher all-cause mortality[1,2]. The effects seem to be more pronounced for men than for women[1]. After controlling for other covariates such as smoking, underweight women have significant reductions in mortality while underweight men have higher mortality[3]. Although obesity increases the risk of cardiovascular diseases such as heart failure, among persons who already have heart failure, outcomes are better for obese persons than for lean ones[4]. Furthermore, for patients with chronic conditions under-

going treatments such as haemodialysis, higher body weight is associated with lower mortality risks[5]. Being underweight is associated with higher all-cause mortality, and increased risks for inpatient care for circulatory diseases[1]. However, breast cancer patients who are overweight or obese have higher mortality risk-than lean individual[6].

There are indications of similarities in health outcomes of underweight and obese individuals. Relative to having healthy body weight, being obese or underweight is associated with a higher risk of death among female breast cancer patients[7]. Lung transplant candidates who are underweight or obese have a higher risk of post-transplant mortality than recipients with a healthy weight[8].

Given the inconclusive evidence and few studies about the effects of being underweight, it is important to examine this issue further to gather evidence that will guide effective intervention creation and implementation.

Study Objectives

The main study question was: Is being underweight as bad for your health as being obese? Related questions are: Relative to individuals with healthy body weights ($18.5 \leq BMI < 25$), what is the health status of those who are underweight ($BMI < 18.5$)? Relative to the health status of individuals who are obese ($30 \leq BMI < 35$ Class1 obese; $35 \leq BMI < 40$ Class2 obese; and $40 \leq BMI$ Class3 obese), what is the health status of those who are underweight?

Study Methods

Study model

The study applied a household health production framework from health economics which posits that, the household produces health using household, individual and environmental inputs[9]. The basic model used in previous studies[10-13], can be represented by the following health production function:

$$H_i = f(I_i, E_i) \quad (1)$$

Where: the subscript i denotes the individual as the unit of analysis; H is a vector depicting health output; I is a set of individual and household variables (inputs) and E represents environmental inputs. Researchers have applied this framework in studies of various health-related phenomena such as effects of prenatal care on birth weights[14]; household production and demand for health inputs and their effects on birth weights[15] effects of childhood and education on health[16]; the impact of maternal smoking on child neurodevelopment[8] and the relationship between household production, fertility and child mortality[17]. Within the health production framework, body weight classes are inputs in the production of general, physical, and mental health. Based on the household health production process represented by equation 1 above the econometric model we use in multivariate analysis of general health (GH) utilizes the following equation:

$$GH_i = f(D_i, S_i, B_i, H_i, E_i) \quad (2)$$

Where: D represents demographic factors; S is socioeconomic status (SES); B is health behaviors; H is stock of health capital, E are environmental factors such as access to care. This equation represents the analysis model used to address study question three. Health status is measured as self-assessed general health status, and the number days within a 30-day period that an individual experienced poor physical health.

Data Source and study variables

The study data source was the 2012 Behavioral Risk Factor Surveillance System (BRFSS) survey. BRFSS is an annual nationwide telephone survey of non-institutionalized adults conducted by the CDC in collaboration with state health departments[18]. The survey is based on a multistage cluster design that uses random-digit dialing to select samples that are representative of the US population. It includes questions about health behaviors, health status, socioeconomic status variables, environmental variables and others that affect health. The study sample is drawn from all states in the US.

Dependent variables

The 2012 BRFSS survey had questions about individual self-assessed general health (GH) status: *Would you say that in general your health is 1. Excellent, 2. Very good, 3. Good, 4. Fair, or 5. Poor?* Responses to this question were coded one (1) for excellent, very good or good health and zero (0) for fair or poor health. Other BRFSS questions quantified poor health experiences in number of days of poor health within a 30-day period: *Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?* Responses to these questions provided quantitative measures of the individuals' health status.

Independent variables

Data about body weight were derived from responses to two BRFSS questions: "*About how much do you weigh without shoes? About how tall are you without shoes*?" Responses to these questions were used to calculate respondents' body mass index (BMI), which was then coded into six body weight classes: $BMI < 18.5$ is underweight; $18.5 \leq BMI < 25$ is healthy weight; $25 \leq BMI < 30$ is overweight; $30 \leq BMI < 35$ is Class1 obese; $35 \leq BMI < 40$ is Class2 and $BMI \geq 40$ is Class 3 obese.

BRFSS data included the individual's demographics such as age, ethnicity, sex, marital and veteran status. There was data on educational attainment, income, home-ownership, employment, educational levels and access to personal cell-phones. Other data were used as surrogate measures of household climate, including number of dependent children, whether the household was female-headed with no adult males or male-headed with no adult females present.

Measures of individual health behavior included tobacco and alcohol use, participation in physical exercise, the use of seatbelts in automobiles, vaccination status, and health screenings such as HIV-tests. BRFSS also provided data about access to care and health capital. We measured access to care using three variables: having health insurance and personal doctors and inability to access care due to high costs of care. Measures of individual health capital stock were disability status and whether the respondent had ever been diagnosed with chronic health conditions.

Disability was measured from responses to two BRFSS questions: *Are you limited in any way in any activities because of physical, mental, or emotional problems? Do you now have any health problem that requires you to use special equipment, such*

as a cane, a wheelchair, a special bed, or a special telephone? Responses to these questions were coded one (1) for "yes" and zero (0) for "no."

Data about chronic health conditions were derived from responses to BRFSS survey question: *Has a doctor, nurse, or other health professional EVER told you that you had any of the following: heart attack also called a myocardial infarction, angina or coronary heart disease, stroke, asthma, skin cancer, other types of cancer, chronic obstructive pulmonary disease (COPD), arthritis, depressive disorder, kidney disease, trouble seeing, diabetes?* Responses to these questions were coded one (1) for "yes" and zero (0) for "no". It is important to note that BRFSS defines arthritis to include rheumatoid arthritis, gout, lupus, or fibromyalgia and COPD to include emphysema or chronic bronchitis. Depressive disorders include depression, major depression, dysthymia or minor depression.

We measured oral health using responses to the BRFSS question: *How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons, such as injury or orthodontics*. Responses indicating tooth loss were coded one (1) and those with no tooth loss were coded zero (0). We also measured eyesight using responses to the question: *How much difficulty, if any, do you have in recognizing a friend across the street?* Responses indicating visual difficulties were coded one (1) and those with no visual difficulties were coded zero (0).

Analysis methods

To test the study hypothesis, Student's T test (t-test) and Chi-Square test of independence ($\chi 2$ test) were utilized to determine the statistical significance of the differences in health, disability and prevalence of chronic health conditions across the body weight classes. We applied $\chi 2$ testson differences in categorical variables and t-tests for differences in the number of days respondents experienced poor health.

Multivariate analysis estimated the likelihood of good general health as represented in equations 2 above. To set a control group, we tested the assumption that there was no general health status difference between the healthy body-weight and the overweight classes. This assumption was based on examination of the data which indicated general health status differences between the healthy body weight class and the overweight to be very small. For example, the difference in the number of days of poor health in a 30-day period was 0.29 days. Setting alpha = 0.05, we tested the statistical significance of the general health status differences between these two body weight classes and found them to be statistically insignificant. Based on this finding we used these two bodyweight classes (which include individuals with $18.5 \leq BMI < 30$) as the control in multivariate analysis. This analysis enabled the study to measure the effects of being underweight or obese while controlling for other health production factors.

Results

Table 1 displays study sample distribution by body weight class and the average number of days they experience poor health within a 30-day period. The largest group (66.2%) includes individuals with healthy weight (32%) or overweight (34.2%). The smallest group (7,803 people or 1.6% of the sample) were underweight, while 27% were obese.

On average, individuals with a healthy body weight or who are overweight experienced approximately four days of poor physical health within a 30-day period. Class3 obese individuals experienced the largest number of days (about nine days) of poor physical health. Underweight individuals and those who are Class2 obese experienced about six days while those who are Class1 obese experienced five days of poor physical health in a 30-day period.

Table 1: Sample distribution of weight classes and average number of days in poor physical health within a 30-day period.

Body weight class	N	% of Sample Total	Mean Days in poor physical health
Underweight (BMI < 18.5)	7,803	1.6	6.22
Healthy weight (18.5 ≤ BMI < 25)	151,985	32.0	3.57
Overweight (25 ≤ BMI < 30)	162,768	34.2	3.86
Class 1 Obese (30 ≤ BMI < 35)	79,839	16.8	5.1
Class 2 Obese (35 ≤ BMI < 40)	29,429	6.2	6.48
Class 3 Obese (40 ≤ BMI)	18,388	3.9	8.91
Total	450,212	94.6	
Unknown*	25,475	5.4	

*BMI could not be determined because the individual didn't answer questions about their weight or height.

Table 2: Results of t-tests of differences in days of poor physical health in a 30-day period between underweight and other five body-weight classes.

Body Weight Class	Mean Days	Mean Difference	T-Statistic	N
Under weight (BMI < 18.5)	6.22	0		7803
Healthy weight (18.5 ≤ BMI < 25)	3.57	2.65	27.39[a]	156615
Over weight (25 ≤ BMI < 30)	3.86	2.36	23.69[a]	167311
Class 1 Obese (30 ≤ BMI < 35)	5.1	1.12	9.74[b]	85765
Class 2 Obese (35 ≤ BMI < 40)	6.48	-0.26	1.87	36392
Class 3 Obese (40 ≤ BMI)	8.91	-2.69	17.23[a]	25529

[a]$p < 0.000$, [b]$p < 0.01$

Table 2 displays results of t-tests of mean-differences (in number of days of poor physical health) between underweight individuals and individuals in the other five body-weight classes. Underweight individuals experience 2.65 days more of poor physical health than those with healthy body weight and 2.36 days more than those who are overweight. These differences are statistically significant ($p < 0.000$). Individuals with Class1 obesity experience 1.12 days less of poor physical health

than those who are underweight and this difference is also statistically significant ($p < 0.01$). The difference between underweight and Class 2 obese individuals is very small (0.26 days) and statistically insignificant. Individuals with Class3 obesity experience 2.69 more days of poor physical health than those who are underweight. This difference is also statistically significant ($p < 0.000$). These results suggest that being underweight might have a similar effect on physical health as being Class 2 obese.

Table 3 displays percentages of individuals in good health, those diagnosed with chronic health conditions, those with disabilities, and those using assistive devices. The proportions are displayed for each body weight class, and the proportion average for the study sample.

Table 3: Distribution of individuals in each body weight group by health condition.

Health Condition	Percent of total number of individuals in each body weight class in good health and those diagnosed with the specified chronic health condition						
	Under-Weight	Healthy weight	Over weight	Class 1 Obese	Class 2 Obese	Class 3 Obese	Sample Average
Self-assessed good health							
Good general Health	73.5	85.4	83.1	76.3	68.2	55.5	80.4
Good physical health	55.5	65.9	64.7	58.0	50.5	40.7	61.8
Disability							
Has Disability	29.8	19.4	22.2	29.6	37.2	49.9	24.8
Uses Assistive Devices	15.2	8.2	9.5	13.5	19.5	30.2	11.4
Diagnosed chronic condition							
Heart attack	6.4	4.7	6.4	7.5	8.1	8.5	6.2
Angina or coronary heart disease	5.4	4.6	6.5	7.8	8.9	10.0	6.4
Stroke	5.5	3.6	4.1	4.5	5.1	5.4	4.1
COPD	15.5	6.8	6.8	9.0	11.9	16.7	8.1
Asthma	12.9	10.6	11.1	14.5	19.4	26.0	12.7
Diabetes	4.4	5.5	11.2	19.1	26.9	34.8	12.5
Kidney disease	3.5	2.6	3.0	3.8	5.1	6.0	3.3
Arthritis	29.3	27.5	33.5	41.3	47.1	54.0	34.5
Depressive disorder	20.2	15.7	16.5	21.4	27.0	35.3	18.6
Skin cancer	9.0	9.2	9.2	7.9	7.0	5.2	8.7
Other cancer	11.3	9.0	9.3	9.4	9.1	9.2	9.2
Lost at least one permanent tooth	53.0	46.4	53.9	59.0	61.5	65.1	53.2
Poor eye-sight	20.5	15.7	16.3	19.1	22.1	27.5	17.5

Comparisons of proportions of underweight individuals to average sample proportions indicate that the underweight self-assessed good health is lower, and their disability proportions are higher than the sample average. With the exception of angina, arthritis, and diabetes, the proportion of underweight individuals diagnosed with chronic conditions is much higher than the sample average.

A comparison between the underweight and healthy weight classes indicates that the underweight have poorer self-assessed general and physical health, higher disability and greater proportions of diagnosed chronic conditions. These numbers seem to suggest that on the average, underweight individuals might have poorer health than individuals with healthy bodyweights.

Comparisons of overweight and underweight classes show that the underweight class has poorer self-assessed general and physical health, and higher disability. The underweight class also has greater proportions diagnosed with chronic health conditions except for heart attack, angina, diabetes, arthritis, diabetes, and skin cancer where the proportions for overweight individuals are higher or equal to the proportions for the underweight class. The proportion of underweight individuals diagnosed with heart-attack is 6.4% exactly equal to the proportion for individuals who are overweight. The proportions of overweight individuals diagnosed with angina,diabetes, and arthritis are higher than proportions of underweight individuals diagnosed with these conditions. These results suggest that on the average, the underweight are less healthy than the overweight.

Compared to Class1 obese, the underweight have lower proportions with good self-assessed general and physical health, suggesting that they are less healthy. Although they have similar disability (as shown by their similar disability proportions) the proportion of underweight individuals using assistive devices is higher than for Class1 obese – denoting that the underweight have more severe disability. The proportions diagnosed with depressive disorders or kidney disease is similar and both are above the sample average. However, the underweight class has smaller proportions of individuals diagnosed with diabetes, heart attack, angina, asthma and arthritis. From these results one might infer that on the average, the underweight have worse or similar health to Class1 obese except for the five chronic conditions.

Comparisons of proportions of the underweight with Class2 obese show that Class2 obese has poorer self-assessed general and physical health, greater disability, and higher proportions diagnosed with asthma, arthritis, depressive disorder,

kidney disease, poor sight, oral health and diabetes. However, Class2 obese is similar to or better than the underweight in proportions diagnosed with stroke, skin and other cancers and COPD.

Compared to Class3 obese, the underweight fare better in all measures applied with some exceptions. The proportion of underweight individuals diagnosed with stroke (5.5%) is only slightly higher the proportion for individuals who are Class3 obese (5.4%) and is much higher than the sample average (4.1%). The underweight also have higher proportions of skin and other cancer than Class3 obese.

Table 4 displays results of $\chi 2$ tests of proportional differences between the underweight and the other five bodyweight classes. The $\chi 2$ test statistics indicate that all health differences (except skin cancer) between the underweight and the healthy weight classes are statistically significant. The health of the underweight class is significantly poorer than the health of the healthy weight class except for diabetes. The healthy weight class has higher proportions diagnosed with diabetes than the underweight class. The difference in skin cancer diagnosis is statistically insignificant.

The $\chi 2$ test statistics of the health differences between underweight and the overweight classes show the differences to be statistically significant except for proportions diagnosed with heart attack, skin cancer and oral health. The overweight class has significantly greater proportions diagnosed with of angina, arthritis, and diabetes than the underweight. For all other measures of health (including general health, physical health, disability, and cancer) the health of the underweight class is significantly worse than that of the overweight.

Differences between obese Class1 and the underweight class are statistically significant except disability and kidney disease diagnosis. However, the difference for disability measured in terms of the use of assistive devices was statistically significant ($p < 0.000$). This finding suggests that the underweight class has a proportionately greater need for assistive devices than Class1 obese. Measured in terms of general and physical health and in proportions diagnosed with stroke, skin cancer, other cancer, COPD, and poor sight, the health status of Class1 obese is better than that of underweight class. However, Class1 obese has significantly ($p < 0.000$) higher proportions diagnosed with diabetes, arthritis, heart attack, angina, and oral health measured as loss of at least one permanent tooth.

Differences between Class2 obese and the underweight class are statistically significant except for proportions diagnosed with stroke. The numbers show that Class2 obese has significantly worse health than the underweight class. However, the underweight class has significantly greater proportions diagnosed with skin and other cancers that Class2 obese. These findings are similar to findings about the differences between the underweight class and Class3 obese.

Table 4: Results of $\chi 2$ tests of differences in health status of Underweight individuals and of the other five body weight classes.

Health Status & Health Capital	Healthy Weight	Overweight	Class1 Obese	Class2 Obese	Class3 Obese
Self-assessed good health					
Good General Health	805.95[a]	475.9[a]	30.22[a]	83.29[a]	742.7[a]
Good Physical Health	353.77[a]	277.23[a]	17.92[a]	60.76[a]	484.66[a]
Disability					
Has a Disability	496.57[a]	242.91[a]	0.18	141.43[a]	876.16[a]
Uses Assistive Devices	460.41[a]	275.02[a]	16.99[a]	74.08[a]	633.73[a]
Diagnosed Chronic Conditions					
Heart Attack	46.24[a]	0.009	11.27[b]	24.21[a]	31.16[a]
Angina	9.3 b	15.21[a]	60.34[a]	99.56[a]	146.56[a]
Stroke	77.24[a]	37.05[a]	15.54[a]	2.11	0.089
COPD	848.05[a]	831.47[a]	347.52[a]	72.34[a]	5.75[c]
Asthma	41.06[a]	24.81[a]	14.49[a]	173.82[a]	537.24[a]
Diabetes	17.334[a]	350.20[a]	1048.04[a]	1810.59[a]	2647.48[a]
Kidney Disease	20.37[a]	4.78*	2.59	37.75[a]	69.60[a]
Arthritis	11.99[b]	57.94[a]	422.58[a]	788.04[a]	1332.18[a]
Depressive Disorder	112.48[a]	74.27[a]	5.61[c]	149.15[a]	584.68[a]
Skin Cancer	0.26	0.13	13.14[a]	37.31[a]	134.92[a]
Other Cancer	44.23[a]	34.46[a]	27.65[a]	34.72[a]	25.20[a]
Lost at least one permanent tooth	125.56[a]	2.50	101.95	183.18[a]	330.81[a]
Has poor eye-sight	123.64[a]	93.71[a]	8.11[b]	9.16[b]	142.99[a]

[a]$p < 0.000$, [b]$p < 0.01$, [c]$p < 0.05$

Table 5 displays multivariate analysis results. These are results of logistic regression analysis estimating the likelihood of good general health while controlling for other relevant determinants of health such as demographics, SES and other variables.

Table 5: Results of Logistic Regression Estimating the Effects of Body-weight on the Likelihood of Good General Health.

	B	Wald	Sig.	Exp(B) (Odds-ratio)	95% C.I. for EXP(B)	
					Lower	Upper
Demographics						
Female	.205	111.403	.000	1.227	1.181	1.274
Latino/a	-.750	876.537	.000	.473	.450	.497
Young	.190	37.348	.000	1.209	1.138	1.285
Veteran	.018	.764	.382	1.018	.978	1.060
Household climate						
Dependent Children	.025	9.020	.003	1.025	1.009	1.042
No Adult Women	-.008	.134	.714	.992	.950	1.036
No Adult Men	.076	18.421	.000	1.078	1.042	1.116
Body Weight						
Underweight	-.422	78.664	.000	.656	.597	.720
Class1 obese	-.079	23.180	.000	.924	.895	.954
Class2 obese	-.258	124.151	.000	.773	.738	.809
Class3 obese	-.469	283.023	.000	.626	.593	.661
SES						
Unemployed	-.549	908.067	.000	.578	.557	.599
Education Level	.277	1619.134	.000	1.319	1.302	1.337
Income	.116	913.777	.000	1.123	1.115	1.132
Has personal Cellphone	.250	265.778	.000	1.283	1.246	1.323
Health Behavior						
Non-Smoker	.098	51.435	.000	1.103	1.074	1.133
Current-drinker	.317	510.815	.000	1.373	1.335	1.411
Pneumonia shot	-.130	82.833	.000	.878	.854	.903
Physical Ex.	.551	1614.952	.000	1.735	1.689	1.783
Seat belt always	.043	5.779	.016	1.044	1.008	1.081
HIV-tested	-.073	21.665	.000	.930	.901	.959
Access to care						
Insured	.037	2.493	.114	1.038	.991	1.088
Has personal doctor	-.088	13.707	.000	.916	.875	.960
Cost-Barred	-.451	498.888	.000	.637	.612	.663
Health Capital						
Heart Attack	-.449	348.896	.000	.639	.609	.669
Angina	-.637	756.635	.000	.529	.505	.553
Stroke	-.372	197.198	.000	.689	.654	.726
Asthma	-.163	74.934	.000	.849	.818	.881
Other cancer	-.551	885.270	.000	.576	.556	.597
COPD	-.672	1101.029	.000	.511	.491	.532
Arthritis	-.377	722.944	.000	.686	.667	.705
Depression	-.340	468.316	.000	.712	.690	.734
Kidney	-.630	478.086	.000	.532	.503	.563
Poor Sight	-.411	730.264	.000	.663	.644	.683
Diabetes	-.729	1977.307	.000	.482	.467	.498
Disability	-1.125	5802.094	.000	.325	.315	.334
Assistive Devices	-.553	990.782	.000	.575	.556	.596
Model fit	**R^2 = .466**	**$\chi 2$ = 87333.31**	**Accurate Prediction = 86.2%**		**N = 253806**	

The logistic regression results show that relative to having a healthy weight, being underweight or Class1-3 obese has a negative and statistically significant ($p < 0.000$) effect on the likelihood of good general health. Coefficient sizes indicate that being underweight has a larger negative effect on the likelihood of good health than being Class1 or Class 2 obese but a slightly smaller effect than Class3 obese. Other factors with statistically significant and negative effects on the likelihood of good health are: being unemployed or Latino/a, and having poor health capital stock as indicated by diagnosis of chronic health conditions such as heart attacks, angina, stroke, asthma and cancer. Factors that relate positively with the likelihood of good health are educational attainment, income, social support (measured by having access to a cell phone), having good health behavior (such as not smoking and engaging in physical exercise) being female and being young.

Discussion

The results seem to suggest that being underweight has a significant effect on health, disability and incidence of chronic health conditions. The results show that health effects of body weight differ across the six bodyweight classes. The underweight self-assessed good health is lower and their disability proportions are higher than the sample average. Proportions of underweight individuals diagnosed with chronic conditions are much higher than the sample average except for angina, arthritis, diabetes, and kidney disease. The underweight appear to have lower incidences of these conditions.

The health of the underweight appears to be worse than the health status of those with healthy body weight, overweight, and Class1 obese. Being underweight appears to have a larger negative effect on the likelihood of good general health than being Class1 obese. Classes 2 and 3 obese have significantly worse health than the underweight class. However, the underweight class has significantly greater proportions diagnosed with skin and other cancers than Classes 2 and 3 obese.

Before drawing any conclusions from these results, it is important to note that the interpretation of these results should be cognizant of the strengths and weakness of the BRFSS data. These data are cross-sectional, representing a single snapshot in time. Consequently, no causality can be established. Furthermore, the data are from the US and the results might not necessarily generalize to other populations with different social, economic, and political environments or different health systems.

An important strength of the BRFSS is that CDC's strong quality control over survey questions ensures that data collected are comparable across all states in the US. The survey questions have been used and improved upon consistently since 1984. Over time BRFSS has developed a computer-assisted-telephone-interviewing system which improves data collection speed and reduces survey costs. Because it is an ongoing survey, it provides useful means of tracking trends on prevalence of self-reported asthma/adult asthma history, cardiovascular disease, diabetes, health risk factors and behaviors. BRFSS data is self-reported, therefore, it has the advantage of gathering information that is only available to the individual.

A major weakness of the BRFSS is that it excludes individuals who are institutionalized or have no telephones. Individuals with no telephones tend to be low-income with higher health risks. This fact suggests that BRFSS data might understate health risks. BRFSS data come from self-reported information. Individuals tend to underreport their risky behaviors especially those that are socially undesirable or illegal. Therefore, BRFSS's data might underreport such behaviors. Other weakness include possible biases resulting from less than ideal response rates common to telephone surveys, inaccurate recall by those responding to the survey, cultural biases, language barriers, or inadequate health knowledge might result in inaccurate responses to the survey. Any generalizations or conclusions must be read within the context of these data strengths and weaknesses.

Conclusions and Implications

These results suggest that being underweight is as bad (or worse) for health as being class1 obese. It is slightly better than being Class2 or 3 obese. The results also show differences in health status and diagnosis across the six weight classes. Therefore, it is important to study the effect of body weight on health in a more targeted manner using specific bodyweight classes. The targeted examination might lead to more targeted and relevant interventions. It is as important for public health to consider and examine underweight as Class 1 obese. Although individuals with obesity Classes2 and 3 have worse effects on health than being underweight, for specific conditions such as cancer, it might be more urgent to examine being underweight. Because of the statistically significant health differences across the six body weight classes, it is important for studies to examine the relationship between body weight and health with specific body weight classes. Instead of treating obesity as one group, it might be more useful to examine it as three specific conditions.

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