HHS Public Access
Author manuscript
Obesity (Silver Spring). Author manuscript; available in PMC 2018 June 27.

Published in final edited form as:
Obesity (Silver Spring). 2018 February ; 26(2): 426–431. doi:10.1002/oby.22047.

Body Mass Index and Subjective Social Status: The Coronary Artery Risk Development in Young Adults (CARDIA) Study

Emily J. Dhurandhar[1], **Gregory Pavela**[2,3], **Kathryn A. Kaiser**[2,3], **Gareth R. Dutton**[5], **Kevin R. Fontaine**[2,3], **Daniel Kim**[6], **James M. Shikany**[3,5], **David B. Allison**[4], and **Cora E. Lewis**[5]

[1]Department of Kinesiology and Sport Management, Texas Tech University, Lubbock, TX

[2]Department of Health Behavior, University of Alabama at Birmingham, Birmingham, AL

[3]Nutrition Obesity Research Center, University of Alabama at Birmingham, Birmingham AL

[4]School of Public Health-Bloomington, Indiana University

[5]Division of Preventive Medicine, University of Alabama at Birmingham, Birmingham AL

[6]Department of Health Sciences, Bouve College of Health Sciences, Northeastern University, Boston, MA

Abstract

Objective—Subjective Social Status (SSS), or perceived social status, may explain, in part, the relationship between socioeconomic status (SES) and obesity. We tested whether SSS mediates the relationship between two indicators of SES (income and education) and body mass index (BMI).

Methods—We applied a cross-sectional, structural equation path analysis to the Coronary Artery Risk Development in Young Adults (CARDIA) study (n=2,624). We tested whether SSS (MacArthur scale), education and income were associated with BMI at the year 20 exam (adjusting for sex, age and race), hypothesizing that the associations of education and income with BMI would be at least partly mediated by SSS.

Results—SSS had a significant direct effect on BMI (−0.21, p=0.018). Education had a significant direct relationship with SSS (0.11, p<0.001) and a small but significant indirect relationship with BMI through SSS (−0.02, p=0.022). Income, although it did not have a significant direct relationship with BMI, did have a significant indirect relationship through SSS (b=−0.05, p=0.019).

Conclusions—Results are consistent with our hypothesized model where SSS partially mediates the relationship between socioeconomic status indicators and BMI.

Contact Information: Emily J. Dhurandhar, Ph.D. Department of Kinesiology and Sports Management, Texas Tech University, Box 43011, Lubbock, TX 79409. Ph: 806-834-6556. emily.dhurandhar@ttu.edu.

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

Keywords

Socio Economics; Psychosocial; Weight Gain

Introduction

Traditional indicators of socio-economic status (SES) such as income and education are inversely associated with obesity, although this finding is inconsistent across populations and may depend on economic development of the region, age, race, and sex (1). For example, in the United States, the inverse relationship between SES and obesity tends to be more pronounced in women and less pronounced in minority populations (2). The relationship between socioeconomic status and obesity is complex and not entirely understood; in part, because multiple causal relations may underlie the SES-obesity association (3). Lower SES may causally lead to obesity (4), obesity may cause a decline in achieved SES (5–7), or obesity and low SES may share a common prior cause. Although each of these causal relations may contribute to the association between SES and obesity in developed countries, Fontaine et al. (2011) used an adoption study to show that some (but not all) of the relationship between SES and obesity appeared to be due to unique contribution from SES to obesity that was not attributable to the rearing environment. Given evidence that at least some of the association between SES and obesity is due to the causal link from SES to increased body weight, understanding the specific mechanism of action is important.

SES may contribute to overweight and obesity in industrialized countries because low SES populations generally have less access to a “healthy” environment including healthy foods and safe and comfortable exercise opportunities (8). Additional findings from the fields of ecology and evolutionary biology suggest that perceived food insecurity elicited by an adequate but unpredictable food supply and social subordination results in increased body fat stores, perhaps as an adaptive strategy to ensure survival in difficult times (9, 10). In socially housed monkeys, both dominant and subordinate animals prefer a high energy density diet, but subordinate animals consume more of a high energy density diet and more energy overall than dominant animals (11). In line with the hypothesis that perceived food insecurity leads to greater energy intake in the context of an inconsistent food supply, food insecurity is also associated with overweight status in women (12). These findings suggest that the *perception* of the food environment and social position may interact and be key influences on body fatness and eating behavior (13).

Consistent with this hypothesis, subjective social status (SSS), or one’s perceived rank in the social hierarchy, is often more highly associated with health outcomes including body mass index (BMI, kg/m^2) than are objective measures of SES (14–17). Prior research has identified several determinants of SSS, including feelings of financial insecurity, occupational position, satisfaction with standard of living, educational attainment, sense of control in one’s job, and household income (18). Although one’s own assessment of social status may be based on psychological factors such as subjective well-being, the primary determinants of SSS appear to be the traditionally used objective measurements of socioeconomic status such as education and income, as well other variables that capture an individual's perception of whether or not he or she has "enough" resources (feelings of financial security, job satisfaction, and standard of living satisfaction) (19). Financial insecurity and desire for money have been demonstrated to result in increased desire for food (20). Thus, it is plausible that a desire for financial resources and a better standard of living that accompanies low SSS may result in increased food-seeking behavior or altered food choices, and that SSS may be a more sensitive proxy for social stressors that may trigger overeating and/or increased fat storage than the commonly used objective SES measures. Bratanova et al., (21), found that participants asked to read about and personally identify with financial scarcity in their society consumed more calories than participants asked to read and write about material abundance in their society. In a pilot study on the effects of social status on energy intake, Cardel et al. (22), found that participants assigned to a low-status condition consumed 130 more kilocalories on average than the high status group, though this group difference was not statistically significant. Further, in a series of four experiments, Cheon et al., (23) found that participants induced to feel low socioeconomic status relative to others in imagined interactions demonstrated a preference for high calorie foods in selection or actual consumption scenarios. Given the above research on social standing, food insecurity, and body weight, we hypothesized that SSS mediates, at least in part, the relationship between two objective measures of SES, income and education, and obesity. While previous research suggests SSS mediates the relationship between SES and health outcomes including self-rated health and depression (24), no prior research has, to our knowledge, tested whether SSS mediates the association between SES and obesity. Given research that the relationship between SSS and BMI differs by sex and race/ethnicity, with stronger associations among whites and females, we also test whether the indirect effects of income and education through SSS differ by sex and race/ethnicity (16, 25).

Methods

Data

Data come from the Coronary Artery Risk Development in Young Adults (CARDIA) study, an eight-wave longitudinal study beginning in 1985–86 of 5,115 black and white adults aged 18–30 at baseline (1985–1986) (26, 27). CARDIA is uniquely suited to questions of SES and health because the original sample was approximately balanced in the proportion of participants with and without a high school education (27). We included those examined in year 20. Participants were excluded from the analysis if any condition that would significantly impact body weight/body composition was present, for example if pregnant, currently taking diabetes medication, had significantly reduced ability to exercise due to health impairment, reported any previous cancer diagnosis, had previous bariatric surgery, or were transgender. After applying these exclusion criteria, the analytic sample consisted of 2,624 adults. Cases with missing data for BMI, (n=11), education (n=13), income (n=42), and subjective social status (n=46) were retained and contributed to maximum likelihood estimates using full information maximum likelihood (FIML). FIML assumes, as does multiple imputation, that data are missing at random (28).

Measures

Our primary outcome of interest is BMI. BMI was calculated from measured height and weight. SSS was the main predictor of interest. SSS was measured using the MacArthur Scale of SSS (29), a 10-rung ladder representing a visual analog scale where participants indicate where in the social hierarchy, from bottom to top, they perceive themselves to be. Participants were asked to "think of this ladder as representing where people stand in the United States. At the top of the ladder are the people who are the best off--those who have the most money, the most education, and the most respected jobs. At the bottom are the people who are worst off--who have the least money, least education, and the least respected jobs or no job. The higher up you are on this ladder, the closer you are to the people at the very top and the lower you are, the closer you are to the people at the very bottom. Where would you place yourself on this ladder?"

We adjusted for education, income, race, age, and sex. Education was measured as years of education completed, indicated on a continuous scale from 1–20+. Income was measured on a 9-point ordinal scale, from combined household income of less than $5,000 up to $100,000+. Race was self-reported and dichotomously coded (black=1), as was sex (female=1). Age was measured in years.

Models Tested

As described and justified in greater detail below, we tested two models: 1) a mediation model using all measures as predictors of BMI and paths from education and income to SSS. 2) a second mediation model that additionally included paths from sex to SSS (Figure 1).

Statistical Analysis

We first calculated means, standard deviations, and inter-correlations of all variables in the analysis. We evaluated a model per our hypothesis (Model 1) where SSS, sex, age, race, education and income are associated with BMI, and that the association between education and income with BMI would be at least partly mediated by SSS. A structural equation path analysis was performed to assess whether the education and income have direct or indirect effects on BMI through SSS [34]. Analyses were estimated using PROC CALIS in SAS software, Version 9. 4® (Copyright, SAS Institute Inc.). Please see supplementary information for the SAS syntax used to estimate mediation model 2. Significant indirect effects of education and income indicate that SSS partially mediates the effect between education, income, and BMI. We use the term "effect' to indicate hypothesized statistical effects, which are indicative of associations; we do not suggest that our model includes all necessary variables or the study design to estimate true causal effects.

We also tested whether the indirect effects of education and income differed by sex by estimating a multi-group path analysis and testing whether differences in the indirect effects were significantly different from zero using bootstrap standard errors and bias-corrected confidence intervals from 1000 samples (33). This is referred to as Model 2. Bootstrapped estimates were generated using STATA/IC 14.0.

Goodness of fit statistics were calculated for each estimated model. As discussed in the results below, we estimate the initial mediation model (Model 1), in which the only predictors of SSS are education and income. Based on modification indices, we estimate a second mediation model (Model 2) in which SSS is also predicted by sex. The model chi-square test statistic indicates whether a specified model is a good fit to the data, with small chi-square values indicating poor model fit (34). Given that large samples can generate chi-square values that may be error prone, as well as other limitations (35), we additionally report the following goodness of fit indices: the Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). Values of CFI greater than 0.94 indicate a good fit between the data and model (36). Values of SRMR and RMSEA less than 0.055 indicate good model fit (37).

Results

Table 1 presents descriptive statistics of the complete cases (N=2,530) in the analytic sample for our models. Mean age was 45.0 years, 54.3% of the analytic sample was female and 48.7% was black with a mean BMI of 28.9 kg/m^2. Mean score on the SSS scale (which ranges from 1–10) in year 20 was 6.0. On average, respondents had 15 years of education and an income of 6.8 on a scale from 1–9 (6 corresponding to $50,000 through $74,999 and 7 corresponding to $75,000 through $99,999). Figure 1 presents the mediation model with direct effects of SSS on BMI and paths from education, income, and race to SSS (model 2). Table 2 is the correlation matrix of the analytic sample with complete records and Table 3 contains goodness-of-fit indices for both the initial (Model 1) and revised mediation model (Model 2).

Model 1 tests whether BMI is a function of several exogenous variables (education, income, sex, race) and the endogenous variable SSS. All exogenous variables were allowed to covary with each other. Estimated path coefficients were significantly different from zero (χ^2=12.31, df=3, p=0.0064). Squared multiple correlation values indicate that the predictor variables are associated with 6.2% of the variation in BMI and 20.0% of the variation in SSS. The CFI, SRMR, and RMSEA (90% CI 0.05–0.08) all indicate good model fit with the data. Examination of Lagrange Multipliers indicated the model fit could be significantly improved by adding paths from sex to SSS. We thus estimated a revised mediation model (Model 2) with this additional path. A chi-square difference test confirmed that the addition of this path resulted in a significant improvement in model fit ($\Delta X^2(\Delta df, 1)=11.8$, p=0.0006). Goodness-of-fit statistics for the revised mediation model were within the range of good model fit (CFI=1.000, SRMR=0.0024, and RMSEA=<0.0000).

Table 4 presents unstandardized estimates of hypothesized direct and indirect effects from the revised model from Model 2 and Figure 1 presents the path diagram, with labels for each path to aid interpretation of coefficients listed in Table 4. In Model 2, direct effects of sex (b=−0.190, p=0.0006) on SSS were significant, indicating that, on average, female is associated with lower SSS. SSS had a significant direct effect on BMI (−0.21, p=0.0181), thus individuals who reported a higher SSS had, on average, a lower BMI, consistent with our hypothesized model and previous reports (14–17).

Based on the improvement in fit and goodness-of-fit statistics, we use Model 2 to test whether SSS mediates the effect of income and education on BMI. Education had a small but significant indirect effect on BMI through SSS ($b = -0.02$, $p=0.0219$). Income, although it did not have a significant direct effect on BMI, did have a significant indirect effect through SSS ($b = -0.05$, $p=0.0192$). The indirect effect of income on BMI comes from its large direct effect on SSS ($b = 0.24$, $p<0.0001$). The significant indirect effects of education and income with BMI indicate that SSS at least partially mediates the relationship between objective measures of SES and BMI. Finally, race had a significant direct effect on BMI ($b = 2.92$, $p<0.0001$), but age and sex did not have significant direct effects. There was no evidence that the indirect effects of income and education differed by sex in Model 2.

Discussion

Results from our path analysis are consistent with the hypothesis that SSS mediates the relationship between objective measures of SES and BMI. This finding is similar to a previous report that SSS mediates the relationship between income and education and several other health outcomes (24). Not surprisingly, given that income and education are both important predictors of SSS (18, 19, 29), both had large direct associations with SSS in our model. In the mediation model, education, income, and had a significant association with BMI indirectly through its association with SSS. Our findings are consistent with a theoretical model where the association between traditional measures of SES with BMI may be operating through its association with an individual’s perception of their social status.

As hypothesized, SSS had a small but significant direct association with BMI after adjusting for income and education. This suggests that *perception* may be involved in the associations of social factors and resources on body fatness. It has long been understood that a key regulator of the response to a given environment is determined by an organism’s perception of that environment (38). This fact may have important implications for the way the relationship between the environment and health is understood, and in the way it is addressed, and suggests that targeting perception of the environment, rather than the environment itself, may have some impact on health outcomes.

For example, calorie restriction increases lifespan in many species, and some evidence from our work and the work of others suggests that increased lifespan is driven by *perception* of energetic resources in the environment (10). Exposing calorically restricted fruit flies to the smell of food, to generate the perception of food availability, reverses the association of caloric restriction on lifespan (39). Similarly, we demonstrated in an Alzheimer’s mouse model that inducing the sensation of hunger using a ghrelin agonist in well-fed mice is sufficient to attenuate cognitive decline (40). If complex processes such as aging and longevity can be influenced by perception of energetic resources, we argue that it is plausible that perception of social standing as it relates to resources as measured by SSS may influence body size and body fatness, as well.

Several limitations need to be considered when interpreting our findings. First, these findings are observational associations and cannot establish causation. While we use the term “effect” to describe statistical estimates, we do so within the context of the estimated model, not to imply true causal effects. We also used techniques that are focused on the central part of the BMI distribution, and that assume a linear relationship between SSS and BMI. Because the BMI distribution may have an elongated right-tail in some samples, it is possible this analysis does not capture the influence of SSS at this upper end of the distribution. Of the participants included in our analysis, 15.8% had a BMI > 35 kg/m^2. In addition, because energy expenditure through physical activity and energy intake are two major factors in energy balance, it is plausible that SSS could operate through its association with one or both of these variables. Future studies with more accurate and complete measures of these variables would be helpful to explore this possibility.

Another important caveat to consider is that although our findings are statistically significant, the explanatory power of SSS to predict BMI is small. Because adult BMI is likely influenced by a myriad of biological, environmental, and social factors, such small associations of one factor are frequently found and are not surprising. Thus, the significance of the potential degree of impact of SSS on BMI should not be overestimated, and should be considered in the context of many interacting factors. This model should be tested in other datasets and via experimentation when possible.

Finally, it is important to consider that our findings may not be applicable to other populations. The dynamics between income and perception of social status may be different, for example, in countries at varying stages of economic development or varying levels of income gap. Therefore, we can only draw conclusions about the association and mediating associations of SSS on BMI in this cohort from the United States in this timeframe when BMI was rapidly increasing, and our findings may not be generalizable to other countries, populations or time periods.

Future studies should attempt to replicate our findings in other longitudinal studies, determine the interactions of SSS with sex and race on BMI, and determine if the relationship between SSS and BMI is causal. Although SSS is a perception that may not be easily subjected to manipulation and controlled trials (and may operate over long periods), there may be methods and interventions to increase SSS and determine the effect on eating behavior, physical activity, and body weight outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported in part by NIH grants 3R01AG043972-03S2, 3P30DK056336-13S1, 2T32DK062710-11. Also, The Coronary Artery Risk Development in Young Adults Study (CARDIA) is supported by contracts HHSN268201300025C, HHSN268201300026C, HHSN268201300027C, HHSN268201300028C, HHSN268201300029C, and HHSN268200900041C from the National Heart, Lung, and Blood Institute (NHLBI), the Intramural Research Program of the National Institute on Aging (NIA), and an intra-agency agreement between NIA and NHLBI (AG0005). The opinions expressed are those of the authors and not necessarily those of the NIH or any other organization.

References

1. McLaren L. Socioeconomic status and obesity. Epidemiologic reviews. 2007; 29:29–48. [PubMed: 17478442]
2. Zhang Q, Wang Y. Socioeconomic inequality of obesity in the United States: do gender, age ethnicity matter? Soc Sci Med. 2004; 58(6):1171–80. [PubMed: 14723911]
3. Fontaine KR, Robertson HT, Holst C, Desmond R, Stunkard AJ, Sorensen TI, et al. Is socioeconomic status of the rearing environment causally related to obesity in the offspring? PloS one. 2011; 6(11):e27692. [PubMed: 22110724]
4. Lissau-Lund-Sorensen I, Sorensen TI. Prospective study of the influence of social factors in childhood on risk of overweight in young adulthood. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity. 1992; 16(3): 169–75.
5. Sonne-Holm S, Sorensen TI. Prospective study of attainment of social class of severely obese subjects in relation to parental social class, intelligence, and education. Br Med J (Clin Res Ed). 1986; 292(6520):586–9.
6. Sorensen TI, Sonne-Holm S. Intelligence test performance in obesity in relation to educational attainment and parental social class. Journal of biosocial science. 1985; 17(4):379–87. [PubMed: 4055828]
7. Baum CL 2nd, Ford WF. The wage effects of obesity: a longitudinal study. Health economics. 2004; 13(9):885–99. [PubMed: 15362180]
8. Mirowsky J, Ross CE. Education, Personal Control, Lifestyle and Health: A Human Capital Hypothesis. Research on Aging. 1998; 20(4):415–49.
9. Gosler AG. Environmental and social determinants of winter fat storage in the great tit Parus major. J Anim Ecol. 1996; 65(1):1–17.
10. Kaiser KA, Smith DL Jr, Allison DB. Conjectures on some curious connections among social status, calorie restriction, hunger, fatness, and longevity. Ann N Y Acad Sci. 2012; 1264:1–12. [PubMed: 22834696]
11. Wilson ME, Fisher J, Fischer A, Lee V, Harris RB, Bartness TJ. Quantifying food intake in socially housed monkeys: social status effects on caloric consumption. Physiology & behavior. 2008; 94(4):586–94. [PubMed: 18486158]
12. Townsend MS, Peerson J, Love B, Achterberg C, Murphy SP. Food insecurity is positively related to overweight in women. The Journal of nutrition. 2001; 131(6):1738–45. [PubMed: 11385061]
13. Sanghez V, Razzoli M, Carobbio S, Campbell M, McCallum J, Cero C, et al. Psychosocial stress induces hyperphagia and exacerbates diet-induced insulin resistance and the manifestations of the Metabolic Syndrome. Psychoneuroendocrinology. 2013; 38(12):2933–42. [PubMed: 24060458]
14. Singh-Manoux A, Marmot MG, Adler NE. Does subjective social status predict health and change in health status better than objective status? Psychosomatic medicine. 2005; 67(6):855–61. [PubMed: 16314589]
15. Adler NE, Epel ES, Castellazzo G, Ickovics JR. Relationship of subjective and objective social status with psychological and physiological functioning: preliminary data in healthy white women. Health psychology : official journal of the Division of Health Psychology, American Psychological Association. 2000; 19(6):586–92.
16. Goodman E, Adler NE, Daniels SR, Morrison JA, Slap GB, Dolan LM. Impact of objective and subjective social status on obesity in a biracial cohort of adolescents. Obesity research. 2003; 11(8):1018–26. [PubMed: 12917508]
17. Hu P, Adler NE, Goldman N, Weinstein M, Seeman TE. Relationship between subjective social status and measures of health in older Taiwanese persons. Journal of the American Geriatrics Society. 2005; 53(3):483–8. [PubMed: 15743294]
18. Miyakawa M, Magnusson Hanson LL, Theorell T, Westerlund H. Subjective social status: its determinants and association with health in the Swedish working population (the SLOSH study). European journal of public health. 2012; 22(4):593–7. [PubMed: 21646364]

19. Singh-Manoux A, Adler NE, Marmot MG. Subjective social status: its determinants and its association with measures of ill-health in the Whitehall II study. Social Science & Medicine. 2003; 56(6):1321–33. [PubMed: 12600368]
20. Briers B, Pandelaere M, Dewitte S, Warlop L. Hungry for money: the desire for caloric resources increases the desire for financial resources and vice versa. Psychological science. 2006; 17(11): 939–43. [PubMed: 17176423]
21. Bratanova B, Loughnan S, Klein O, Claassen A, Wood R. Poverty, inequality, and increased consumption of high calorie food: Experimental evidence for a causal link. Appetite. 2016; 100:162–71. [PubMed: 26809142]
22. Cardel MI, Johnson SL, Beck J, Dhurandhar E, Keita AD, Tomczik AC, et al. The effects of experimentally manipulated social status on acute eating behavior: A randomized, crossover pilot study. Physiol Behav. 2016; 162:93–101. [PubMed: 27094920]
23. Cheon BK, Hong Y-Y. Mere experience of low subjective socioeconomic status stimulates appetite and food intake. Proceedings of the National Academy of Sciences. 2017; 114(1):72–7.
24. Demakakos P, Nazroo J, Breeze E, Marmot M. Socioeconomic status and health: the role of subjective social status. Soc Sci Med. 2008; 67(2):330–40. [PubMed: 18440111]
25. Ha Y, Choi E, Seo Y, Kim TG. Relationships among subjective social status, weight perception, weight control behaviors, and weight status in adolescents: findings from the 2009 Korea Youth Risk Behaviors Web-Based Survey. J Sch Health. 2013; 83(4):273–80. [PubMed: 23488888]
26. Friedman GD, Cutter GR, Donahue RP, Hughes GH, Hulley SB, Jacobs DR Jr, et al. Cardia: study design, recruitment, and some characteristics of the examined subjects. Journal of Clinical Epidemiology. 1988; 41(11):1105–16. [PubMed: 3204420]
27. Cutter G, Burke G, Dyer A, Friedman G, Hilner J, Hughes G, et al. Cardiovascular risk factors in young adults: the CARDIA baseline monograph. Controlled Clinical Trials. 1991; 12(1):1S–77S. [PubMed: 1851696]
28. Allison, PD. SAS Global Forum. Orlando, FL: 2012. Handling Missing Data by Maximum Liklihood. 2012
29. Adler, N., S, J. MacArthur Research Network on SES & Health. San Fransisco: The John D. and Katherine T. MacArther Foundation; 2007. [updated March, 2007. Available from: http://www.macses.ucsf.edu/research/psychosocial/subjective.php
30. Sidney S, Jacobs DR Jr, Haskell WL, Armstrong MA, Dimicco A, Oberman A, et al. Comparison of two methods of assessing physical activity in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. American journal of epidemiology. 1991; 133(12):1231–45. [PubMed: 2063831]
31. McDonald A, Van Horn L, Slattery M, Hilner J, Bragg C, Caan B, et al. The CARDIA dietary history: development, implementation, and evaluation. Journal of the American Dietetic Association. 1991; 91(9):1104–12. [PubMed: 1918764]
32. Schoeller DA, Thomas D, Archer E, Heymsfield SB, Blair SN, Goran MI, et al. Self-report-based estimates of energy intake offer an inadequate basis for scientific conclusions. Am J Clin Nutr. 2013; 97(6):1413–5. [PubMed: 23689494]
33. Bollen KA, Stine R. Direct and indirect effects: Classical and bootstrap estimates of variability. Sociological methodology. 1990:115–40.
34. O'Rourke, NH., L. A Step-by-Step Approach to Using SAS for Factor Analysis and Structural Equation Modeling. 2. Cary, NC, USA: SAS Institute, Inc; 2013.
35. Kline, RB. Principles and Practice of Structural Equation Modeling. New York: Guilford Press; 2005.
36. Hu LB, P M. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal. 1999; 6(1):1–55.
37. McDonald RP, Ho MH. Principles and practice in reporting structural equation analyses. Psychological methods. 2002; 7(1):64–82. [PubMed: 11928891]
38. Folkman S, Lazarus RS, Dunkel-Schetter C, DeLongis A, Gruen RJ. Dynamics of a stressful encounter: cognitive appraisal, coping, and encounter outcomes. Journal of personality and social psychology. 1986; 50(5):992–1003. [PubMed: 3712234]

39. Libert S, Zwiener J, Chu X, Vanvoorhies W, Roman G, Pletcher SD. Regulation of Drosophila life span by olfaction and food-derived odors. Science. 2007; 315(5815):1133–7. [PubMed: 17272684]

40. Dhurandhar EJ, Allison DB, van Groen T, Kadish I. Hunger in the absence of caloric restriction improves cognition and attenuates Alzheimer's disease pathology in a mouse model. PloS one. 2013; 8(4):e60437. [PubMed: 23565247]

Study Importance Questions

1. What is already known about this subject?

- Objective indicators of socio-economic status such as income and education are associated with obesity.
- Subjective social status, an indicator of an individual's perception of their social status, is more highly associated with many health outcomes than objective indicators.
- Subjective social status is associated with obesity, and many recent experiments suggest experimentally manipulated perception of social hierarchy can influence eating behaviors.

1. What does this study add?

- This study replicates the finding that SSS is associated with body mass index in a large sample of the U.S. population.
- This study demonstrates that perceived social status mediates, in part, the relationship between income and education with obesity.

Author Manuscript
Author Manuscript
Author Manuscript

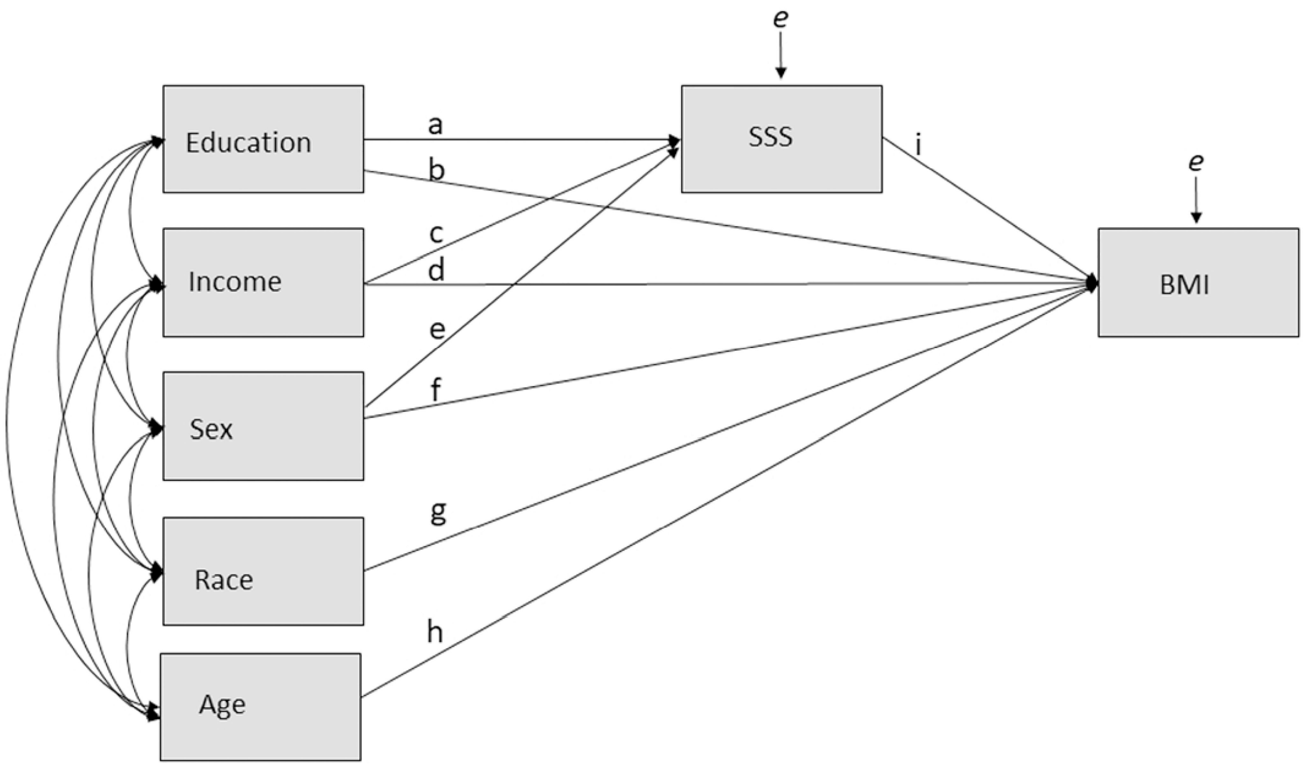

Figure 1.
Path diagram for model 2.

Table 1

Means and Standard Deviations of CARDIA Sample Year 20 (wave 7) data; N = 2,530 (complete cases)

Measure	Mean	Std. Dev.	Range
BMI (year 20, wave 7)	28.9	6.5	15.0–75.8
SSS (0–9 scale, low to high)	6.0	1.6	0–9
Education (years)	15.0	2.6	7–20
Income (1–9 scale)*	6.8	2.2	1–9
Female (%)	54.3	-	-
Black (%)	48.7	-	-
Age (year 20 wave 7, years)	45.0	3.6	37–55

Abbreviations: BMI=Body Mass Index (kg/m^2); SSS=Subjective Social Status Income range at point 6 was $50,000–$74,999, point 7 was $ 75,000 – $999,999

Table 2

Correlation Matrix of Variables Used in Analysis, CARDIA sample at year 20; N = 2,530 (complete cases).

Measure	BMI	SSS	Education	Income	Female	Black	Age
BMI	1						
SSS	−0.10*	1					
Education	−0.13*	0.32*	1				
Income	−0.09*	0.41*	0.43*	1			
Female	0.04*	−0.09*	0.02	−0.10*	1		
Black	0.24*	−0.18*	−0.34*	−0.32*	0.07*	1	
Age	−0.01	0.04*	0.10*	0.06*	−0.005	−0.16*	1

Note: BMI=Body Mass Index; SSS=Subjective Social Status.

*Bivariate correlation $p<0.05$

Table 3

Goodness-of-Fit Statistics for Estimated Models

Model	X^2	df	X^2, p-value	ΔX^2	Δdf	CFI	SRMR	RMSEA
Baseline	1848.14	21	<0.0001					
Model 1	12.31	3	0.0064	1835.8	18	0.9949	0.0118	0.0344
Model 2	0.5368	2	0.7646	11.8	1	1.000	0.0024	0.0000

Abbreviations: X^2=chi-square; df=degrees of freedom; CFI=Comparative Fit Index; SRMR=Standardized Root Mean Square Residual; RMSEA=Root Mean Square Error of Approximation

Table 4

Path Coefficients for Model 2

Path	Coefficient (path label)	Std. Error	p
Direct Effects			
Education->SSS	0.11 (a)	0.01	<0.0001
Education -> BMI	−0.14 (b)	0.06	0.0142
Income -> SSS	0.24 (c)	0.01	<0.0001
Income -> BMI	0.12 (d)	0.07	0.0868
Sex (Female=1) -> SSS	−0.19 (e)	0.06	0.0006
Sex -> BMI	0.38 (f)	0.25	0.1302
Race (Black=1) -> BMI	2.92 (g)	0.27	<0.0001
Age -> BMI	0.05 (h)	0.03	0.1106
SSS ->BMI	−0.21 (i)	0.09	0.0181
Indirect Effects			
Education -> BMI	−0.02 (a->i)	0.01	0.0219
Income -> BMI	−0.05 (c->i)	0.02	0.0192
Sex -> BMI	0.04 (e->i)	0.02	0.0517

Note: BMI=Body Mass Index; SSS=Subjective Social Status;