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Obesity, race/ethnicity and the multiple dimensions of socioeconomic status during the transition to adulthood: A factor analysis approach

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Abstract

Racial/ethnic disparities in obesity widen dramatically during young adulthood in the US. Understanding racial/ethnic differences in the association between socioeconomic status (SES) and obesity can provide insight on these disparities. However, the delay and complexity of the transition to adulthood creates challenges for defining SES using traditional, single indicators, such as income or years of education. Our objective was to define a multidimensional measure of young adult SES using exploratory factor analysis and to investigate whether distinct SES dimensions differentially predicted obesity across race/ethnicity in 11,250 young adults (mean age = 21.9 years) from the National Longitudinal Study of Adolescent Health (Wave III: 2000–2001). Four factors (social advantage; schooling; employment; and economic hardship) extracted from a principal factor analysis on 38 SES indicators comprised our multidimensional measure of young adult SES. The respondents' scores on each factor were entered into gender-stratified Poisson regression models to estimate the relative risk of young adult obesity for a contrast of approximately one standard deviation in score. The association of the "Social advantage" and "Economic hardship" factors with obesity differed by race/ethnicity ($p<0.05$ for Wald test of interaction) in females; high "Social advantage" scores were inversely associated with obesity in white and Hispanic females (9–20% lower) while high scores on "Economic hardship" were positively associated with obesity (7–76% higher) in white and Asian females. In contrast, no significant racial/ethnic differences were detected in young adult males. The "Schooling" factor was significantly protective (RR=0.91; 95% CI: 0.85, 0.98) for females of all racial/ethnic groups. These results facilitate understanding of the impact of multiple, distinct SES dimensions during the complex transition to adulthood and thus provide salient information for reducing racial/ethnic disparities in obesity during this important period for obesity development.

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Keywords

USA; Social class; Minority groups; Obesity; Young adults; US; Factor Analysis; socioeconomic status (SES)

INTRODUCTION

Obesity is a major public health problem in the US, particularly in racial/ethnic minority populations (Hedley, Ogden, Johnson, Carroll, Curtin, & Flegal, 2004; Ogden, Carroll, Curtin, McDowell, Tabak, & Flegal, 2006). The higher rate of obesity in minorities is often linked to the disproportionate representation of these groups in lower socioeconomic status (SES) categories. However, low SES, as traditionally defined using indicators of income, education or occupation, has been consistently associated with higher obesity in US whites only, with comparatively weak inverse associations among minority women, and positive associations among minority men (Gordon-Larsen, Adair, & Popkin, 2003; Patterson, Stern, Crawford, McMahon, Similo, Schreiber et al., 1997; Zhang & Wang, 2004).

The transition to adulthood is characterized by increasing obesity incidence and divergent racial/ethnic trends in obesity (Gordon-Larsen, Adair, Nelson, & Popkin, 2004; Guo, Huang, Maynard, Demerath, Towne, Chumlea et al., 2000; Kimm, Barton, Obarzanek, McMahon, Sabry, Waclawiw et al., 2001), underscoring the importance of this stage of the life course for reducing disparity. However, assessing the role of SES in these trends is hindered by the later and varied timing of transitions in residence, employment, schooling and social roles in contemporary US young adults compared to previous generations (Fussell & Furstenberg, 2004; Settersten, Furstenberg, & Rumbaut, 2004).

Entry into adulthood is increasingly uncoupled from chronological age, and traditional SES specifications assuming the completion of multiple transitions can no longer adequately capture the SES of young adults (Shanahan, Porfeli, Mortimer, & Erickson, 2004). Thus, researchers typically substitute the comparatively stable SES of the parent. While parental background has a strong influence on the SES of young adult offspring, the latter is vastly understudied and likely to differ from parental SES in composition. Further, young adult SES may uniquely predict variations in health. Thus, the study of young adult SES, independent of parental SES, is particularly important during this transition period.

In addition, there is little consensus on a theoretically sound definition of the SES construct at any life stage. Although most agree it comprises multiple dimensions, the traditional approach to defining SES uses single indicators of income or education (Ball, Mishra, & Crawford, 2002; Krieger, Williams, & Moss, 1997; Oakes & Rossi, 2003). We addressed important limitations in defining SES during the complex transition to adulthood using exploratory factor analysis. This strategy summarized the natural relationships within a large collection of SES indicators, capturing the breadth of young adult SES in multiple dimensions specifically relevant to the complex young adult age range.

Conceptualizing the inter-relationships between SES, race/ethnicity and obesity can be challenging. Racial/ethnic associations with health are often adjusted by socioeconomic indicators to determine the extent to which SES “explains” racial differences. However, inadequate or improper specification of SES can bias estimates towards independent effects of race/ethnicity, which have the danger of being interpreted as “biological” effects of race (Kaufman, Cooper, & McGee, 1997; Williams, 1997). Since research shows that minorities experience “diminishing returns” in translating better SES into better health, exploring racial/ethnic differences in relationships between SES and health can provide insight on racial/ethnic

disparities (Farmer & Ferraro, 2005; Shuey & Willson, 2008). Thus, our strategy was to investigate racial/ethnic differences in the association of young adult SES with obesity.

In summary, we used exploratory factor analysis to define a multidimensional measure of SES in a diverse sample of US young adults. We then examined the association between this SES measure and obesity in young adulthood, with the hypothesis that this relationship would differ by race/ethnicity.

METHODS

Study population and design

We used data from the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative study of health behaviors in youth (Wave I; 1994–1995 grades 7–12, ages 11–21 years), followed with multiple interview waves into young adulthood (Wave III; 2001–2002; ages 18–28 years). This school-based study used a multistage, stratified, cluster sampling design, supplemented with special minority samples and collected under protocols approved by the Institutional Review Board of the University of North Carolina, as described elsewhere (Harris, Florey, Tabor, Bearman, Jones, & Udry, 2003). Our analytic sample was drawn from the pool of young adult respondents in Wave III with post-stratification sample weights (N=14,322), using Wave I data to define important covariates for multivariable modeling, including gender, race/ethnicity and adolescent obesity. Seriously disabled or pregnant respondents at either wave were excluded because of the impact of these conditions on height and weight. The majority of missing observations were lost due to listwise deletion of observations missing data on the large set of SES variables used in factor analysis. We arrived at a final analytic sample of 11,250 respondents (47.8% female), comprising four major racial/ethnic groups: non-Hispanic whites, non-Hispanic blacks, Hispanics and Asians, aged 18 to 28 years (mean = 21.9 years) at Wave III. The excluded sample was younger, had a higher proportion of blacks and Hispanics and higher BMI at both waves, as well as lower values on traditional young adult SES indicators (e.g. income, years of education). We empirically assessed the impact of sample selectivity on our results.

Definition of variables

Outcome: young adult obesity (Wave III)—Obesity in young adulthood was defined in Wave III (aged 18–28 years) using the adult BMI cut point for obesity (30 kg/m2) (NHLBI, 1998) based on self-reported height and weight. We controlled for adolescent (Wave I) obesity in our multivariable models. Since only self-reported height and weight were available at Wave I, we used the self-report measure at Wave III to have comparability in measurement across time points as recommended for longitudinal analysis (Field, Aneja, & Rosner, 2007) and to allow inclusion of respondents who refused to be weighed and/or whose body weight exceeded scale capacity. Add Health self-report values have been shown to correctly classify obesity status for a large proportion of the respondents (Goodman, Hinden, & Khandelwal, 2000). Using a longitudinal sub-sample of Add Health respondents, we confirmed that serial measured vs. serial self-reported height and weight produced similar results (not shown).

Exposure: young adult SES (Wave III)—A large set of indicators of young adult SES was selected from the Wave III questionnaire to represent three major domains of SES shown in the literature to uniquely identify social status: (1) material endowments, (2) skills and knowledge, and (3) the status, power and abilities of one's social network, or material, human and social capital, respectively (Oakes & Rossi, 2003). We used exploratory factor analysis to summarize the relationships among these variables into a small set of factors without restrictions in number of factors or variable composition, because we had no *a priori* expectation that the resulting factors would fall into the three literature-based domains. Patterns

that emerged from the analysis were driven by the responses of young adults and thus specific to this age range. Our "multidimensional measure" of young adult SES jointly comprised the *set* of factors that emerged from our analysis. The full procedure and listing of variables is presented in the "Factor Analysis" section.

Covariates

Adolescent obesity (Wave I): Obesity in adolescence was assessed using self-reported height and weight from Wave I (aged 11–21) and defined using the International Obesity Task Force (IOTF) reference cut-points for obesity in children and adolescents (Cole, Bellizzi, Flegal, & Dietz, 2000). Given normal changes in BMI with growth and development, use of a single cut-point to define obesity in youth is not possible. The widely-used IOTF reference curves for BMI statistically link the percentiles for youth with the adult BMI cut point of 30 kg/m^2, thus providing the only comparative reference data that can be used to define obesity across the transition from adolescence to adulthood (Cole, Bellizzi, Flegal et al., 2000).

Demographics: Self-designated race/ethnicity from Wave I was used to classify respondents into mutually-exclusive categories of Hispanic, non-Hispanic white, non-Hispanic black and Asian/Pacific Islander (Hispanic, white, black and Asian, respectively). Gender and age (as of last birthday) were self-reported at Wave III.

Conceptual model

Figure 1 presents our conceptual model. Our ultimate goal was to determine whether the association of young adult SES with young adult obesity was modified by race/ethnicity. While contemporaneous assessment of SES and obesity in young adulthood precluded a causal interpretation of this association, we reduced bias by adjusting our models for confounding by adolescent obesity, which may associate with lower young adult SES and higher young adult obesity. Obesity in adolescence has been linked to lower wages (Finkelstein, Ruhm, & Kosa, 2005) and less educational and occupational opportunity in adulthood due to pervasive stigmatization (Latner & Stunkard, 2003) and discrimination in hiring and wages faced by those with excess weight (Averett & Korenman, 1999;Baum & Ford, 2004;Gortmaker, Must, Perrin, Sobol, & Dietz, 1993), despite the high prevalence of obesity in the US (Ogden, Carroll, Curtin et al., 2006). Adolescent obesity has also been identified as an important predictor of young adult obesity because of its strong tracking across the transition to adulthood (Magarey, Daniels, Boulton, & Cockington, 2003;Serdula, Ivery, Coates, Freedman, Williamson, & Byers, 1993). Importantly, our adjustment for adolescent obesity was also a partial control for the strong influence of early life (i.e. parental) SES on earlier obesity development.

Analytic Strategy

Statistical analyses were carried out using Stata, version 9.0 (StataCorp, 2007). Our strategy was to create a multidimensional measure of young adult SES in a pooled racial/ethnic sample of young adults using factor analysis and to investigate racial/ethnic differences in the association of specific SES dimensions with young adult obesity using multivariable modeling.

Factor analysis—The "principal factor" method was used to find the least number of factors to account for the common variance of a large set of SES variables, excluding variable-specific (unique) variance (Gorsuch, 1983). Beginning with 55 indicators selected to represent the full range of young adult SES-related variables measured in Add Health, we iteratively reduced the variable set to optimize the analysis. Although the correlation-based factor analysis procedure typically assumes interval data, ordinal and dichotomous data are permissible if their underlying correlations are moderate or weak (≤ 0.7) (Kim & Mueller, 1978). Thus, we dropped one member of each highly inter-correlated (>0.7) pair of ordered-categorical variables

measuring similar substantive aspects of SES based on Pearson correlations (Kim, Nie, & Verba, 1977); we applied the same criteria to pairs of substantively-similar binary variables based on tetrachoric correlations, which assume that binary variables are indicators of underlying continuous latent variables (Garson, 1998). Continuous variables with highly skewed (>1.5) distributions were log transformed before being entered into the factor analysis. The final variable set for factor analysis included 38 young adult SES indicators (Table 1).

The Kaiser criterion (eigenvalues >1.0), cumulative percent of common variance explained and Scree tests were employed to determine the optimal number of factors, and a standard orthogonal rotation (Varimax) of the original SES variable space was used to achieve a structure with independent (non-overlapping) factors, using the Horst (1965) normalization to eliminate the heavy weight of variables with high initial loadings. Rotated factors were assigned labels to describe the pattern of highly-loading variables. Factor scores were generated by the Bartlett method (Gorsuch, 1983), which calculates, for each individual, the "weighted sum" of their standardized value for every variable multiplied by the corresponding factor loading of the variable. These scores summarized each subject's relative position with respect to a given factor (Kline, 1994). The inter-quartile range on each factor was similar across racial/ethnic groups, minimizing concern about limited group-specific distributions. Furthermore, the correlations between factor scores and age were low to moderate and thus were likely to be reasonably controlled by the inclusion of age in our models. Post-stratification sample weights were applied to the factor procedure to reduce bias in factor loadings due to unequal selection into the probability sample.

Multivariable modeling—Poisson regression models were used to estimate the relative risk of young adult obesity associated with the generated factor scores. We used the "modified Poisson regression" approach described by Zou (2004) to directly estimate the relative risk of young adult obesity, our highly-prevalent binary outcome. Scores for each factor were entered jointly into the model as independent exposures that together comprised our multidimensional measure of SES. Orthogonal rotation ensured that the factors were uncorrelated, such that univariate associations of each factor separately with obesity were essentially the same as associations from the final, multivariate models mutually adjusted for all four factors (not shown). Effect estimates reflect the risk of obesity associated with a one-unit increase in the continuously-scaled factor score while holding the other factors constant, where a unit is approximately equivalent to one standard deviation in score. Given gender differences in obesity and in the relationship of SES with obesity, all models were run separately by gender. Within gender, we modeled the interaction of race/ethnicity with each factor score to test our hypothesis that the association of young adult SES with obesity differs by race/ethnicity. Significant factor by race interaction terms ($p<0.05$ for Wald test of interaction) were used to calculate racial/ethnic-specific results.

To build the final models, we examined the influence of age and adolescent obesity as covariates. We did not find support for a three-way interaction of age with race/ethnicity and SES for either gender. Further, there was only weak evidence for two-way interactions between age and select young adult SES factors in males (not shown). For both males and females, we ultimately retained age as a confounder in our models based on the 10% change in estimate criterion (Maldonado & Greenland, 1993). Evidence for confounding also justified the retention of adolescent obesity in all models. Stata survey procedures were used in modeling to correct for unequal probability of selection and the underestimation of variance due to the clustered sample design, thus reducing bias in estimates and standard errors.

RESULTS

The mean age of young adult respondents in the analysis was approximately 22 years, capturing the early stage of young adulthood (Table 2). Obesity prevalence was high in adolescence and increased dramatically from adolescence to adulthood, especially in black and Hispanic females.

The exploratory factor analysis generated a final solution of four young adult SES factors that explained 86.4% of the common variance. The factor loadings for the 38 SES variables used in the final factor analysis are shown in Table 3, with response options arranged in ascending order with respect to the construct. For simplicity, only factor loadings greater than 0.15 are shown. The indicated direction of association (i.e. positive vs. negative) was used to interpret the interrelationships of highly loading variables within a factor.

Factor 1 was the only factor with high loadings for all indicators of social capital but had positive loadings on highly-advantaged characteristics from all three domains of SES and thus was labeled “Social advantage.” Factor 2 was named “Schooling” due to highly positive loadings for education-related variables, including current enrollment in full-time schooling and in a four-year college, as well as notable loadings on indicators beyond education that characterize the experience of being in school, including the receiving of income from family and having student loans. Factor 3 was named “Employment” to represent its high loadings for number of jobs and having a job of higher status in the early stage of young adulthood, as well as the highest loading for total personal income. High positive loadings for the inability to pay for rent or basic services as well as for the receiving of food stamps, AFDC, housing assistance and other forms of welfare informed the labeling of Factor 4 as “Economic hardship.”

We observed dramatic racial/ethnic variation in mean factor scores among males (Figure 2, left panel) for Factor 2 (“Schooling”), with highly negative scores in blacks and Hispanics and highly positive scores in Asians, while males of all racial/ethnic groups had negative scores for Factor 4 (“Economic hardship”). In contrast, females (Figure 2, right panel) of most racial/ethnic groups had positive scores for “Schooling” as well as “Economic hardship” (especially black females), but showed marked variation by race/ethnicity for Factor 1 (“Social advantage”). Males and females had similar patterns across racial/ethnic groups for Factor 3 (“Employment”). To facilitate interpretation of model results, we calculated the average predicted values of high loading variables for “Economic hardship” (i.e. income from food stamps and unable to pay rent or mortgage in past 12 months) for a one-unit change in factor score. Increasing score from 0 to 1 yields an increase in the proportion receiving food stamps from 0.8% to 3.1%, and unable to pay rent/mortgage from 3.7% to 9.7% in the total sample. Similar calculations for salient variables on “Social advantage” (i.e. years of education and received BA degree) produce an increase in the average years of education from 13.2 to 14.5 years, and an increase from 0.1% to 8.2% in the average proportion having a bachelors degree. Significant interactions ($p<0.05$) between SES factor scores and race/ethnicity in Poisson regression models of young adult obesity were observed only in females for Factor 1 (“Social advantage”; $p=0.013$) and Factor 4 (“Economic hardship”; $p=0.017$). Thus, we used interaction terms to calculate racial/ethnic-stratified estimates of the association between these two SES factors and obesity in the final model for females only. We did not have sufficient evidence to stratify estimates by race/ethnicity for Factors 2 and 3 in females or for any factors in males.

Thus, in Table 4, we present age-adjusted, racial/ethnic-stratified and non-stratified estimates for females along with non-stratified estimates for males from final models adjusted for adolescent obesity. None of the young adult SES factors were significantly related to obesity prevalence in the racial/ethnic-pooled model for males. However, holding all other young adult

SES factors constant, a one-unit increase in score on "Social advantage" was associated with a reduced risk of obesity for white and Hispanic females. Among all females, we observed a protective association of the "Schooling" factor with young adult obesity (RR=0.91; 95% CI: 0.85, 0.98). Expanding the contrast from one unit (approximately one standard deviation) to the difference between the highest versus lowest quartile in score to better represent the spread of the population on this factor demonstrates a much greater magnitude of protective effect (RR=0.76; 95% CI: 0.62, 0.94). Interestingly, the "Employment" factor did not show strong associations with obesity for any gender or racial/ethnic group.

DISCUSSION

In this nationally representative sample of US adolescents followed into young adulthood, we used exploratory factor analysis to define a multidimensional measure of young adult SES with unique relevance to this transitional stage of the life course. The complex patterning of SES characteristics facilitated the characterization of young adults in the process of accomplishing traditional milestones of adulthood. Moreover, we capitalized on the sophisticated level of detail captured by multiple SES dimensions to identify specific aspects of young adult SES associated with obesity as well as important racial/ethnic and gender differences in these associations.

Young adult SES factors

Considerable heterogeneity *within* several SES dimensions highlights the limitations of using single SES indicators during this period. For example, the "Social advantage" factor had high loadings on several indicators of civic involvement. However, salient loadings on indicators of information and financial access suggest that aspects of material capital co-occur along with "Social advantage." Furthermore, the "highest grade attained" variable representing years of education, traditionally used as a single indicator of SES, had its highest loading on "Social advantage." However, the multitude of other highly-loading variables on this factor suggests that analyses using only years of education as their SES measure may mistakenly ascribe associations to length of education that are more accurately attributable to this high-capital milieu. Conversely, true associations may be missed because the single indicator of education does not sufficiently capture the complex pattern of SES characteristics that have an important influence on health.

Racial/ethnic variation was observed in scores for several factors, particularly in males. For instance, black and Hispanic males had much lower scores for the "Social advantage" and "Schooling" factors than the other racial/ethnic groups, while black and Asian males had the lowest scores for the "Employment" factor. In addition, we found gender differences in scores on several factors. For example, males scored low on the "Public assistance" factor while females had comparatively high scores. These results are consistent with data on the national Food Stamp Program for 2000 showing that females, especially black females, comprised the majority (60%) of participants (Cunnyngham, 2001); such gender and racial/ethnic differences parallel those observed in other welfare programs (Rank & Hirschl, 2002).

Racial/ethnic differences in association with obesity

The inverse relationship between the "Social advantage" factor and obesity observed in females of several racial/ethnic groups is consistent with the nascent literature on social capital and health outcomes (Holtgrave & Crosby, 2006; Kim, Subramanian, Gortmaker, & Kawachi, 2006). We have particular interest in the strong inverse association in Hispanic females, a historically underprivileged minority group, given our ultimate goal of reducing racial/ethnic disparity in obesity. "Social advantage" may be a target for reducing obesity in Hispanic females, suggesting that broad social interventions that increase community involvement in

this group could have secondary impact related to obesity prevention. In contrast, we found no association between "Social advantage" and obesity in black females, consistent with previous work showing little reduction in obesity at higher parental SES for black adolescents (Gordon-Larsen, Adair, & Popkin, 2003) and adults (Farmer & Ferraro, 2005).

The absence of strong associations between the "Economic hardship" factor and young adult obesity in black and Hispanic females suggests that a history of hardship may have already exerted its influence on obesity development by increasing adolescent obesity, but was already accounted for by controlling for this variable in the final models. These results underscore the difficulty of isolating the impact of SES on obesity during young adulthood in racial/ethnic minorities because these groups are likely to be exposed to a history of lower SES that increases obesity risk early in life, as supported by the high rates of adolescent obesity in blacks and Hispanics in our descriptive data (Table 2).

Although the "Economic hardship" factor had high loadings for several types of public assistance, such as the National Food Stamp program, the significant positive associations with obesity observed in White and Asian females do not necessarily imply that participation in these public programs increases obesity risk in these groups. While other cross-sectional studies have found similar positive relations (Gibson, 2003; Townsend, Peerson, Love, Achterberg, & Murphy, 2001), comparatively small effects from longitudinal research suggests that underlying variables not measured in our study, including long-term material hardship and psychological stress, likely increase both the risk of receiving public assistance and the risk of being obese (Jones & Frongillo, 2006). In general, however, our findings suggest that researchers consider including measures of hardship to better capture low SES in US young adults.

There may be statistical explanations for the lack of racial/ethnic differences in associations between obesity and the "Schooling" and "Employment" factors in females (and all factors in males). First, tests for interaction have low power, reducing our ability to detect significant differences in association by race/ethnicity even when heterogeneity truly exists (Type II error). However, relaxing our threshold significance level from 0.05 to 0.15 did not detect additional interactions (not shown), suggesting that our original analysis captured the most salient differences in our data. Second, there may have been insufficient variability within race/ethnicity on these factors to detect important associations with obesity. Factors were defined the same way across race/ethnicity, creating the potential for limited group-specific distributions. However, similar distributions of factor scores across race/ethnicity suggest that variation in exposure and thus the ability to detect an association was not reduced in particular racial/ethnic groups, supporting our original findings of homogeneity. The absence of modification by race/ethnicity and the lack of significant associations within the pooled racial/ethnic sample in males are consistent with literature showing that relationships between SES and obesity in adult males are equivocal, especially in minorities, and depend on the selected indicator of SES (Ball & Crawford, 2005; Sobal & Stunkard, 1989). While we expected our multidimensional SES measure to better predict variation in obesity, non-SES determinants may play a greater role in racial/ethnic disparities in obesity in males.

Racial/ethnic-pooled associations

The inverse relationship between obesity and "Schooling" observed in females of all racial/ethnic groups makes an important contribution to the literature. The presence of this association while holding constant the years of educational attainment and other typical benefits of pursuing higher education summarized in the "Social advantage" factor suggests that even before the benefits can be realized in tangible terms, the act of being in school still can influence health outcomes. Thus, efforts to increase attendance at institutions of higher learning, while beneficial in many respects, may also have a positive impact on obesity rates. The literature

on participation in post-secondary education and obesity tends to focus on associations *within* these student populations, such as predictors of weight change across the residential transition to a four-year college (Levitsky, Halbmaier, & Mrdjenovic, 2004), or correlates of obesity among college students (Gary, Gross, Browne, & LaVeist, 2006; Nelson, Gortmaker, Subramanian, Cheung, & Wechsler, 2007). We used a nationally representative sample to contrast the risk of obesity for young adults who were more versus less likely to be in school, thus enabling us to identify schooling as a salient exposure (and potential intervention target) for obesity in young adult females. However, due to the cross-sectional nature of our findings, we cannot rule out the possibility that young adult females who pursue higher education are different in other ways that reduce their risk of being obese.

The significant inverse association with obesity for being in school further supports our contention that "traditional" SES measures are not likely to adequately capture the SES of young adults, many of whom have not completed their education or other training. Using a single indicator of "income" or "years of education" might rank a respondent enrolled in higher education as low SES despite being on a high SES trajectory, which could bias associations with obesity. Our factor analysis results show an important inverse association of obesity with the complex pattern of characteristics summarized by the "Schooling" factor that would have been masked using a simple approach to SES assessment.

Analytic concerns related to adolescent obesity

We modeled the association between young adult SES and young adult obesity, adjusting for adolescent obesity to reduce the confounding bias due to the direct influence of adolescent obesity on young adult SES and on young adult obesity *and* to adjust for the earlier influence of parental SES on earlier obesity development, thus providing clarity on relationships specific to young adulthood (Greenland, 2003). Our strategy was supported by evidence from several preliminary analyses, including empirical assessment for confounding by adolescent obesity (as detailed in the Methods), as well as evaluating whether the addition of parental SES to models including adolescent obesity would change estimates beyond a reasonable threshold (>10%). We found evidence for confounding by adolescent obesity but little evidence for additional confounding bias due to parental SES (data not shown). Thus, model parsimony (Greenland, 1989) dictated that we control only for adolescent obesity in our final model, with the assumption that parental SES primarily exerts an influence on our relationship of interest through its strong association with the development of adolescent obesity.

Limitations and strengths

This study was not without limitations. All factor analysis results depend on the set of variables initially included and on the correlations within a particular sample (Diez-Roux, Kiefe, Jacobs, Haan, Jackson, Nieto et al., 2001; Kline, 1994). In addition, several important decisions about the number of factors, rotation strategies and the labeling of factors make it difficult to reproduce risk estimates of measures created using this method in epidemiologic research (Martínez, Marshall, & Sechrest, 1998). However, inclusion of a large set of SES indicators covering a breadth of domains consistent with established theory (Krieger, Williams, & Moss, 1997; Oakes & Rossi, 2003) and the nationally representative sample provide confidence in our results.

Sample selectivity was an additional concern. Although the use of sample weights reduced the likelihood of bias due to attrition from Wave I to Wave III, our exclusions may have biased associations. For sample selectivity to introduce bias, the pattern of inter-relationships among variables in the factor analysis and/or the association between the factor scores and the outcome would have to be different in the included and excluded individuals. We addressed the latter possibility by including covariates in our model that differed between the included and

excluded samples (e.g., age adolescent obesity). Since it would have been difficult to evaluate sample differences in the pattern of relationships within factor analysis, we addressed the former possibility by regressing young adult obesity on traditional, single indicators of young adult SES (i.e. income and years of education) and found no evidence for significant selectivity bias in our results (data not shown).

While we excluded respondents pregnant at time of exam, we did not include pregnancy history, a potential confounder to our association of interest, in our final model. We empirically tested the addition of this variable to our model, finding that despite a significant association with young adult obesity status, the addition of pregnancy history only marginally attenuated (<10% change) estimates on the young adult SES factors (data not shown). Given that parental socioeconomic disadvantage strongly predicts early childbearing, the additional effects of pregnancy on young adult SES in the Add Health sample were likely to be small once early life disadvantage was taken into account (Lee, 2008).

The contemporaneous assessment of SES and obesity in young adulthood precluded any temporal argument for causality despite the control for underlying variables consistent with our conceptual model. Longitudinal analyses using future waves of the Add Health study hold great potential for exploring the character of SES across the full transition to adulthood and racial/ethnic differences in the association of SES with obesity over time. Further, the wide age-range of the sample provided older respondents with a longer opportunity to create their own SES while younger respondents simply were not old enough to have the opportunity to establish their independent lives. However, respondents could score highly on some factors and lower on others to reflect a combination of young-adult SES characteristics specific to their chronological age, a strength of this analysis.

Other study strengths include the large population size, the wide range of data on SES indicators, and the ability to make nationally representative estimates. Furthermore, exploratory factor analysis provided a unique solution to the problems of defining SES in the understudied young adult period.

Conclusions

Young adulthood in the US is characterized by high risk for obesity incidence, especially for racial/ethnic minorities. Despite interest in exploring the role of SES in these obesity trends, the varying paths to financial and social independence creates difficulty in assessing the association between obesity and SES during this transitional stage of the life course. We defined a measure that captures the inherent multidimensionality of SES and the complexity of the transition to adulthood, using factor analysis to identify a diverse, complex and relevant set of SES dimensions from the relationships that naturally exist between variables in our representative young adult population. The patterning of characteristics related to “Schooling” was identified as a salient factor for obesity in all females, while “Social advantage” and the multiple variables capturing “Economic hardship” were important for females of specific race/ethnicity. In contrast, no significant racial/ethnic differences in association of factors with obesity were detected in young adult males. Overall, these findings provide valuable information for efforts to slow the increasing incidence and widening of racial/ethnic disparity in US young adult obesity.

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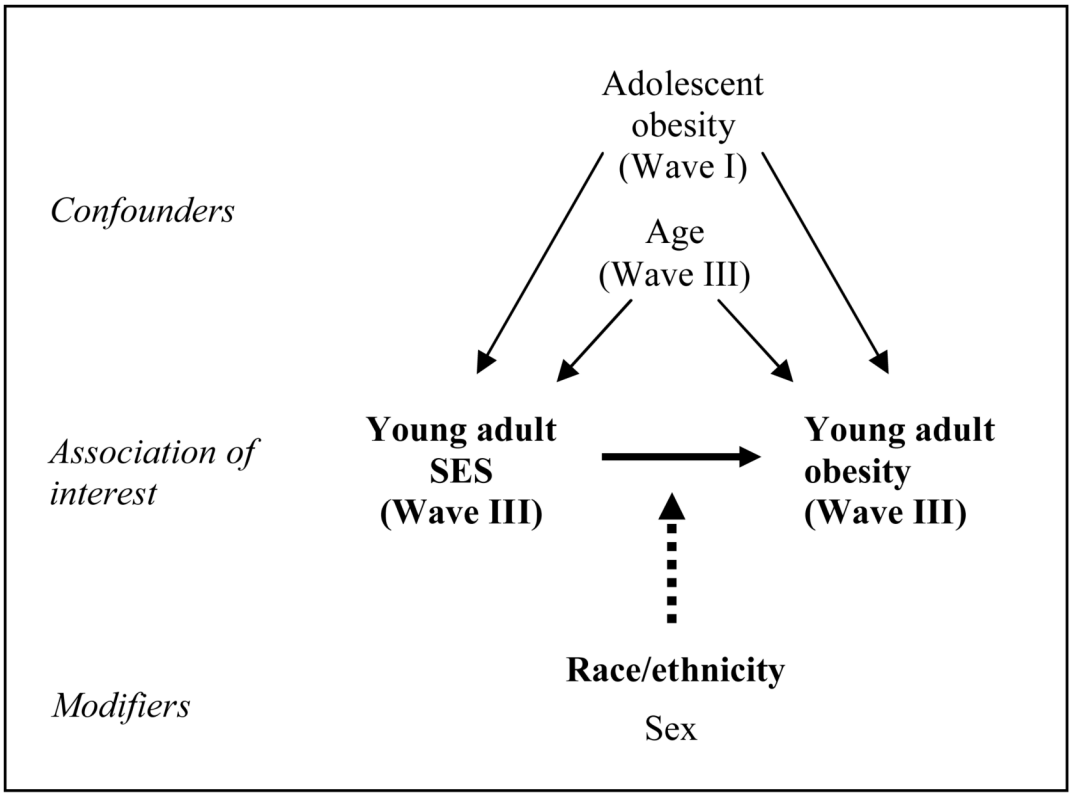

Figure 1.
Conceptual diagram of relationships examined using Poisson regression modeling. The time of assessment for non-fixed attributes is indicated in parentheses. The main exposure of interest, i.e. young adult SES, was defined prior to modeling using exploratory factor analysis.

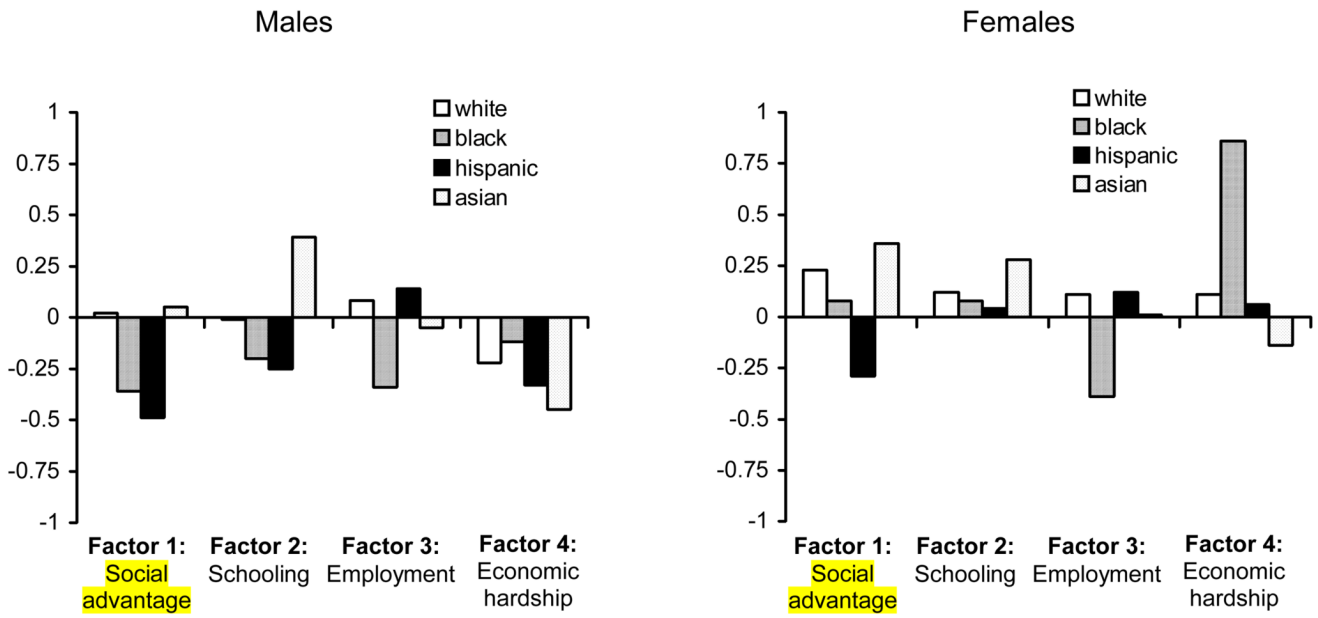

Figure 2.
Mean SES factor scores for male (left panel) and female (right panel) young adults (Add Health Wave III; 2000–2001), by race/ethnicity.

Table 1

38 young adult (Add Health Wave III; 2000–2001) SES indicator variables used to generate SES factors, listed by three domains of SES (Material, Human, and Social Capital).

Material Capital	**Material Capital (cont'd)**	**Human capital**
Income sources (no/yes)	***Economic hardship in the last year (no/yes)***	***Education***
Wages, including tips/bonus	Without telephone service	Highest grade attained
Interest from stocks, bonds	Unable to pay rent/mortgage	HS diploma (no/yes)
Income from family/friends	Gas/electricity/oil turned off	BA degree (no/yes)
		In school part/full time (no/yes)
Personal economics	Unable to afford doctor	In 4-year college (no/yes)
Personal income in 2001	Evicted for not paying rent	
Own residence (no/yes)		***Labor experience***
Own vehicle (no/yes)	***Public assistance (no/yes)***	Number of jobs
	Housing assistance	Job description
Information and financial access (no/yes)	Food stamps	
	AFDC, welfare	
Own/access to computer	Ever received assistance other than food stamps	**Social capital**
Have email account		
Have checking account		Community activities
Have credit card	***Miscellaneous***	Volunteer experience
Have savings account	Number of months of health insurance in past year	Organ donor (no/yes)
Have shares of stock		Registered to vote (no/yes)
Have student loan	Currently living with parents (no/yes)	Voted in 2000 (no/yes)
Have credit card debt		Political affiliation (no/yes)

Table 2

Demographic and obesity data on multivariate analysis sample present in both Wave I (1994–1995) and Wave III (2000–2001) of the National Longitudinal Study of Adolescent Health[a].

	Total (n=11,250)	Males (n=5,462)	Females (n=5,788)
Wave I (1994–1995)			
Female (%, SE)	47.8 (0.8)	--	--
White (%, SE)	70.6 (2.8)	70.2 (2.9)	70.9 (2.9)
Black (%, SE)	13.9 (1.9)	13.5 (1.9)	14.3 (2.0)
Hispanic (%, SE)	11.5 (1.7)	12.1 (1.8)	10.8 (1.6)
Asian (%, SE)	4.1 (0.8)	4.1 (0.8)	4.0 (0.8)
Adolescent obesity (%, SE)	8.5 (0.5)	9.8 (0.6)	7.2 (0.5)
White	7.9 (0.6)	9.6 (0.7)	6.2 (0.6)
Black	12.0 (1.0)	11.7 (1.8)	12.4 (0.9)
Hispanic	9.4 (1.1)	10.1 (1.8)	8.5 (1.3)
Asian	4.2 (1.5)	6.1 (2.3)	2.0 (1.1)
Wave III (2000–2001)			
Age (range: 18–28 years)	21.9 (0.1)	22.0 (0.1)	21.8 (0.1)
Young adult obesity (%, SE)	18.4 (0.7)	18.4 (0.9)	18.5 (0.9)
White	17.1 (0.9)	18.4 (1.1)	15.7 (1.1)
Black	25.3 (1.3)	20.4 (2.0)	30.3 (1.9)
Hispanic	21.0 (1.5)	18.8 (1.9)	23.8 (2.0)
Asian	11.0 (2.5)	11.7 (3.1)	10.1 (2.8)

[a]Weighted and corrected for clustering to generate nationally-representative estimates.

Table 3

Factor loadings[a] for theoretically plausible young adult (Add Health Wave III; 2000–2001) SES indicator variables, after Varimax rotation and Horst normalization

Young adult SES variable	Factor 1: Social advantage	Factor 2: Schooling	Factor 3: Employment	Factor 4: Economic hardship
Material capital				
Income sources *(no/yes)*				
Wages, including tips/bonus			0.44	
Interest from stocks, bonds	0.33			
Income from family/friends		0.32		
Personal economics				
Total personal income: 2001			0.31	
Own residence (no/yes)		−0.21		
Own vehicle (no/yes)	0.15		0.29	
Information and financial access *(no/yes)*				
Own/access to computer	0.25	0.24	0.16	
Have email account	0.40	0.40		
Have checking account	0.45	0.19	0.28	
Have credit card	0.45		0.29	
Have savings account	0.31			−0.16
Have shares of stock	0.41			
Have student loan	0.31	0.31		
Have credit card debt	0.23		0.29	
Economic hardship in the last year *(no/yes)*				
Without telephone service	−0.15			0.36
Unable to pay rent/mortgage				0.43
Gas/electricity/oil turned off				0.36
Unable to afford doctor				0.26
Evicted for not paying rent				0.25
Public assistance *(no/yes)*				
Currently receiving housing assistance				0.33
Currently receiving food stamps			−0.15	0.48
Currently receiving AFDC, public assistance or welfare			−0.18	0.45
Ever received public assistance other than food stamps				0.44
Miscellaneous				
Number of months health insurance in past year	0.37	0.22		
Currently living with parents (no/yes)	−0.18			−0.23
Human capital				
Education				
Highest grade attained	0.67	0.33		

Young adult SES variable	Factor 1: Social advantage	Factor 2: Schooling	Factor 3: Employment	Factor 4: Economic hardship
Received HS diploma (no/yes)	0.35	0.29		
Received BA degree (no/yes)	0.58	−0.15		
Currently in school (no/yes, part time/yes, full time)		0.80		
Currently in 4-year college (no/yes)		0.79		
Labor experience				
Number of jobs working for pay at least 10 hours/week			0.75	
Job description (Higher values = higher status occupations)			0.72	
Social capital				
Number of community activities	0.24		0.30	
Number of volunteer organizations	0.25	0.29		
Organ donor (no/yes)	0.22			
Registered to vote (no/yes)	0.41			
Voted in 2000 (no/yes)	0.46			
Political party affiliation (no/yes)	0.32			

[a] Factor loadings >0.15, i.e. salient loadings for sample size

Table 4

Relative risk of obesity in young adulthood (Add Health Wave III; 2000–2001) associated with a one-unit increase in continuous SES factor scores from gender-stratified, multivariable Poisson regression models of young adult obesity.[a]

	RR (95% CI)[b]	
Factor score	**Males[c]**	**Females[d]**
Factor 1: Social advantage	1.00 (0.94, 1.06)	--
White	--	0.91 (0.84, 0.99)
Black	--	1.05 (0.95, 1.17)
Hispanic	--	0.80 (0.70, 0.92)
Asian	--	0.93 (0.66, 1.31)
Factor 2: Schooling	0.96 (0.89, 1.03)	0.91 (0.85, 0.98)
Factor 3: Employment	1.05 (0.97, 1.13)	0.97 (0.92, 1.01)
Factor 4: Economic hardship	1.04 (0.98, 1.11)	--
White	--	1.07 (1.01, 1.14)
Black	--	1.03 (0.97, 1.10)
Hispanic	--	1.05 (0.96, 1.16)
Asian	--	1.76 (1.31, 2.37)

[a] The final models for both males and females were adjusted for age and adolescent obesity.

[b] RR= relative risk; CI=confidence interval

[c] Models for males were pooled and adjusted by race/ethnicity

[d] Significant interactions ($p<0.05$) between race/ethnicity and Factor 1 ($p=0.013$) and Factor 4 ($p=0.017$) were used to calculate racial/ethnic-stratified results in models for females