

Race/Ethnicity, Socioeconomic Status and Obesity across the Transition from Adolescence to Adulthood

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ABSTRACT

Melissa Scharoun Lee: Race/Ethnicity, Socioeconomic Status and Obesity across the Transition from Adolescence to Adulthood
(Under the direction of Penny Gordon-Larsen, PhD)

Although racial/ethnic minorities in the U.S. have higher rates of obesity than whites throughout the life course, these disparities increase dramatically during the transition from adolescence to adulthood, a period of complex changes in schooling, employment, residence and social roles. Minority adolescents have higher obesity at all levels of parental income and education, and further, these disparities widen at higher parental socioeconomic status (SES). Such findings provoked our desire to go beyond simple measures of parental SES to better capture important facets of SES exposure for obesity development in minorities, and to investigate whether the association between better conceptualized measures of SES and obesity truly differ by race/ethnicity, i.e. do racial/ethnic minorities receive fewer health benefits from higher SES? We explored these issues using a rich set of parental and young adult socioeconomic data from the National Longitudinal Study of Adolescent Health, a nationally representative, racial/ethnically-diverse study following U.S. adolescents with multiple interview waves into adulthood. Using factor analysis to identify SES dimensions of unique relevance to the young adult context, we found that the high status milieu of “social capital” was associated with reduced young adult obesity for white and Hispanic females only, while “schooling” reduced obesity risk in all females. We then used latent class analysis to characterize the heterogeneity of combinations of parental and young adult SES, revealing detailed subtypes of life course SES exposure to “disadvantage.” Although

we demonstrated important gender differences in the association of these SES exposure groups with longitudinal patterns of obesity across the transition to adulthood, these relationships did not differ substantially by race/ethnicity. Further, obesity trends remained higher in racial/ethnic minorities across life course SES groups, underscoring the need to identify social forces beyond SES that shape these disparities earlier in life. Overall, these findings highlight several dimensions of young adult SES that present opportunities for efforts to reduce racial/ethnic disparities in young adult obesity, as well as groupings of life course SES from the parent to young adult that may provide important avenues to reduce obesity for all racial/ethnic and gender groups during this complicated stage of the life course.

To my parents, Jacques and Jeanine Scharoun

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I. Introduction

A. Background

The higher rates of poor health among racial/ethnic minorities in the US are a significant public health concern. Although these disparities in disease rates have been well documented, we still do not fully understand why gaps persist, and are in some cases widening. As noted by D. R. Williams (1997), “An understanding of the determinants of the differential distribution of health problems among racial or ethnic groups is a prerequisite to the development and direction of effective programs and services to address them.” There is a strong need to go beyond the social constructs of race and ethnicity to identify specific socioeconomic, demographic and contextual factors which can serve as intervention targets to reduce disparities in health outcomes.

Racial/ethnic differences in the prevalence, morbidity and mortality from obesity and nutrition-related chronic diseases are a worsening problem in the US, with higher obesity rates consistently observed in racial/ethnic minority groups (Flegal, Carroll et al. 2002; Ogden, Flegal et al. 2002). These disparities in obesity trends are seen early in the life course, but increase dramatically during adolescence, a period during which lifestyle and health-related behaviors are solidified. Furthermore, obesity itself increases dramatically from adolescence to adulthood (Serdula, Ivery et al. 1993; Parsons, Power et al. 1999; Gordon-Larsen, Adair et al. 2004). Thus, longitudinal research that bridges the important

and complex transitional period from adolescence to young adulthood can provide critical information for interventions aimed at reducing racial/ethnic differences in obesity.

Lower socioeconomic status (SES) has been consistently associated with higher disease burden, and since ethnic minorities remain disproportionately represented in lower SES groups (USDHHS 1998), racial/ethnic differences in SES have often been invoked as an explanation for racial/ethnic disparity in obesity trends (Winkleby, Kraemer et al. 1998; Winkleby, Robinson et al. 1999). However, few studies have used a life course approach to investigate racial/ethnic differences in the influence of SES factors at different life stages on obesity. This perspective, which posits that long-term effects of exposures earlier in life have important impacts on later adult health, could shed new light on the role of SES factors in widening race/ethnic disparities during the transition from adolescence to adulthood.

We recognize that these underlying social factors act through proximate behaviors to influence the physiological balance of energy intake and expenditure to ultimately affect weight status, and thus acknowledge that limiting our analyses to these three constructs of race/ethnicity, SES and obesity is a dramatic simplification of the full causal model. However, the theory of SES as a “fundamental cause” of health differences (Link and Phelan 1995; Herd, Goesling et al. 2007) supports the importance of *net effects* of underlying social variables on obesity development. Identifying racial/ethnic differences in how this fundamental construct is related to obesity is a step towards understanding the social and societal mechanisms that underlie the racial/ethnic disparities in obesity trends. Thus, the primary objective of this work was to explore, from the life course perspective, the influence of well-defined SES factors at different stages in the life cycle on the differential distribution of young adult obesity across racial/ethnic groups.

B. Research Aims

The overarching goal of this study was to investigate racial/ethnic differences in the dynamic and complex associations between SES and obesity across the transition from adolescence to young adulthood using data from the three waves (1995, 1996, 2001) of the National Longitudinal Study of Adolescent Health (Add Health). Add Health was well suited to this research because it is a longitudinal, population-based survey that includes large samples of non-Hispanic blacks, Hispanics, and Asians, and provides in-depth SES data across generations. Specific aims of this work were as follows:

1. Examine the association of SES and obesity in young adulthood, with the hypothesis that this relationship differs by race/ethnicity. Given the challenges of defining SES during the complex transition to adulthood in the US today and evidence that SES is best operationalized as a multidimensional construct, exploratory factor analysis was used to identify uniquely relevant dimensions of young adult SES from a wide range of available variables. We then explicitly tested our hypothesis of racial/ethnic differences in associations with obesity by assessing interaction of the young adult SES dimensions with race/ethnicity. Finally, these interactions were used to calculate racial/ethnic-stratified estimates, when justified.
2. Investigate the combined influence of parental and young adult SES on obesity during the transition to adulthood, with the hypothesis that these relationships differ by race/ethnicity. In the initial phase of this research aim, we defined longitudinal SES exposure variables from adolescence to adulthood, guided by two alternative life course SES hypotheses: a.) Inter-generational social mobility, using simple *ad hoc*

combinations of income and education, and b.) Cumulative disadvantage, using a novel application of latent class analysis on a wide range of parental and young adult SES variables. We then compared the ability of these two measures to characterize the heterogeneous experience of SES exposure during this transitional period, using their association with prevalent young adult obesity as an illustrative example of relative predictive value. The second phase of this analysis built on the results from the first, specifically exploring racial/ethnic differences in the association of the “novel” measure of life course SES defined using latent class analysis with longitudinal obesity patterns across the transition to adulthood. We hypothesized that this detailed characterization of SES experience would facilitate the identification of racial/ethnic differences in the “meaning” of SES for the dynamic process of obesity development during this period.

II. Literature Review

A. The public health importance of obesity in the US

1. Obesity has substantial health and economic consequences

Overweight and obesity are among the top modifiable risk factors for cardiovascular disease and diabetes, and are linked to many additional adverse health outcomes (Must, Jacques et al. 1992; NIH 1995; Must, Spadano et al. 1999; Must and Strauss 1999). Early development of adiposity in childhood and adolescence is of particular concern, both for its predictive association with obesity in adulthood and for its relationship with extensive health and economic consequences, independent of adult obesity (Must, Jacques et al. 1992; Dietz 1997; Power and Hertzman 1997; Magarey, Daniels et al. 2003). Several studies have documented the economic consequences of early obesity, including reduced likelihood of getting married (among women), lower income and greater likelihood of living below the poverty line (Gortmaker, Must et al. 1993; Averett and Korenman 1999). However, of greatest public health interest are the health consequences of obesity in childhood and adolescence, which include dyslipidemia, hypertension, orthopedic difficulties, growth issues and insulin resistance. Furthermore, signs of obesity-related chronic disease that historically were limited to adults, such as type II diabetes and coronary heart disease, are revealing themselves at alarmingly early ages (Must, Jacques et al. 1992; Pinhas-Hamiel, Dolan et al. 1996; Srinivasan, Bao et al. 1996; Bao, Srinivasan et al. 1997; Must, Spadano et al. 1999;

Must and Strauss 1999; Calle, Rodriguez et al. 2003; Cook, Weitzman et al. 2003).

Together, these consequences have the potential to place considerable future burden on health costs and services, which underscores the public health importance and urgent need to address the increasing obesity rates among young people.

2. Trends in adolescent and young adult obesity are of concern

Obesity prevalence in the U.S. has increased dramatically (Kuczmarski, Flegal et al. 1994; Troiano, Flegal et al. 1995; Flegal, Carroll et al. 1998; Mokdad, Ford et al. 2003), tripling among adolescents (Ogden, Flegal et al. 2002; Hedley, Ogden et al. 2004), and more than doubling in 20-39 year olds (Flegal, Carroll et al. 2002) over the last three decades.

While these secular trends among the age groups of interest for this study are alarming, the longitudinal trends across the transition to adulthood highlight the salience of this stage of the life course for the study of obesity. Obesity prevalence increases dramatically in young adulthood. A substantial amount of weight gain occurs between the ages of 20 and 40 years (Lewis, Jacobs et al. 2000; McTigue, Garrett et al. 2002), with strong tracking of obesity from the second decade into 35-40 years (Guo, Huang et al. 2000) and from adolescence to adulthood (Serdula, Ivery et al. 1993; Guo, Roche et al. 1994; Srinivasan, Bao et al. 1996; Magarey, Daniels et al. 2003). Although the high proportion of adolescents becoming and remaining obese into adulthood (Gordon-Larsen, Adair et al. 2004) is reason enough to pay attention to obesity development during this stage in the life course, this work was further motivated by evidence suggesting that adult lifestyle and health-related behaviors are solidified during adolescence (Baranowski, Cullen et al. 1997), thus increasing the potential for meaningful risk factor modification during this important period.

B. Disparities in obesity trends

Although one might argue that all predictive exposures are potential sources of “disparity” in health outcomes, the term is usually reserved for social factors across which a gradient occurs in health, resulting in relative disadvantage for some groups as compared to others on the outcome of interest. Researchers in health disparities are interested in differences in health across the axes of social characteristics that have been associated with group disadvantage, such as gender, age, race/ethnicity or SES. Although many of these characteristics have been historically viewed as inherently biological, those who embrace the study of health disparities in more recent times view these characteristics as categories that embody important variations in the socio-political and cultural environment because of the important role they play in social stratification (Williams 1996; Williams 1997; Kaufman and Cooper 2001). It is with this perspective that we studied racial/ethnic and SES disparities in obesity across the transition from adolescence to adulthood.

1. What is race?

The definition of race has undergone a significant evolution in both the social and biomedical sciences, albeit at somewhat different rates. In the social sciences, and to a slightly lesser degree, the biomedical sciences, there is a growing consensus that rejects the historical view of race as a biological classification scheme encoding genetic homogeneity. Evidence suggests that there is no firm scientific foundation for the genetic meaning of race, which reflects a history of classification that pre-dates the modern era of genetics (Williams 1997). We now know that the phenotypic traits used to define race are not strongly related to

genotypic variation, and in fact, there is more genetic variation within races than between them (Wilson, Weale et al. 2001; Sankar and Cho 2002). Moreover, the genes that determine the phenotypes typically associated with race (e.g. skin color) are not strongly correlated with those that determine variations in health status (Williams 1997; Goodman 2000). Therefore, many biomedical and social scientists argue that race is a social construct that has been shaped by cultural and political forces and has served important ideological functions in society (Williams 1996; Williams 1997). Most major journals implement guidelines for using self-defined race as an analytic variable, limiting its use as a purely genetic definition. In addition, there is an expanding literature in biomedical journals devoted to demonstrating how most attempts to show genetic “race effects” in analyses are conceptually and statistically flawed. Despite such efforts, the use of race in epidemiology and other biomedical sciences, particularly in medical education and clinical practice, is still largely fraught with more genetic meaning, which can have adverse effects on the study of health disparities (Sankar, Cho et al. 2004).

For most biomedical research on US populations, the term “ethnicity” is often conjoined with “race” to form the phrase “race/ethnicity,” and this tendency partially reflects the blurred distinction between these terms by researchers and survey respondents alike. There are historic and more recent differences between these terms, with “race” carrying a biological connotation in historic biomedical research of genetic homogeneity based on physical attributes (e.g. skin color), while “ethnicity” has been promoted more recently as a more culturally-oriented alternative classification term, identifying persons and populations by common aspects of social, religious, dietary and other less biological variables (Witzig 1996; Williams 1997; Kaufman and Cooper 2001; Sudano and Baker 2006). However, since

we believe that self-designation of Hispanic ethnicity carries the same sense of group identity (and similarly reflects the social and cultural environment in which this identity is made, i.e. marks the social contexts in which people live their lives) as does self-designating black, white, Native American or Asian race, we collapsed these terms into a single construct referred to as “race/ethnicity.”

To summarize, in this study, we treat race/ethnicity primarily as a social construct that reflects social stratification and inequality in the system of power relations, transmitted through the individual and institutional effects of racism to produce the observed disparities in health outcomes. That said, we do not completely exclude all possible contribution of biology to the conceptualization of race, since there is considerable biological variation in human populations. Rather, we take the view of Williams (1997) in defining race/ethnicity as a “construct reflecting the confluence of biological factors and geographical origins, culture, economic, political and legal factors, as well as racism.” These forces are interrelated and may combine in both an additive and interactive manner to affect both health status and health care utilization. As an analytic variable, we treat race/ethnicity as a social-status category created by the aforementioned large-scale societal forces and institutions; these categories reflect differential exposure to risk factors and resources that ultimately affect health through biological pathways. While it was beyond the scope of this study to fully explore these macro-level social forces that combine to produce the classification scheme we call race/ethnicity, our statistical inferences and conclusions are cautiously informed by this conceptualization of the race/ethnicity variable.

2. *What is SES?*

SES is a complex, multidimensional attribute comprising several potential components, but reflecting at least two characteristics: 1) resources, and 2) a measure of relative position within a hierarchy (e.g. status, rank, social class). There has been a general lack of consensus on the specific operationalization of this abstract concept, such that different researchers use different measures, making comparability across studies a challenge (Krieger, Williams et al. 1997). Studies have assessed SES with a wide variety of indicators, using household income or years of education most often, and less frequently occupation and/or family background. Whilst these “objective” measures have been most common, several recent studies have found important associations between health and “subjective” perceptions of relative ranking, such as the perceived placement in the social hierarchy captured by the Subjective Social Status (SSS) scale (Goodman, Adler et al. 2001; Goodman, Adler et al. 2003; Lemeshow, Fisher et al. 2008). However, most studies use only one objective measure, but the different mechanisms relating the separate components to obesity underscores the need to study multiple components.

As a social variable, SES, similar to race/ethnicity, cannot directly affect overweight/obesity status, a physiological variable. Rather, SES operates through intermediate behavioral factors that determine weight through control of energy intake, expenditure and metabolism. A more detailed examination of the mechanisms is facilitated by separately considering the links between obesity and two major indicators of SES, i.e. income and education (Sobal 1991). Income affects the level of resources available to families; those with higher incomes have more options in food access and food choices, such as more expensive foods that may aid in weight control. Wealthier people also have greater financial resources to engage in voluntary energy expenditure (i.e. physical activity) to

reduce their fatness levels. Education helps dictate how resources are allocated among individuals in the household and between food and other resources, and is likely to have an influence on a population level by providing the intellectual resources for acquiring information about eating and activity, as well as providing the knowledge about benefits of healthy eating and of regular exercise for weight control. Those with higher education are also more likely to participate in sports and active recreational activities; this effect appears to transmit across generations, since evidence suggests that adolescents of highly educated mothers are less likely to be inactive (Gordon-Larsen, McMurray et al. 2000).

3. What is the relationship between race/ethnicity, SES and obesity?

Racial/ethnic minorities are disproportionately represented in lower SES groups, with consistently lower education levels, higher unemployment and greater proportions in poverty (e.g. US Census data shows that 55% of black, and 60% of Hispanic families lived in poverty or near poverty in 1997 (USDHHS 1998)) as compared to whites. Since there is overwhelming evidence for the adverse impact of low SES on health, racial/ethnic differences in SES have been implicated in racial/ethnic health disparity.

However, the relationship between SES, race/ethnicity and obesity is far from clear (Smith 2000). For example, in children and young adults, obesity is higher among racial/ethnic minorities, even when matched with whites on SES factors (Burke, Savage et al. 1992; Winkleby, Kraemer et al. 1998; Winkleby, Robinson et al. 1999). In addition, several studies document an inverse relationship between SES and obesity for whites but not Blacks, both in adolescence (Kimm, Obarzanek et al. 1996; Patterson, Stern et al. 1997; USDHHS 1998; Gordon-Larsen, Adair et al. 2003) and in adulthood (Sobal and Stunkard 1989; Ball

and Crawford 2005). These findings support the possibility of an interaction between race/ethnicity and SES on obesity. That is, it appears that high SES does not confer the same health benefits (in terms of obesity risk) for minorities versus whites. However, few studies have explicitly examined the precise nature of these interactions (e.g. strength, direction, differences by SES indicator), focusing instead on main effects of race and SES (Farmer and Ferraro 2005). Yet, the techniques employed by this latter approach are fraught with troubling limitations.

First, researchers routinely adjust the main effect of race/ethnicity on health by socioeconomic indicators to determine the extent to which racial/ethnic disparities in distribution of socioeconomic resources “explain” racial differences in health. However, several sources of residual confounding, including the inadequate characterization of SES, measurement error in SES indicators, use of aggregated SES measures and variation between groups in the association between covariates of the SES-health relationship, can bias estimates towards independent effects of race/ethnicity. These “independent” race effects have the danger of being interpreted as intrinsic biological effects of race (Kaufman and Cooper 1995; Kaufman, Cooper et al. 1997; Williams 1997; Cooper and Kaufman 1998). Further, non-economic factors linked to race are likely to affect health, including individual and institutionalized racism, migration, and acculturation (Williams 1996), but are not typically measured in studies of SES and health, and thus race/ethnicity (and indeed, the “independent” effect of race) becomes a marker for these unmeasured factors.

A second flawed technique is conceptually distinct yet mechanically similar to the first. For this method, race/ethnicity is considered an intrinsic, fixed variable that causally precedes all covariates, including SES. Thus, “adjusting” the effect of race/ethnicity for SES

becomes an exercise in adjusting for a causal intermediate to decompose the total effect of race into its indirect (via SES) and direct (via unspecified pathways) effects on health. However, the most likely scenario is the misspecification of intermediate SES variables, leading to spurious direct effects of race. Even if SES is correctly specified, this technique is prone to bias because adjustment for intermediates does not, in general, produce valid estimates of direct effects unless a set of highly unrealistic assumptions are satisfied (Kaufman and Cooper 2001).

Given these limitations to the “adjustment” approach, using an “interaction” approach to understand the interplay of race/ethnicity and SES in association with obesity is a conceptually and methodologically attractive alternative. The statistical assessment of interaction between race/ethnicity and SES in association with health can test the hypothesis that minorities do not experience the same returns as whites on higher SES achievement (Farmer and Ferraro 2005). Postulated explanations for these “diminishing returns” include the reduced ability of minorities to translate socioeconomic resources into good health due to discrimination that influences their access to health care, social support, neighborhood context and stress levels (Shuey and Willson 2008). Institutionalized racism, in particular, can create structural barriers that restrict the benefits of SES achievements for racial/ethnic minorities (Hayward, Miles et al. 2000).

Although most research on the diminishing returns hypothesis has been from an economic perspective, e.g. racial/ethnic differentials in the translation of educational attainment into material resources such as income and wealth (Lynch 2006), a few recent studies have extended this hypothesis to study racial/ethnic disparities in health. For example, Farmer and Ferraro (2005) found significant interactions between race and

education in association with self-rated health, thus concluding that blacks do not experience the same beneficial health effects from education as whites. Shuey and Willson found similar results, extending their analysis to conclude that the disparate returns for blacks on education are compounded with age (2008). In contrast, Hayward et al. (2000) did not find support for the diminishing returns hypothesis, instead concluding that racial disparities in health are the consequence of differential distribution of socioeconomic resources by race.

A larger degree of racial effects on obesity could likely be “explained” with a better conceptualization of the SES construct that includes all relevant aspects of socioeconomic position that may be linked to obesity status and thus reduces residual confounding.

However, given the evidence for racial/ethnic differences in quality of education, wealth associated with a given level of income, the purchasing power of income and employment stability associated with socioeconomic status (Williams 1997), a question of similar importance and fewer methodological limitations is whether high SES confers the same health benefit for racial/ethnic minorities as for whites. To address these overarching research objectives in the understudied young adult period, we created comprehensive, theoretically informed measures of life course SES during the complex transition to young adulthood and investigated racial/ethnic differences in the influence of SES on obesity development.

4. What evidence exists for disparities in obesity across the transition to adulthood?

Adolescence is the period during which major racial/ethnic differences in overweight become apparent (Kimm, Barton et al. 2001). This is supported by both secular trends, showing minimal differences in overweight across race/ethnicity for younger children but

substantial differences for older children and adolescents (Freedman, Khan et al. 2006), as well as in longitudinal studies, with considerable differences by race/ethnicity in the tracking of childhood BMI into adulthood, despite having similar BMIs at the initiation of the study (Freedman, Khan et al. 2005). Furthermore, SES-related differences in obesity emerge in adolescence (Power and Moynihan 1988; De Spiegelaere, Dramaix et al. 1998; Goodman 1999) and increase with age (House, Lepkowski et al. 1994). However, research is lacking on the complex interplay between SES and race/ethnicity in producing differential obesity trends across the transition to adulthood.

C. SES in young adulthood: challenges and importance for study of obesity

As we have shown, young adulthood is an important period for obesity development, as well as for development of racial/ethnic and SES disparities in obesity. Better specification of SES across the transition to adulthood can provide greater insight about racial/ethnic differences in the “meaning” (i.e. value or benefit) of SES factors on obesity development during this critical time. However, we must look beyond traditional indicators of SES when investigating the association of SES and obesity during young adulthood, because: 1) Young adulthood is a time of complex demographic transition with differential and delayed timing of attainment of traditional SES measures, and 2) SES is a multidimensional concept, regardless of when it is measured. We explore each of these challenges in the following paragraphs.

1. Young adulthood is a time of demographic transition

The transition from adolescence to adulthood is characterized by multiple transitions in residence, employment, schooling and social roles, all of which have bearing on the SES of the young adult. Moving out of the parental home to full residential independence is a complex transformation with many potential pathways, e.g. marriage, semi-autonomy and premarital residential independence (Avery, Goldscheider et al. 1992; Goldscheider, Thornton et al. 1993; Elder 1998). Further, evidence suggests that choices among these pathways are at least partly determined by parental SES (Goldscheider and DaVanzo 1989; Avery, Goldscheider et al. 1992). Life course research has traditionally focused on “trajectories” or sequences of transition status events (Modell 1989; Mouw 2004) including changes in social and geographic mobility, labor force participation, and the acquisition of new roles. More recent research (Fussell and Fustenberg 2004; Osgood, Ruth et al. 2004) has examined the various combinations of multiple transitions that tend to cluster together (e.g., one group or cluster may include young adults who are single, working, parents and living independently). Regardless of how they are examined, these trajectories of multiple transitions are very likely to influence health-related behaviors of interest to this research. Previous studies suggest that there are associations between specific trajectories and weight status as well as obesity-related behaviors; for example, getting married has been associated with an increase in body weight (Jeffery and Rick 2002) for both sexes, while having children or starting work has been linked with decreased physical activity in young women (Brown and Trost 2003).

However, recent studies in the US suggest that a number of the “traditional” transitions are being delayed by an increasing proportion of the young adult population. Although the prevailing view among scholars for decades was that the entry into adulthood

was delineated by five transition markers, including leaving home, completing school, beginning one's career, marrying, and becoming a parent, the point in life at which a young person becomes an adult has been blurred and largely postponed (Shanahan, Porfeli et al. 2004). Three trends are likely responsible for this remarkable change in the age-structuring of the transition to adulthood: the prolongation of the period of education, the lengthening of a period of non-family living after leaving the parental household and before forming one's own family, and the delay in the age by which young people marry and have children (Fussell and Fustenberg 2004). These trends are related to the technological revolution, which raised the importance of technical knowledge and thus education in the labor market, as well as the gender revolution, which has had a considerable effect on the delay of transitions experienced by US females. Since our young adult study population ranged in age from 18 to 28 years, a substantial proportion of the sample was simply too young at the time of measurement to have had the opportunity to earn an income that reflected their potential because they were still in school or other types of career training.

Thus, it is apparent from the literature that defining young adult SES is complicated by the existence of multiple transitions and the delay with which they are now occurring in the US. Adolescents of the relatively homogenous circumstance of attending high school move through one of a number of heterogeneous pathways or "trajectories" through the transition to the adulthood, dependent on their choices of starting or delaying employment, continuing or stopping their education, entering a long-term romantic relationship, moving out of the parental household, etc. Their choice of trajectory has a definite impact on socioeconomic resources available to them in young adulthood, as well as their obesity-related health behaviors (Baranowski, Cullen et al. 1997; Baranowski, Koehly et al. 1999;

Cullen, Koehly et al. 1999). Further, the rather early “young adult” age range of the analysis sample for this work made it difficult to assume that their measured SES was indicative of eventual attained SES, because many respondents were still in some form of higher education or in the military or otherwise still very much “in transition” at the time of assessment.

Finally, it bears mention that most of the work on demographic transitions has been done on whites, with a small but growing subset of research that contrasts family patterns and transitional processes of black and white Americans; relatively little work has been done on US Hispanics and Asians. Blacks tend to have greater delay in leaving home for marriage and joining the labor force (Goldscheider 1997), while transitional patterns of Hispanics are similar to white Americans. Blacks and Hispanics also have greater employment instability than non-Hispanic whites, with more employment transitions (Hsueh and Tienda 1996). Black men show particularly troubling trends in their employment trajectories; in a recent study, nearly 40% of Black men had accumulated six months of unemployment between the ages of 24 and 26, in contrast to 14% of white males (Corcoran and Matsudaira 2004). Parenthood is another example of a demographic transition that varies in timing across race/ethnicity; recent work showed that rates of early parenthood exceeded 50% for native and first generation blacks, while having a child in early adulthood was far less common among native white and Chinese young adults (Mollenkopf, Waters et al. 2004). These racial/ethnic differentials in demographic transition patterns could influence the meaning of SES for young adults, supporting our hypothesis of racial/ethnic differences in the association between SES and obesity during this period.

2. The SES construct is inherently multidimensional

Regardless of the stage in the life course at which it is assessed, SES is a global, multidimensional characteristic comprising several domains, reflecting differential access to resources and relative position within a hierarchy (e.g. status, rank, social class). Although we already discussed the potential mechanisms through which some of the typically assessed SES indicators can affect obesity, we expand here on our overarching perspective of SES as an attribute of multiple dimensions, all of which likely play a role in how SES impacts obesity. While the number of studies examining the relationship between variously defined measures of SES and health, including obesity, have increased dramatically in the last several decades, relatively little work has focused on defining SES, operationalizing existing definitions, or evaluating the properties of measures (Oakes and Rossi 2003), with little consensus on a theoretically sound definition (Kaplan and Lynch 1997; Krieger, Williams et al. 1997). Public health research in general and obesity research in particular would seem to benefit from using SES measures that capture more of the social context than indices of income, education or occupational position alone can offer.

Thus, one of the major objectives of the present study was to capture the intrinsic multidimensionality of young adult SES. Extending the work of Oakes and Rossi, we view SES as a complex measure comprising three major domains – material capital, human capital and social capital – that uniquely locate the status of individuals in the social structure (Oakes and Rossi 2003). In the material capital domain, we endeavored to capture the observable and tangible materials that are owned by individuals, going beyond earnings and income to include material endowments of all sorts (e.g. homes, cars, and other sources of wealth; income stocks and flow, etc.). All such capital may be important for acquiring good housing, health care or education, which may all play a role in obesity-related behaviors.

Human capital comprises the fixed endowments of an individual, including both their innate traits as well as the education, skills, abilities and knowledge they may acquire, all of which may have plausible links to behaviors linked to obesity. Finally, the social capital dimension summarizes the ability of individuals to secure benefits by virtue of their membership in social networks and other social structures, and indeed there exists a nascent literature on the relationship between characteristics of social networks and weight status (Strauss and Pollack 2003). Overall, our focus on capturing the multidimensionality of the SES construct during the transition to adulthood helped us gain deeper insight into racial/ethnic differences in the effect of SES on obesity, since specific components of SES had a differential impact on obesity status by race/ethnicity.

D. Life course SES and obesity

1. What is the life course perspective?

According to the life course approach to the study of disease, factors acting in early life accumulate and interact with factors acting in later life in the production of adulthood disease (Lynch, Kaplan et al. 1997; Ben-Shlomo and Kuh 2002; Smith and Hart 2002; Kuh, Ben-Shlomo et al. 2003). Although this framework for studying chronic disease was first rigorously proposed in the 1940s, the life course perspective lost favor over the subsequent 50 years as the focus switched to the effects of adult factors on adult disease. Only in the last 10 to 15 years have researchers returned to this paradigm in which early, cumulative and interacting effects are all of interest in the study of chronic disease determinants (Lynch and Smith 2005). Studies that focus on cross-sectional determinants of adult disease and ignore

the influence of factors from earlier in life are potentially reducing their ability to find substantial effects of determinants whose influence fluctuate throughout the life-course.

Studies of life course SES and disease typically choose one of several conceptual frameworks (Lynch, Kaplan et al. 1997; Kuh, Ben-Shlomo et al. 2003). The critical period hypothesis posits the existence of a stage in a person's development in which they are at an increased susceptibility to the influence of external factors that may have important effects on later health (Hallqvist, Lynch et al. 2004). The well-known life course research on uterine or very early infant factors predicting adult health uses this framework (Barker 1990; Barker 1991). The social mobility model considers the influence of changes in SES over the life course on disease risk, while the cumulative SES hypothesis suggests that exposures gradually accumulate to increase the risk of disease (Pollitt, Rose et al. 2005). Although these frameworks often have been viewed as mutually exclusive, a recent set of papers asserted that a.) These competing hypotheses cannot feasibly be disentangled (Hallqvist, Lynch et al. 2004), and b.) It is not clearly necessary to do so, since each approach provides slightly different information that could be combined to build a more complete story of the association between SES and health (Rosvall, Chaix et al. 2006). This inclusive perspective influenced our overall approach to this work.

2. "Longitudinal" does not necessarily equal "life course"

In the broadest sense, research has identified an inverse relationship of income and education to overweight in developed countries such as the US. The published work on this association was summarized over fifteen years ago in Sobal and Stunkard's influential review (1989). A weakness of the literature they reviewed was the predominance of cross-sectional

studies and scarcity of longitudinal investigations, and subsequent studies have attempted to fill that gap, with varied results. In our earlier discussion of evidence for race/ethnic and SES disparities in obesity, we summarized some of the longitudinal work done since that landmark review in youth (e.g. Power and Moynihan 1988; Patterson, Stern et al. 1997; De Spiegelaere, Dramaix et al. 1998; Kimm, Barton et al. 2001; Moore, Howell et al. 2002). A recent review by Ball and Crawford (2005) condenses a substantial portion of the longitudinal literature in adults, focusing on studies that examined the association between SES and weight change in adult populations.

However, this literature is still limited by the fact that few of these longitudinal studies have utilized a true life course approach to this work; standard practice for measuring SES in most health studies is to include measures of current socioeconomic characteristics, thus limiting analyses to just one fairly recent time point (Braveman, Cubbin et al. 2005). We briefly summarize some of the longitudinal literature that does use a life course perspective in the following paragraphs.

3. The life course perspective has enjoyed popularity in mortality research

Much of the work using the life course approach to study SES effects has occurred in research on mortality. Although studies vary in their conclusions about the relative influence of child versus adult SES factors on mortality in adulthood, most conclude that it is useful to differentiate between childhood and adulthood effects to facilitate assessment of the contribution of social class at different stages of life on mortality risk (2003). One interesting mortality study applied a life course perspective to methods typically employed by social scientists, using a pathway model to determine that the effect of parental SES factors on the

educational, marital and employment paths in youth social factors partly determine social class differences in adult mortality (Pensola and Martikainen 2004).

Other recent studies on mortality demonstrate the important contribution of both early (childhood) and later indicators of socioeconomic position to increased mortality risk in adulthood, with a strong association between childhood SES and CVD-specific mortality (Claussen, Davey Smith et al. 2003; Beebe-Dimmer, Lynch et al. 2004). However, the life course approach to the study of SES is relatively uncommon in outcomes other than mortality, with inconsistent results. For instance, childhood socioeconomic circumstances were found to have a strong, independent effect on adult health and health-related behaviors (van de Mheen, Stronks et al. 1998), whereas adult SES was a relatively more important predictor of coronary disease, chronic bronchitis, depression and binge drinking (Marmot, Shipley et al. 2001; Yang, Lynch et al. 2007).

4. The obesity literature should more rapidly embrace the life course approach

The nascent literature applying the life course perspective to study SES and obesity has predominantly used the “critical period” framework. For example, a study by Brunner et al. (1999) found that both childhood and adulthood social position were related to adult obesity for both sexes. As part of a systematic review of the childhood predictors of adult obesity in developed countries, Parsons et al. (1999) found a strong, consistent relationship only between low SES in early life and increased fatness in adulthood among both men and women. Other more recent longitudinal studies have found childhood socioeconomic conditions to be more influential than concurrent adult conditions on adult obesity (Langenberg, Hardy et al. 2003; Power, Manor et al. 2003; Ball and Mishra 2006).

A growing body of literature on life course SES and obesity uses a “social mobility” hypothesis, examining the influence of SES trajectories (e.g. upward, downward, stable) on obesity and weight gain (Poulton, Caspi et al. 2002; Langenberg, Hardy et al. 2003; Pollitt, Rose et al. 2005; Ball and Mishra 2006), including several recent studies in racial/ethnic minority populations (James, Fowler-Brown et al. 2006; Bennett, Wolin et al. 2007). Economic mobility is an important characteristic of free societies, with the upshot that downward mobility is as possible as upward mobility. However, there are racial/ethnic differences in the extent and direction of mobility. In a recent study of native and immigrant youth in New York City, Chinese teens were particularly upwardly mobile (e.g. among those whose parents only had a high school degree or less, 46% went to college, in contrast to 10-20% of other race/ethnic groups with similar parental backgrounds), whereas native Blacks and Puerto Ricans experienced much downward mobility (Mollenkopf, Waters et al. 2004). The authors suggest that the positive mobility of the Chinese youth was related to their tendency to live with their parents longer, forgo childbearing and work less to focus on higher education, whereas the downwardly mobile groups tended to leave home earlier, have children earlier and forgo higher education, thus underscoring the importance of these life transitions.

However, limitations in data (e.g. insufficient “downward” mobility in certain populations) and methodology (e.g. shared experiences across trajectories due to restricted variables and time points) have contributed to an inconsistency of results across social mobility studies (Pollitt, Rose et al. 2005). Indeed, the most consistent findings for obesity, i.e. an intermediate obesity risk for the mobile groups versus the stable high or stable low (Langenberg, Hardy et al. 2003; Ball and Mishra 2006; James, Fowler-Brown et al. 2006),

more clearly support a “cumulative” life course hypothesis. In fact, this hypothesis may be better suited for studying racial/ethnic minorities since they are likely to face a cumulative burden of socioeconomic adversity over their entire life course (Baltrus, Lynch et al. 2005). However, the index of SES disadvantage used in typical cumulative studies is limited, as it necessitates the tenuous assumption that specific negative life experiences have the same impact, regardless of type or when they occur (Pollitt, Rose et al. 2005).

The present study explored ways to overcome the weaknesses of typical applications of the social mobility and cumulative disadvantage life course frameworks in the study of SES and obesity development during the transition to adulthood. Given our perspective that these frameworks would be complementary rather than competing approaches to conceptualize these complex relationships, we used the insights from both frameworks to more fully understand racial/ethnic differences in how early versus later SES of youth affects both current and future propensity to obesity.

E. Summary and significance

As we have shown, the literature supports that young adulthood is an important period for obesity development, as well as for development of racial/ethnic and SES disparities in obesity, an increasingly critical health outcome in the US and worldwide. Although the complexity of this demographic transition presents a challenge in accurately defining young adult SES, tackling this challenge was a worthwhile research objective, since better specification of SES across the transition to adulthood provided us with greater insight about racial/ethnic differences in the effect of SES factors on obesity development during this critical time. The ultimate goal of this work was to investigate, from the life course

perspective, how the influence of well-defined SES factors in adolescence and adulthood on young adult obesity varies by race/ethnicity, thus helping to determine when and what SES characteristics to target to reduce racial/ethnic disparity in US young adult obesity rates.

III. Methods

A basic description of the Add Health study sample and definitions of key explanatory and outcome measures are presented below.

A. Study design: The National Longitudinal Study of Adolescent Health

1. Overview of survey design and sample

Add Health is a longitudinal, nationally representative school-based study of the health-related behaviors of US adolescents in grades 7-12. Surveys of students, parents, and school administrators were collected to examine the causes of these behaviors, with an emphasis on the influence of social context. Researchers selected a random sample of all high schools in the US, stratified by urbanicity, school size and school type, and more than 90,000 adolescents were initially surveyed during an in-school component. From this, adolescents were selected for a core sample, representative of adolescents attending public, private and parochial schools in grades 7 to 12 during the 1994-1995 school year. Special samples were added to the core to enhance representation of disabled youths, non-Hispanic blacks with a college-educated parent, Chinese, Cubans, Puerto Ricans, and siblings of various levels of relationship. Survey procedures, described elsewhere (Popkin and Udry 1998), were approved by the Institutional Review Board of the University of North Carolina at Chapel Hill.

Add Health was designed as a longitudinal study in order to capture changes over time, with the rationale that people, and in particular their health-related behaviors, are both affected by their environment and affect those environments of which they are a part. Thus far, three “waves” of in-home survey data have been collected: Wave I (1994-1995) was conducted with 20,745 eligible participants selected from the larger sample that completed the in-school survey, Wave II (1996; N=14,438 eligible adolescents) followed up those participants still enrolled in high school after a one-year interval, and Wave III (2001-2002; N=15,197) was completed on eligible original Wave I participants (regardless of participation in Wave II), now in their young adult years (18 to 28 years old). Approximately 17% of the wave III respondents were married at the time of assessment; 20% had children, independent of marital status. Almost all completed high school; approximately 33% were currently in college, and 52% had ever been to college. The vast majority had successfully entered the labor force, working at least part-time. Follow-up for Wave III included 77% of the Wave I sample (adjusted for death and ineligibility). A major strength of Add Health is the large, nationally representative sample of under-studied minorities of various SES backgrounds, including 3,933 non-Hispanic blacks (with an oversample of black adolescents from highly educated families), 3,148 Hispanics, and 1,337 Asians.

2. Sample weights and survey clustering

For descriptive analyses, we used post-stratification sample weights appropriate to the specific analyses (i.e. cross-sectional versus longitudinal sample weights) to generate nationally representative results (i.e. generalizable to the population of adolescents attending middle and high schools in the US in 1994-1995). The Add Health cluster sampling design

(clusters sampled with unequal probability) complicates statistical analysis because observations are not independent and not identically distributed. Thus, for all multivariate analyses, we used the widely accepted series of survey (SVY) commands in STATA version 9.2 (StataCorp 2007) to control for survey design effects of multiple stages of cluster sampling, thereby reducing bias in estimates and standard errors.

B. Measurement of key variables

1. Defining race/ethnicity

The following paragraphs provide detail on how we defined race/ethnicity in this study, addressing a number of issues of operationalization that have been recognized as integral to enhancing understanding of the role of race in health, as reflected in fairly recent guidelines for author submissions to biomedical journals (Winker 2004).

Who designated race/ethnicity? Add Health collected separate race and ethnicity identification from each adolescent and from parents during the 1994-1995 Wave I (baseline) assessment. The self-designated race identification from adolescents was used to define our race variable for the vast majority of respondents, except in the few cases in which the adolescent reported “other” or declined to answer. For these situations, interviewer (i.e. the race observed by the interviewer) or parent (i.e. the race self-identified by the parent, depending on the family structure) designations of race were substituted. Ethnicity was determined from adolescent reports only. This strategy is consistent with our view that individuals should self-designate race to ensure that the designation most closely matches what they believe reflects their personal and cultural background (Mays, Ponce et al. 2003).

As the “gold standard” for racial/ethnic assessment (Kaufman 1999; Kaufman and Cooper 2001), self-designation is of particular importance when race is measured to act as a proxy for a social or cultural milieu, as it is in our conceptualization (Winker 2004).

Options available for racial/ethnic designation. In the Add Health surveys, adolescent and parent respondents were provided the same set of closed options for both racial and ethnic designation. In response to “What is your race?” both adolescents and parents could select from the following five categories: white, black/African American, American Indian/Native American, Asian or Pacific Islander, or other. Ethnicity was asked in a separate set of questions; in response to “Are you of Hispanic or Latino origin?” adolescents had the option of selecting yes or no, and if yes, they were asked to select from a list of more specific Hispanic background options (e.g. Mexican/Mexican American, Chicano, etc.). The four specific race categories (i.e. all except for “other”) and the one major ethnicity category (“Hispanic or Latino”) asked in the Add Health Wave I assessment are consistent with the Federal government’s Office of Management and Budget (OMB) guidelines for measuring race and ethnicity that were in place at the time of assessment (Wave I: 1994-1995; since 1997, however, the OMB separated the Asian and Pacific Islander category into “Asian” or “Native Hawaiian or other Pacific Islander” (Wallman, Evinger et al.)). Although open-ended options are often preferred for their ability to define more individually accurate descriptions, such design would make categorization much more difficult. The “other” category did provide a degree of open-ness, but as we will see shortly, our coding strategy aimed to reduce the number of “others” when additional information (e.g. from interviewer,

parent, or from multiple options selected by the adolescent) was available to reduce the heterogeneity of both race and ethnicity in the “other” category.

The distinction between race and ethnicity. As mentioned above, Add Health collected information on race separate from Hispanic ethnicity. That said, the distinction between these terms is usually blurred, both for researchers and for survey respondents, who often consider the terms synonymous. We are of the view that to self-designate as Hispanic ethnicity carries the same sense of cultural group identity (and serves as a risk marker, i.e. a proxy for macro-level social forces) as does self-designating black, white, Native American or Asian race. Thus, we decided to collapse these constructs into a single dimension that we refer to as “race/ethnicity.” This collapsing of terms was operationalized by the construction of a single race/ethnicity variable, whereby if a respondent answered yes to the question of “Hispanic or Latino” origin, they were considered Hispanic at the exclusion of any race they may have also indicated.

The handling of multiple races. The 2000 US census provided respondents, for the first time, with option of choosing more than one race and ethnicity, and nearly a quarter of respondents did so in some regions of the country (Winker 2004). This is not surprising, as the US is a nation of immigrants who have been intermarrying between racial/ethnic groups with increasing frequency (Sondik, Lucas et al.; Witzig 1996). Similarly, Add Health also provided its respondents with the option of choosing more than one race, though the questionnaire also asked individuals to mark the “ONE category that best describes [their] racial background.” While we consider these self-identified multi-racial/ethnic respondents

to be a particularly interesting group in their own right, separate consideration of their experiences in addition to that of the primary racial/ethnic groups was beyond the scope of this study. The simplest coding strategy to reflect all the combinations of races (not including Hispanic ethnicity) selected by respondents produced a variable of 31 categories, all of which could likely reflect a somewhat different social and cultural milieu. Thus, our coding strategy, which is summarized below, endeavoured to use all available information to place these multi-racial/ethnic individuals in a single category, recognizing that this created a degree of heterogeneity in experiences within our categories.

Summary of coding rules for race/ethnicity variable. In the previous paragraphs, we briefly described our rationale for the strategies used for coding our measure of race/ethnicity. Here, we summarize those strategies, though we note that the order of presentation was not necessarily their order of application. If the adolescent respondent selected Hispanic ethnicity, they were assigned to the “Hispanic” group. If they did not self-select as Hispanic, we primarily used the self-identified race selected by the adolescent respondent. If they selected only one of the four races, they were assigned to that group. If they selected “other,” refused to answer, or selected more than one race, information from the interviewer-observed race, the parent self-designated race, or the adolescent’s response to the single race that best describes their racial background was used in order to assign them to a single category, depending on the specific situation and the information available. For our final race/ethnic sample, we excluded the “Native American/American Indian” and “other” groups due to their small numbers; the Asian group was also quite small thus unstable for several stratified modeling analyses, but we retained them for descriptive and pooled

modeling analyses. Thus, our final race/ethnicity variable had the following four categories: Non-Hispanic white, Non-Hispanic black/African American, Hispanic and Asian or Pacific Islander, which, for ease of reading, we refer to as white, black, Hispanic and Asian.

2. Measures of socioeconomic status

Given our perspective that commonly utilized definitions of socioeconomic status are inadequate for capturing the true role that these social factors play in the observed racial/ethnic disparities in obesity, defining SES was of critical importance to this work. Here we present only the rationale for why we selected the particular type of SES measures, and direct the reader to Chapters IV and V for specific analytic strategies on how we created these measures for Aims 1 and 2, respectively.

SES measures for Aim 1. Our objective was to define a set of variables that captured the intrinsic multidimensionality of young adult SES while accounting for the challenges of defining SES during a complex transitional period. The literature supports our view of SES as a complex measure comprising three major domains: (1) material endowments (e.g. earned income, dividend income, property), (2) skills and knowledge (a combination of both innate and acquired ability), and (3) the status, power and abilities of one's social network, or material, human and social capital, respectively (Oakes and Rossi 2003). Thus, we used factor analysis techniques to capture the dimensionality of the SES construct from a large set of potential SES variables. While we leave the details of the factor analytic technique for Chapter IV, we note here that the pool of variables used to represent material capital went beyond income to include measures of wealth, information and financial access, and

indicators of hardship, including receipt of public assistance. Furthermore, the extensive detail about education and schooling helped characterize the human capital domain, whereas measures of labor experience helped characterize both the material and human domains. Finally, indicators of civic engagement, including volunteerism and participation in community activities along with the previously mentioned education variables helped define the social capital domain.

SES measures for Aim 2. In recognition of the importance of past and current socioeconomic experiences on current health, our objective, in Aim 2, was to examine the joint influence of parental and young adult SES on obesity. We investigated two frameworks for combining SES at these two stages in the life course, including both a social mobility and cumulative mechanism.

We used the social mobility framework to investigate the influence on obesity of change from parental SES of the adolescent household to the SES that the children created for themselves in young adulthood. The proper operationalization of a change mechanism generally requires measures that are especially similar, if not identical in their metric (e.g. type, range, etc.). This was especially true for the *ad hoc* “longitudinal SES exposure” groupings we manually created using parent and young adult income and education variables. While our overall view of SES is that of a multidimensional, global characteristic, the traditional approach to modeling social mobility is restricted in the number and type of variables that can be used, as detailed in Chapter V, and thus limited us to simple indicators of income and education to create these social mobility measures. Substantively, income is an important dimension of SES related to command over goods and services. Although it

does not fully capture all relevant family resources, it is the most widely used measure of SES in the US, and thus provides a highly useful metric for comparison across studies. Furthermore, most programs and policies that address inequality in the US are based on income and involve direct provision of goods and services or income transfers. As discussed in the background, education is a powerful measure of access to information, skill in allocating resources, and ability to efficiently utilize resources (Barerra 1990; Ross and Mirowsky 1999). Further, education can reflect a range of non-economic social characteristics (e.g. general and health-related knowledge, literacy and problem solving skills, prestige, influence over others and one's own life) that have important health effects for both individuals and for their families (Ross and Mirowsky 1999; Braveman and Cubbin 2003). Thus, we considered both income and education to be substantively important dimensions of SES.

For the parental SES variables, we used household income, reported in \$1000 increments on the questionnaire administered to the parents during the Wave I assessment. Where household income was missing due to non-response, the variable has been imputed using data on parental occupation, family structure and school community, as has been done in other national surveys (Kalton 1983; Ezzati-Rice, Khare et al. 2004). Parents were also asked to report their highest level of education; we used the highest reported education for either parent, making the common assumption that this is static (Kaplan and Keil 1993). For the young adult SES variables, we used a measure of "total personal income" from all possible sources, including income from family, public assistance and other sources in addition to the typical measure of earnings. Although income in early part of young adulthood is not likely to be reflective of true earnings potential due to the incomplete nature

of transitions in education, employment, residence, etc. during this period, we needed a measure comparable to the family income used to represent parental SES. Similarly, assessing young adult education was hindered by the fact that a substantial proportion of the sample had not completed their education at the time of the Wave III assessment simply because they were too young to do so. We thus used a measure of current educational attainment (e.g. years of schooling or degrees attained) with caution, and compared its classification to a measure of educational trajectory that used information about current schooling and the type of school, as compared to same-aged peers. Further, we explored different categorization of these variables, though we ultimately settled on dichotomous definitions (e.g. High versus Low parent income) to minimize the number of parent-(offspring) young adult grouping.

Our second approach to combining SES at these two stages in the life course used a cumulative framework. This facilitated use of a broader range of potential SES variables at both the parental and young adult level. We used Latent Class Analysis (LCA) to group respondents based on their values for a large set of both parental SES and young adult SES measures. Although we postpone discussion of the specific details of the procedure to Chapter V, this model-based algorithm placed respondents in the same group or “latent class” if they shared a common joint probability distribution among the observed variables. The key to such an analysis was the selection of appropriate variables; for this approach, “appropriate” implied that they captured as full a range of the dimensionality of SES as possible, thus providing an advantage over the *ad hoc* manual groupings we created in our first approach. This procedure also provided flexibility with regards to the types of variables used (e.g. continuous, ordinal, nominal and counts were all acceptable). Therefore, in

addition to the parental and young adult income and education variables used in the first approach, we considered a broader range of potential SES variables at both the young adult and parental level for use in LCA to create group membership variables which we then entered into models of obesity and compared across race/ethnicity.

Finally, we note that despite our best efforts, we could not capture everything that defines SES, and thus when interpreting our results; we were careful to consider how important unmeasured SES factors may have influenced our conclusions (Braveman, Cubbin et al. 2001; Winker 2004; Braveman, Cubbin et al. 2005). This was of particular concern in light of our objective of examining racial/ethnic differences in the influence of these SES measures on obesity. While we hoped to show that a substantial proportion of racial/ethnic differences in health are related to comprehensively assessed SES measures at two stages in the life course, we also expected and observed persistent, systematic SES differences between racial/ethnic groups that likely reflect the impact of racial discrimination.

3. Measures of weight status

An appropriate measure for excess weight should accurately reflect body fat, be comparable across studies, and have public health significance. We used body mass index (BMI), calculated as body weight in kilograms divided by squared height in meters (kg/m^2), as an indicator of overweight/obesity because it is most highly correlated with gold standards of adiposity in adults. BMI is also correlated with disease risk factors associated with adiposity, such as blood triglyceride level, total cholesterol, and blood pressure and thus is a biologically relevant measure of excess weight. BMI does have its shortcomings (Daniels, Khoury et al. 1997), including some degree of height dependence in adolescence, as well as a

potential to misclassify individuals because of its inability to differentiate between excessive weight due to muscle mass as opposed to fat. Evidence also suggests that BMI may not identify body fatness comparably across racial/ethnic groups, gender, and maturity status. Nevertheless, the use of BMI is largely recommended as the most practical indicator of overweight for most age groups, including adolescents and young adults, in epidemiologic as well as clinical settings (Rolland-Cachera 1993; Himes and Dietz 1994; WHO 1995).

BMI can be modeled as either a continuous or a categorical outcome. Since we believed that showing an effect on discrete obesity status has a greater public health impact, we preferred to use a categorical outcome for all analyses. Among adults of all ages, risk-based BMI cut points of 25 and 30 kg/m² have been used to define categories of “overweight” and “obesity,” respectively (NHLBI 1998). Thus, for Aim 1, the use of a categorical outcome was relatively straightforward, given that this first aim was focused solely on obesity among (young) adults.

However, a potential difficulty arose with categorization of BMI in the analyses for Aim 2, for which we examined longitudinal changes in obesity status across the transition from adolescence to young adulthood. Excess weight in childhood and adolescence is typically categorized in a manner different from adults; since BMI changes during growth, age- and sex-specific BMI percentiles are used as cut points during this period. The 85th and 95th percentiles, based on nationally representative data from the 2000 CDC growth curves, have been recommended for use in classifying “at risk for overweight” and “overweight” among children and adolescents in the US (Centers for Disease Control and Prevention 2000). Discrepancies between the assessment methods for children and adolescents versus adults could thus limit our ability to generate comparable obesity prevalence and hinder

efforts to calculate obesity incidence, persistence or reversal over this transition period. Thus, we used the growth curves and percentile cut points developed by the International Obesity Task Force (IOTF) for children and adolescents that correspond to the adult BMI cut points (Cole, Bellizzi et al. 2000). That is, to facilitate comparisons across the transition, we used these childhood ‘equivalents’ to the adult BMI cut point for obesity to assign obesity status in adolescence (Gordon-Larsen, Adair et al. 2004).

We note that only self-reported height and weight data were available for Wave I. We used these values for several analyses to maximize sample size (since the Wave I adolescent sample is considerably larger than the Wave II sample, as detailed in previous sections). Self-report measures may underestimate actual values, particularly at higher weights (Stewart 1982; Kuskowska-Wolk, Bergstrom et al. 1992). However, the Add Health self-report values have been shown to correctly classify a large proportion of the respondents (Goodman, Hinden et al. 2000). Further, since the longitudinal outcomes of interest combine obesity assessments across two waves of data, we decided to minimize the potential for differential measurement error between discordant types of assessment (i.e. measured vs. self-report) across waves by restricting the analysis to concordant assessment types across the two time points (Field, Aneja et al. 2007). Finally, prior work suggested that many of those respondents missing measured anthropometric data for Wave III had body weights in excess of the scale capacity of 330lbs. Since none of these individuals also reported the biologically implausible height required for this weight to translate to a “normal” BMI, these off-scale respondents were re-coded as obese for our analyses.

IV. Obesity, race/ethnicity and the multiple dimensions of socioeconomic status in young adulthood: A factor analysis approach

A. Introduction

Obesity is a major public health problem in the US, particularly in racial/ethnic minority populations (Flegal, Carroll et al. 2002; Hedley, Ogden et al. 2004; Ogden, Carroll et al. 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, has been consistently associated with higher obesity in US whites only (Kimm, Obarzanek et al. 1996; Patterson, Stern et al. 1997; Gordon-Larsen, Adair et al. 2003).

The transition to adulthood is characterized by increasing obesity incidence and divergent racial/ethnic trends in obesity (De Spiegelaere, Dramaix et al. 1998; Guo, Huang et al. 2000; Kimm, Barton et al. 2001; Gordon-Larsen, Adair et al. 2004), underscoring the importance of this stage of the life course for reducing disparity. However, assessing the role of SES in these trends has been hindered by the later occurrence of transitions in residence, employment, schooling and social roles (e.g. marriage) in current US young adults as compared to previous generations (Shanahan, Porfeli et al. 2004). “Traditional” SES specifications based on the completion of such transitions are likely to misclassify the SES of young adults, especially those who have not yet completed their education or other training. Furthermore, there is little consensus on a theoretically sound definition of the SES construct

at any life stage, and although most agree it comprises multiple dimensions, it is most often assessed using crude indicators of income or education (Krieger, Williams et al. 1997; Ball, Mishra et al. 2002; Oakes and Rossi 2003). We address these important limitations in specification of SES during the complex transition to adulthood using exploratory factor analysis. This strategy summarizes the natural relationships within a large collection of SES indicators into a small set of multidimensional SES “factors” in a young adult population.

Assessing the role of SES in racial/ethnic disparities in obesity is also mired by challenges in conceptualizing the inter-relationships between these key measures of interest. Researchers often statistically “adjust” racial/ethnic effects on health by socioeconomic indicators to determine the extent to which SES “explains” racial differences. However, inadequate or improper specification of SES can bias estimates and their inference towards independent effects of race/ethnicity, which have the danger of being interpreted as “biological” effects of race (Kaufman, Cooper et al. 1997; Williams 1997; Cooper and Kaufman 1998). Further, researchers have suggested that there are racial differences in the meaning of SES, including the quality of education, wealth associated with a given level of income, and employment stability (Williams 1997). Our strategy is to investigate racial/ethnic differences in the association of young adult SES factors with obesity, thus avoiding potential bias from the more routine practice of adjusting estimates of race/ethnicity effects by SES.

In summary, we use exploratory factor analysis to define SES in a diverse sample of US young adults, with the hypothesis that this measure will capture a number of SES dimensions of particular relevance during young adulthood. We then examine the

association of this multidimensional SES measure with obesity in young adulthood, with the hypothesis that this relationship differs by race/ethnicity.

B. Subjects and Methods

1. 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 school-aged youth (grades 7-12 at Wave I; 1994-1995; N=20,745), followed with multiple interview waves into young adulthood (Wave III; 2001-2002; N=15,197). 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 et al. 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 their Wave I data from adolescence to define important underlying covariates. We excluded respondents who were seriously disabled or pregnant at either survey period, as well as those missing data on study variables, including the 38 young adult SES indicators used in factor analysis. The factor analysis procedure used listwise deletion, which removed a relatively large number of observations missing data on relatively few of the SES variables entered into the 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 at Wave III. The excluded sample was younger and had higher BMI at both Wave I and Wave III relative to the analysis sample.

2. Conceptual model

Our primary interest was in the extent to which race/ethnicity modified the association between young adult SES and young adult obesity. While this approach might over-simplify the dynamic interplay between race/ethnicity, SES and health outcomes, it is consistent with our hypothesis that SES might have different meaning and effect across racial/ethnic groups. Furthermore, this strategy facilitated assessment of the influence of important covariates in this framework.

Although the contemporaneous assessment of SES and obesity in young adulthood precluded a causal interpretation, we attempted to reduce bias in our estimates by adjusting for salient underlying covariates. The most important covariate for this analysis was adolescent obesity, which has been linked to lower wages and less educational and occupational opportunity in adulthood due to the stigmatization and discrimination faced by those with excess weight (Gortmaker, Must et al. 1993; Sobal 1994; Averett and Korenman 1999). Adolescent obesity has also been identified as an important predictor of young adult obesity because of the strong tracking of obesity across the transition to adulthood (Serdula, Ivery et al. 1993; Srinivasan, Bao et al. 1996; Magarey, Daniels et al. 2003). Thus, adjusting our models for adolescent obesity reduced the confounding bias due to the relationship between lower SES and higher obesity in young adulthood through this variable.

However, since both the development of obesity and the exposure to SES evolve over the life course, adjusting for adolescent obesity also reduced our ability to completely assess the influence of earlier SES (e.g. SES of the parental household) on obesity status, since those who became obese early as a consequence of low parental SES were removed from

consideration in the model. In other words, controlling for adolescent obesity underestimated the total effect of life course SES on obesity in young adulthood. Yet, this underestimation did not limit our primary goal of attaining the least biased estimation of the association between SES and obesity during a young adult snapshot of the life course.

Therefore, both the reduction in confounding bias and our interest in young adult associations justify our adjustment for adolescent obesity in our final models. In fact, due to the direction of spurious and/or indirect associations we reduced by this adjustment, we expected our estimates to be conservative. To confirm this, we performed a secondary analysis without adolescent obesity in the model, and we present these findings along with our primary results.

3. Definition of variables

Young adult obesity. Given its high prevalence in our population as well as its public health impact, we focused our analysis on obesity rather than overweight. Young adult obesity, defined using the adult BMI cut point for obesity (30 kg/m²) (NHLBI 1998), was assessed using self-reported height and weight from Wave III to maximize sample size and comparability with the self-reported adolescent values from Wave I (Field, Aneja et al. 2007). Although the Add Health self-report values have been shown to correctly classify a large proportion of the respondents (Goodman, Hinden et al. 2000), we repeated our analysis on the smaller young adult sample with adolescent data from Wave II (1995-1996), when measured height and weight were first assessed in addition to self-report, and confirmed that results were very similar across assessment types (data not shown).

Young adult SES. The variables entered into factor analysis were selected from multiple sections of the young adult (Wave III) questionnaire to represent three major domains of SES that 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 and Rossi 2003). Although the correlation-based factor analysis procedure typically assumes interval data (Gorsuch 1983), ordinal and dichotomous data are permissible if the underlying correlations between such variables are moderate or weak (≤ 0.7) (Kim and 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 et al. 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).

Adolescent obesity. We defined obesity in adolescence using self-reported height and weight from Wave I and the International Obesity Task Force (IOTF) reference cut-points for obesity (Cole, Bellizzi et al. 2000), which link adolescent BMI centiles to the adult BMI cut-point of 30kg/m^2 .

Demographics. Self-designated race/ethnicity from Wave I was used for the vast majority of respondents and included mutually exclusive categories of Hispanic, non-Hispanic white, non-Hispanic black and Asian or Pacific Islander. For simplicity, we refer to

these groups as Hispanic, white, black and Asian. Sex was self-reported at Wave III, and age was the reported age at the participant's last birthday at Wave III.

4. Analytic Strategy

Statistical analyses were carried out using Stata, version 9.0. Guided by the conceptual framework summarized above, our overall analysis strategy was to create a multidimensional measure of young adult SES in a pooled racial/ethnic sample of young adults using factor analysis, and then to investigate racial/ethnic differences in the association of this SES measure with young adult obesity using statistical modeling.

Factor analysis. We theorized that the set of SES variables measured during the complex transition to adulthood and included in the factor analysis would not neatly fall into the three literature-based domains (material, human and social capital) that guided their selection. Thus, we used exploratory factor analysis to detect the underlying structure of relationships between these 38 SES variables. We allowed the process to identify factors or “SES dimensions” from this large variable set without constraint to any particular number or type of factors, therefore capturing the natural complexity of SES during this important transitional period. Factors were generated in the pooled racial/ethnic sample to facilitate assessment of differences across race/ethnicity.

We used the “principal factor” method to find the least number of factors that could account for the common variance of a large set of SES variables, excluding variable-specific (unique) variance (Gorsuch 1983). Beginning with 55 potential indicators of young adult SES, we iteratively reduced the variable set to 38 SES indicators for factor analysis using the

following criteria: first, variables with high uniqueness (>0.95) were not well explained by the factor model and thus eliminated. We also dropped variables that created “suboptimal” factor solutions, defined by factors with high loadings (>0.3) for only one or two variables. Finally, we eliminated variables with low values (<0.60) on the Kaiser-Meyer-Olkin (KMO) statistic, which measures the extent of inter-correlation for a variable in a given factor solution (Kaiser 1974). Variables with highly skewed (>1.5) distributions were log transformed before being entered into the factor analysis.

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 normalization suggested by Horst (Horst 1965) to eliminate the heavy weight of variables with high initial loadings. More complex orthogonal rotations did not produce substantively different factor structures. Rotated factors were assigned labels to describe the most highly loading variables, with consideration of the overall pattern of young adult SES data. 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 for each factor. These scores summarized each subject’s relative position with respect to a given factor, which in turn provided an opportunity to consider the continuous distribution of scores across variable levels of interest, i.e. obesity status (Kline 1994; Diez-Roux, Kiefe et al. 2001; McDade and Adair 2001). Post-stratification sample weights were applied to the factor procedure to reduce bias in estimates of factor scores due to unequal selection into the probability sample.

Multivariate modeling. Poisson regression models were used to directly estimate the relative risk of young adult obesity, a comparatively common outcome in our population, associated with the young adult SES factors (“dimensions”) (Zou 2004). Scores for each factor were entered jointly into the model as independent exposures that together represent the multidimensional measure of SES. 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. Given gender differences in obesity and in the effect of SES factors on obesity, all models were gender-stratified. Within gender, we assessed potential effect modification of the association between each of the SES factors and obesity by race/ethnicity to explicitly test whether there were racial/ethnic differences in the association of specific young adult SES dimensions with obesity. Only significant factor by race interaction terms ($p < 0.05$ for Wald test of interaction terms) were retained and used to calculate racial/ethnic-specific results. We applied a standard 10% change-in-estimate criterion to determine whether to retain conceptually plausible confounders of the young adult SES-obesity association, including age and adolescent obesity, as controls in the gender-stratified models (Maldonado and Greenland 1993). 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.

C. Results

The mean age of respondents in the analysis was approximately 22 years, capturing the early stage of young adulthood, and there were sufficient numbers of racial/ethnic minorities for the desired analyses (**Table 1**). 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 2**, with response options arranged in ascending order with respect to the variable label and grouped by headings that reflect substantive content. 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 relationships of highly loading variables to each other in their pattern of association with a given factor.

Given positive loadings on indicators of educational achievement as well as various measures of civic participation, we identified Factor 1 as a construct representing “Social capital.” Factor 2, “Schooling,” included highly positive loadings for current enrollment in full-time schooling and in a four-year college, with notable loadings on 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 1**) in 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**) 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 capital”). Males and females had similar patterns across racial/ethnic groups for Factor 3 (“Employment”). To facilitate interpretation of a one-unit change in exposure to a factor in our modeling results (below), 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) given a factor score of 0 versus 1. 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 capital” (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 for Factor 1 (“Social capital”; $p = 0.013$) and Factor 4 (“Economic hardship”; $p = 0.017$) were included in the final model for females. Racial/ethnic differences in the association of SES factors with obesity did not vary by age at Wave III for either gender (data not shown); however, the age variable did exceed our threshold criterion for confounding and was included in the model. Evidence for confounding justified the retention of adolescent obesity in our final models, though we also

performed a secondary analysis without this covariate to further elucidate the influence of underlying obesity in our conceptual model.

We thus present age-adjusted, racial/ethnic-stratified and non-stratified estimates for females in **Table 3** along with non-stratified estimates for males in final models adjusted for adolescent obesity. Holding all other young adult SES factors constant, a one-unit increase in score on “Social capital” 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; further, none of the young adult SES factors was related to obesity prevalence in males. In general, estimates from the final models were conservative as compared to the secondary analysis without adolescent obesity. Most notably, “Economic hardship” was associated with higher obesity risk only for females of White and Asian race/ethnicity in our final models; however, in models not adjusted for adolescent obesity, this factor was positively and more strongly associated with obesity for females of all racial/ethnic groups.

D. 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 that summarizes a diverse set of SES-related characteristics into factors with unique relevance to this stage of the life course. In addition to enhancing the understanding of gender and racial/ethnic variation in the composition of SES during this transitional period, this complex patterning of SES characteristics facilitates the proper classification of young adults who have not yet completed traditional SES milestones. Moreover, we capitalize upon the sophisticated level of detail captured by the multiple dimensions of our measure to identify specific aspects of young adult SES most strongly associated with obesity and important racial/ethnic and gender differences in these associations.

The extraction of multiple, distinct SES factors in our analysis supports the hypothesized multidimensionality of the SES construct during young adulthood. Considerable heterogeneity within several SES dimensions highlights the limitations of using single SES indicators during this period. For example, the “Social capital” factor had high loadings on several measures of civic involvement. However, indicators of information and financial access also had salient loadings on this factor, suggesting that aspects of human and material capital co-occur along with “Social capital.” Furthermore, the variable representing “years of education,” traditionally used on its own as an indicator of SES, had its highest loading on “Social capital,” but 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 education that are more accurately attributable to this high-capital milieu. Conversely, true associations may be overlooked because the single indicator of education does not sufficiently capture the complex pattern of SES characteristics that may 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 capital” 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 “Economic hardship” factor while females had comparatively high scores. Given the high loadings of public assistance variables on this factor, 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 and Hirschl 2002).

The inverse relationship we observed between the “Social capital” factor and obesity in females is consistent with the nascent literature on social capital and health outcomes (Holtgrave and Crosby 2006; Kim, Subramanian et al. 2006). However, the importance of investigating racial/ethnic differences in associations is supported by the relatively strong inverse relationship in females of Hispanic ethnicity. Although white and Asian females also tended towards a protective association, we have particular interest in SES dimensions that show salient associations with obesity for historically underprivileged minority groups, including Hispanics, with the ultimate objective of identifying targets for reducing racial/ethnic disparity in obesity. Interestingly, there is no association between social capital and obesity in black females, the other minority group of interest. These results build on previous work showing little reduction in obesity at higher parental income and education for black adolescents (Gordon-Larsen, Adair et al. 2003) and adults by demonstrating similar trends with a more complex SES measure.

Although the lack of racial/ethnic differences in association between obesity and the “Schooling” and “Employment” factors in females (and all factors in males) substantively suggests homogeneity across groups, there may be statistical explanations for these results. 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 help detect any additional interactions (data 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. Implicit in our strategy for constructing the SES factors was the desire to statistically test for racial/ethnic differences in the association of obesity with SES measures defined the same way across race/ethnicity, creating the potential for limited group-specific distributions. However, similar values across race/ethnicity on several measures of dispersion on the “Schooling” and “Employment” factors suggest that variation in exposure and thus the ability to detect an association was not reduced in particular racial/ethnic groups, thus supporting our original finding of homogeneity on these factors.

Limitations in causal inference from cross-sectional data caution our interpretation of significant racial/ethnic differences in the association of “Economic hardship” with young adult obesity. The absence of strong associations for this factor in black and Hispanic females suggests that a history of such adverse conditions may have already exerted their influence in these groups on the development of adolescent obesity, which is controlled in the final models. Results from our secondary analysis support this possibility, showing significant associations for black and Hispanic females in models not adjusted for prior

obesity. Overall, 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 their obesity risk early in life, as supported by the high rates of adolescent obesity in blacks and Hispanics in our descriptive data (**Table 1**). However, it is important to note that associations for “Economic hardship” and other factors are attenuated in females of all racial/ethnic groups when adolescent obesity is included in the model, suggesting that the history of SES over the life course plays an important role in earlier obesity risk across race/ethnicity.

The direction of association between “Economic hardship” and obesity merits further comment. Although this factor has high loadings for receiving several types of public assistance, the significant positive associations with obesity in White and Asian females in our final model (and in all females in the secondary analysis) do not necessarily imply that obesity risk is increased by participation in these public programs, such as the National Food Stamp program. While other cross-sectional studies have found similar positive relations (Townsend, Peerson et al. 2001; Gibson 2003), comparatively small effects from longitudinal research suggests that underlying variables not measured in our study, including those representing long-term material hardship and psychological stress, likely increase both the risk of receiving public assistance and the risk of being obese (Jones and Frongillo 2006).

Despite our emphasis on racial/ethnic differences, the finding of a significant inverse relationship between obesity and “Schooling” 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 capital” 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 current literature on participation in post-secondary education and obesity tends to focus on associations within these select populations, such as predictors of weight change across the residential transition to a four-year college (Levitsky, Halbmaier et al. 2004), or correlates of obesity among college students (Gary, Gross et al. 2006; Nelson, Gortmaker et al. 2007; Sparling 2007). This study, however, uses a nationally representative sample to contrast the risk of obesity for young adults who are more versus less likely to be in school (as reflected in their scores on the SES pattern characterized by this factor), and thus enables us to identify schooling as a salient exposure for obesity in young adult females.

Furthermore, the significant inverse association for being in school supports our contention that “traditional” SES measures are likely to misclassify the SES of young adults, many of whom have not completed their education or other training. The transition to adulthood in the US is starting later and taking longer than in earlier generations, limiting the utility of SES indicators that depend on the completion of key milestones. 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. However, factor analysis identified “Schooling” as an important SES construct during the transitional young adult period, and therefore we were able to better classify the SES of respondents in school. Thus, a major contribution of this study is the ability of our factor analysis approach to reveal the important inverse association of a complex pattern of

characteristics summarized by the “Schooling” factor with obesity that would have been masked using a more limited approach to SES assessment.

This study is not without limitations. All factor analysis results depend on the set of variables initially included and on the correlations within a particular sample (Kline 1994; Diez-Roux, Kiefe et al. 2001). 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. However, inclusion of a large set of SES indicators covering a breadth of domains consistent with established theory (Krieger, Williams et al. 1997; Oakes and Rossi 2003) and the nationally representative sample provide confidence in our results. Moreover, our intention was primarily to explore hypotheses about the meaning of SES in young adults and about racial/ethnic disparities in the association of SES and obesity in our sample. Although we controlled for underlying variables consistent with our conceptual model, our young adult SES and obesity measures were assessed contemporaneously, precluding any temporal argument for causality. Longitudinal analyses using future waves of the Add Health study hold great potential for future explorations of change in the character of SES across the full transition to adulthood and of racial/ethnic differences in the association of SES with obesity over time. 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 provides a unique solution to the problems of defining SES in the understudied young adult period.

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 complex patterning of characteristics related to “Schooling” was identified as a salient factor for obesity in all females, while “Social capital” and the multiple variables capturing “Economic hardship” were important for females of specific race/ethnicity. Overall, these findings provide valuable information for efforts to slow both the increasing incidence across groups and the widening of racial/ethnic disparity in US young adult obesity.

Table 1. Background data on analysis sample (N=11,250) from Wave III (2000-2001) of the National Longitudinal Study of Adolescent Health*

| Characteristic (Wave) | Total (N=11,250) | |
|---------------------------------------|---------------------|----------------|
| | Years (SE) | |
| Mean age (Wave III) | 21.9 (0.12) | |
| | % (SE) | |
| Female (Wave III) | 47.8 (0.8) | |
| White (Wave I) | 70.6 (2.8) | |
| Black (Wave I) | 13.9 (1.9) | |
| Hispanic (Wave I) | 11.5 (1.7) | |
| Asian (Wave I) | 4.1 (0.8) | |
| Adolescent obesity (Wave I) | Total | |
| | 8.5 (0.5) | |
| | Males | Females |
| White | 9.6 (0.7) | 6.2 (0.6) |
| Black | 11.7 (1.8) | 12.4 (0.9) |
| Hispanic | 10.1 (1.8) | 8.5 (1.3) |
| Asian | 6.1 (2.3) | 2.0 (1.1) |
| Young adult obesity (Wave III) | Total | |
| | 18.4 (0.7) | |
| | Males | Females |
| White | 18.4 (1.1) | 15.7 (1.1) |
| Black | 20.4 (2.0) | 30.3 (1.9) |
| Hispanic | 18.8 (1.9) | 23.8 (2.0) |
| Asian | 11.7 (3.1) | 10.1 (2.8) |

*Weighted and corrected for clustering to generate nationally representative estimates

Table 2. Factor loadings* for theoretically plausible young adult (Add Health Wave III; 2000-2001) SES indicator variables

| Young adult SES variable | Factor 1: Social capital | Factor 2: Schooling | Factor 3: Employment | Factor 4: Economic hardship |
|---|--------------------------------|------------------------|-------------------------|-----------------------------------|
| Material capital | | | | |
| <i>Income sources</i> (no/yes) | | | | |
| Wages, including tips/bonus | | | 0.44 | |
| Interest, from stocks, bonds | 0.33 | | | |
| Housing assistance | | | | 0.33 |
| Food stamps | | | -0.15 | 0.48 |
| Family/friends | | 0.32 | | |
| <i>Personal economics</i> | | | | |
| Total personal income: 2001 | | | 0.31 | |
| Own residence (no/yes) | | -0.21 | | |
| Own vehicle (no/yes) | 0.15 | | 0.29 | |
| <i>Information and financial access</i> (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 | |
| <i>Economic hardship in the last year</i> (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 to go to doctor | | | | 0.26 |
| Evicted for not paying rent | | | | 0.25 |
| <i>Public assistance</i> (no/yes) | | | | |
| Currently getting AFDC, public assistance or welfare | | | -0.18 | 0.45 |
| Ever receive public assistance other than food stamps | | | | 0.44 |
| <i>Miscellaneous</i> | | | | |
| Number of months health insurance in past year | 0.37 | 0.22 | | |
| Currently living with parents (no/yes) | -0.18 | | | -0.23 |

| Young adult SES variable | Factor 1: Social capital | Factor 2: Schooling | Factor 3: Employment | Factor 4: Economic hardship |
|--|--------------------------------|------------------------|-------------------------|-----------------------------------|
| Human capital | | | | |
| <i>Education</i> | | | | |
| Highest grade attained | 0.67 | 0.33 | | |
| 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 | | |
| <i>Labor experience</i> | | | | |
| 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 social capital 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 for president in 2000 (no/yes) | 0.46 | | | |
| Identify with political party (no/yes) | 0.32 | | | |

*Factor loadings after Varimax rotation and Horst normalization are shown if >0.15, i.e. salient loadings for sample size

Table 3. Relative risk of obesity in young adulthood (Add Health Wave III; 2000-2001) associated with a one-unit increase in SES factor scores*

| Factor score | RR (95% CI) ^a | | | |
|-------------------|--------------------------|---|--------------------------|---|
| | Males ^b | | Females ^c | |
| | Final model ^e | Without adolescent Obesity ^d | Final model ^e | Without adolescent Obesity ^d |
| Factor 1: | | | | |
| Social capital | 1.00 (0.94, 1.06) | 0.97 (0.91, 1.03) | -- | -- |
| White | -- | -- | 0.91 (0.84, 0.99) | 0.85 (0.78, 0.93) |
| Black | -- | -- | 1.05 (0.95, 1.17) | 1.01 (0.91, 1.13) |
| Hispanic | -- | -- | 0.80 (0.70, 0.92) | 0.76 (0.66, 0.87) |
| Asian | -- | -- | 0.93 (0.66, 1.31) | 0.96 (0.71, 1.31) |
| Factor 2: | | | | |
| Schooling | 0.96 (0.89, 1.03) | 0.93 (0.86, 1.00) | 0.91 (0.85, 0.98) | 0.87 (0.81, 0.94) |
| Factor 3: | | | | |
| Employment | 1.05 (0.97, 1.13) | 1.03 (0.95, 1.12) | 0.97 (0.92, 1.01) | 0.95 (0.90, 1.01) |
| Factor 4: | | | | |
| Economic hardship | 1.04 (0.98, 1.11) | 1.03 (0.96, 1.11) | -- | -- |
| White | -- | -- | 1.07 (1.01, 1.14) | 1.11 (1.04, 1.20) |
| Black | -- | -- | 1.03 (0.97, 1.10) | 1.08 (1.03, 1.13) |
| Hispanic | -- | -- | 1.05 (0.96, 1.16) | 1.13 (1.03, 1.23) |
| Asian | -- | -- | 1.76 (1.31, 2.37) | 1.82 (1.28, 2.58) |

*Estimates are from age-adjusted, gender stratified, multivariate Poisson regression models of young adult obesity

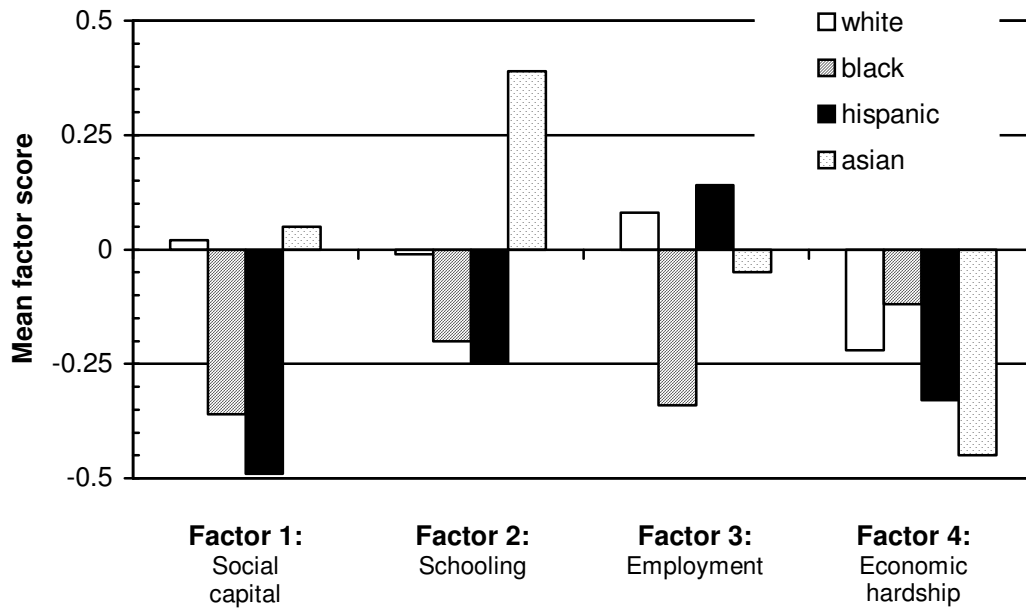
^aRR= relative risk; CI=confidence interval

^bModels for males were pooled and adjusted by race/ethnicity

^cSignificant 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

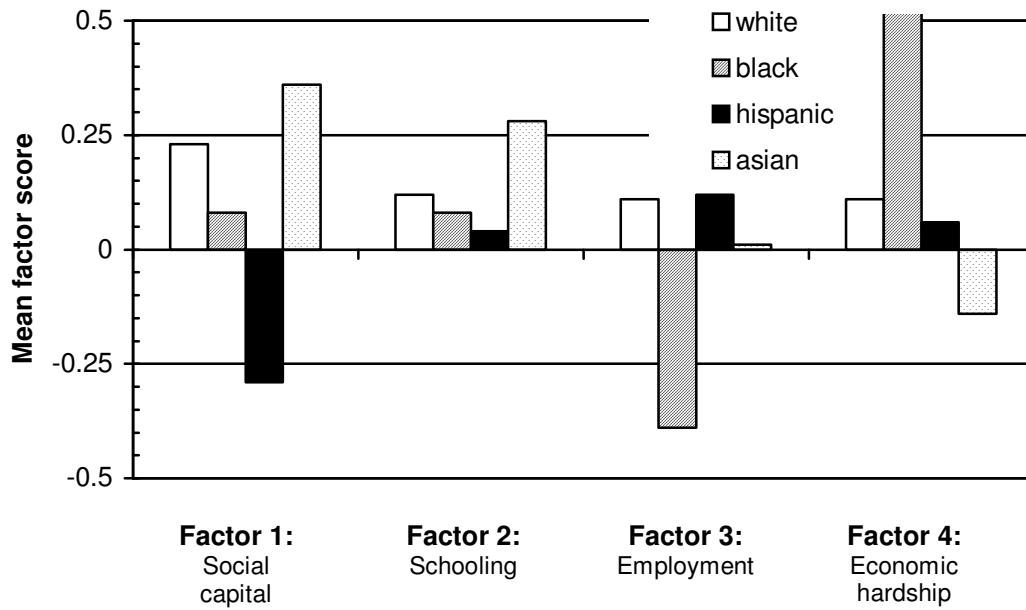
^dThe final models for both males and females were adjusted for age and adolescent obesity. Results from a secondary analysis without adolescent obesity in the model are also presented to illustrate the influence of underlying obesity on the relationships of interest.

Figure 1. Mean SES factor scores* for young adults (Add Health Wave III; 2000-2001) by race/ethnicity: Males



*Factor scores produced by the Barlett scoring method on rotated factors

Figure 2. Mean SES factor scores* for young adults (Add Health Wave III; 2000-2001) by race/ethnicity: Females



*Factor scores produced by the Barlett scoring method on rotated factors

V. The use of latent class analysis to define patterns of life course socioeconomic status across the transition from adolescence to adulthood

A. Introduction

According to the life course approach to the study of chronic disease, factors acting in early life accumulate and interact with later life factors in the production of adult disease (Lynch, Kaplan et al. 1997; Ben-Shlomo and Kuh 2002; Smith and Hart 2002; Kuh, Ben-Shlomo et al. 2003). However, life course methods that use measures of socioeconomic status (SES) at different time points as independent exposures in multivariate models cannot fully disentangle the influence of earlier SES from later SES on disease risk (Hallqvist, Lynch et al. 2004). Alternative methods that group individuals based on SES measures at different time points are one way to circumvent this issue, and can capture important variations in SES exposure. Yet, traditional approaches of combining SES data in this manner are limited, especially in the context of defining life course SES in US young adults.

Typical combinations of SES information over the life course are based on a “social mobility” framework, by which change in SES category from one time point to the next is contrasted with staying in the same category (Hart, Smith et al. 1998). In theory, “Inter-generational” social mobility contrasts the SES of adult children with their parents, while “Intra-generational” analyses contrast the SES of an adult early versus later in life (Rosvall, Chaix et al. 2006), though in the study of young adults, the distinction is blurred. This literature demonstrates better health outcomes for “stable high” versus “stable low” SES,

while the “mobile” generally have intermediate health risk (Pensola and Martikainen 2003; Claussen, Smits et al. 2005; Luo and Waite 2005; Chen, Martin et al. 2007). However, social mobility studies are usually limited to two time points with the trajectory as the unit of analysis, and thus groups tend to share the same SES at one of those points, which may explain the frequent null results (Pollitt, Rose et al. 2005). Furthermore, the number of groups required to exhaustively represent all combinations of more than two to three SES categories per time point can get prohibitively large. As a result, these traditional combination measures lack sufficient detail to truly characterize heterogeneous life course SES exposure. In addition, the structure of these analyses makes it difficult to distinguish mobility effects from cumulative SES effects – is the mobility really the source of variation, or is it the exposure to low SES at one or more time points (Hallqvist, Lynch et al. 2004; Rosvall, Chaix et al. 2006)?

The proper conceptualization of SES during young adulthood is important for understanding its association with health outcomes with enhanced risk during this period, including substance abuse, poor reproductive health and obesity (Harris, Gordon-Larsen et al. 2006). However, the social mobility approach to combining SES information over the life course is especially limited in the young adult context by the later occurrence of transitions in residence, employment, schooling and social roles in current US young adults as compared to previous generations (Shanahan, Porfeli et al. 2004). Traditional combination measures based on income or education are likely to misclassify a large proportion of young adults as “downwardly mobile” because they have not yet completed their education or other training. Similarly, young adults from disadvantaged backgrounds who enter the labor force relatively early may be misclassified as upwardly mobile because they are typically employed in low

status occupations and are later surpassed by those who postpone labor force entry to pursue higher education.

As an alternative to the social mobility framework for combining SES information, we use latent class analysis (LCA) to define patterns of life course SES exposure in a young adult population. LCA is a model-based, person-centered grouping method that is well-suited for characterizing the life course SES of young adults based on their own social position and the social position of their parents. We use this probabilistic technique to discover mutually exclusive and exhaustive “classes” or groups of individuals based on their values for a large set of parental and young adult SES indicators, capturing the multidimensionality of SES and more fully characterizing their SES exposure over the life course. This approach to studying life course SES across the transition to adulthood averts the methodological limitations inherent in traditional combination measures and shifts the framework from “mobility” to “accumulation of exposure,” which may be more appropriate in the young adult context.

Latent structure methods such as LCA have been used in the psychological and economic literature to typify complex behaviors, such as eating disorders, depression, smoking, as well as labor force entry and exit (Clogg 1980; Donovan, Jessor et al. 1993; van Lang, Ferdinand et al. 2005; Duncan, Bucholz et al. 2007; Rose, Chassin et al. 2007). These methods have also been used in sociology to characterize social mobility as it was originally studied, i.e. through the cross-classification of occupational status at two time points (Clogg 1981), and more recently, over multiple time points (Sturgis and Sullivan 2008). While these studies have provided useful frameworks for the study of mobility in older (both in age and cohort) populations with clear hierarchies, they are as limited as traditional mobility analyses

in capturing combinations of social status in the current context of young adulthood in the US. That is, due to the increased delay and variability in timing of multiple transitions into adulthood, categorization based on traditional indicators of occupation or education would likely do more harm than good by misclassifying the SES of the young adult. Indeed, a multidimensional approach that can summarize the cumulative exposure of a number of different SES dimensions of importance for young adults over time would be less prone to misclassification bias. Furthermore, the utility of these latent structure approaches for predicting health have not yet been demonstrated. Finally, recent work that has applied LCA to understanding transitional pathways in recent US cohorts shows the variability and complexity of this period (Osgood, Ruth et al. 2004), underscoring the need to examine SES groupings during this period in a similarly multidimensional manner. To our knowledge, LCA has not been used to characterize life course SES in a young adult population, nor has it been used to understand the associations between SES and health.

In this paper, we use LCA to define patterns of SES exposure across the transition to adulthood in a nationally representative sample of adolescents followed over five years. This methodology could be appropriate for various outcomes of interest in the young adult period, such as reproductive or mental health outcomes. For the present study, we use the example of obesity because this transitional period is one of particularly high risk for obesity incidence and persistence (McTigue, Garrett et al. 2002; Gordon-Larsen, Adair et al. 2004; Ogden, Carroll et al. 2006).

B. Subjects and Methods

1. 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 school-aged youth (grades 7-12 at Wave I; 1994-1995; N=20,745), followed with multiple interview waves into young adulthood (Wave III; 2001-2002; N=15,197). 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 et al. 2003). Our analytic sample was drawn from the pool of young adults in Wave III with post-stratification sample weights (N=14,322), using data from the in-home, in-school and parental questionnaires in Wave I to characterize their adolescent household and the in-home questionnaire in Wave III to summarize their young adult experience. We excluded seriously disabled or pregnant respondents at either survey period, as well as those missing data on the outcome and important covariates in our multivariate modeling. Although many respondents were missing data on one or more of the twenty-five variables used to define our exposure using latent class analysis, we could reasonably assume that missingness on these variables was “at random.” Since the software used for LCA provides maximum likelihood estimation under missing at random, using all available data to estimate the model parameters, we were able to retain all observations with any data on the dependent variables used to define our exposure, thus preserving overall sample size in this phase of the analysis (Arbuckle 1996; Muthen and Muthen 1998-2006). However, the “listwise” deletion of observations missing data on any variables in the subsequent regression modeling reduced the dataset. Our final analytic

sample included 13,432 respondents (48% female) interviewed in both Waves I and III, comprising four major racial/ethnic groups: non-Hispanic whites, non-Hispanic blacks, Hispanics and Asians, aged 18 to 28 years at Wave III. The excluded sample had a higher proportion of females and a higher prevalence of young adult obesity relative to the analysis sample.

2. Conceptual framework

The proper conceptualization of “life course SES” in a young adult population is critical to understanding the relationship of SES exposure with young adult health outcomes. Our use of latent class analysis to define young adult SES in this manner is consistent with the “cumulative” life course framework of SES and health, which posits that the impact of negative SES experiences accumulate over time to influence adult disease risk (Hart, Smith et al. 1998; Singh-Manoux, Ferrie et al. 2004; Carson, Rose et al. 2007). This framework is typically operationalized using cumulative indices of SES disadvantage, i.e. summations of unfavorable SES events or characteristics, which are then used as predictors in models of disease. However, this typical approach to testing cumulative SES hypotheses makes the assumption that specific negative life experiences have the same impact, regardless of type or when they occur (Hallqvist, Lynch et al. 2004; Pollitt, Rose et al. 2005). LCA overcomes these limited assumptions by its ability characterize individuals on a large set of SES characteristics at multiple time points and thus provides an innovative, alternative approach to exploring cumulative SES hypotheses. In our study, LCA permits the assignment of individuals to one of several “life course SES” groups that capture the heterogeneity of cumulative SES exposure of individuals across this dramatic transitional period based on a

diverse array of SES traits of both the parental household in adolescence and the SES that the young adult creates for themselves.

However, despite conceptual similarities to a cumulative life course SES framework, the person-centered nature of LCA, i.e. its grouping of *individuals* based on their values on a set of variables, makes LCA most directly comparable to the social mobility framework. This approach to understanding SES and health focuses on trajectories of change in SES (Pollitt, Rose et al. 2005), defining distinct trajectory groups of individuals who increase, decrease or stay the same on a few select measures over time (Hallqvist, Lynch et al. 2004; Rosvall, Chaix et al. 2006). Although we have already described several weaknesses of this approach, we recognize that there are important preliminary insights to gain from the growing body of literature on SES mobility and health outcomes such as body esteem, obesity and mortality (Langenberg, Hardy et al. 2003; Pensola and Martikainen 2003; McLaren and Kuh 2004; Claussen, Smits et al. 2005; Ball and Mishra 2006; James, Fowler-Brown et al. 2006; Bennett, Wolin et al. 2007). Furthermore, this literature informs expectations about how different combinations of parental and young adult SES variables might influence health. While the term “mobility” suggests a temporal disjoint with the LCA approach, in reality, both approaches can be used to combine information from two time points into distinct groups. For these reasons, we compare life course SES groups defined using LCA versus a traditional social mobility framework in their composition and associations with health. We specifically explore whether LCA provides a more detailed identification of the clustering of SES characteristics associated with the development of health outcomes (in this case, obesity) across the transition to adulthood.

3. *SES variables*

Latent class analysis (LCA). Our desire to adequately capture both the inherent multidimensionality of the SES construct and the heterogeneity of combinations of SES characteristics across generations was balanced by practical limitations to the latent class model. While far more flexible than typical *ad hoc* grouping methods, latent class analysis is a type of mixture modeling, which often has difficulty converging as the number of items increase. Currently, there are no widely accepted rules of thumb about the number of items in LCA, but most published research has been performed on 30 variables or less. Because of the complexity of the measure we wished to capture, the size of our final set of 25 variables was towards the higher end of the published range. A much larger set of variables was initially considered, but redundant variables were iteratively eliminated or combined, guided by a desire to adequately represent three major domains of SES that 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 and Rossi 2003). Details on data source and coding are presented in the Appendix.

Parental SES. Eleven indicators of parental SES (3 continuous, 6 binary categorical and 2 nominal categorical variables) for LCA were generated using information from surveys of parents and adolescents from Wave I (Appendix). Several composite indicators warrant brief description. The "public assistance" indicator summed the number of sources of government assistance (including: SSI, AFDC, food stamps, unemployment insurance, workers compensation or housing subsidy) received by the parent respondent in the past month, collapsed into 0=none, or 1=1 or more sources. "Social capital" was defined by similarly collapsing the sum of participation or membership in various social activities

(including: parent-teacher organizations, veteran’s organizations, hobby or sports groups, civic or social organizations) into two categories. We also included both direct (i.e. “two parent household”) and indirect (i.e. “hours per week worked by a mother/father in the household,” necessarily=0 if not in the household) indicators of family structure in the LCA because this characteristic is an integral determinant of household resources and support, with considerable impacts on both material and social capital. Although these variables are referred to as “parental SES,” they were assessed during Wave I and simultaneously represent the SES of the parent and the SES of the respondent’s adolescent household. Thus, their combination with young adult SES can be viewed as both inter-generational (parent vs. child) and intra-generational (“child” as adolescent vs. “child” as young adult) life course SES measures.

Young adult SES. Fourteen indicators of young adult SES (2 continuous, 11 binary categorical and 1 nominal categorical) for LCA were defined using information from the in-home survey administered to young adults in Wave III (Appendix). We used a broad selection of variables to capture dimensions of particular relevance to young adults, including indicators of being enrolled in higher education, as well as measures reflecting transitions in social roles (i.e. marriage), residence (i.e. no longer living with parents), employment and financial independence. Young adult “hardship” was defined by summing the number of positive responses to the receiving of various forms of public assistance (e.g. food stamps, unemployment benefits) and to the experience of various types of hardship (e.g. inability to pay rent, inability to see a doctor because could not afford it) over the past year and dichotomizing into two categories: 0=none, 1=1 or more positive responses. Young adult

“social capital” was also a two-category collapsed index that summed membership in several volunteer or community organizations (including: youth organizations (e.g. little league), service organizations (e.g. big brother/sister), ethnic-support groups (e.g. NAACP)) as well as civic participation activities (including: writing government official about political or community issues, attending a political rally, running for office).

Traditional social mobility approach. A combination of in-home surveys of parents and adolescents from Wave I provided parental SES data on income and education appropriate for simple combination measures of SES mobility (Appendix). Household income was reported in \$1000 increments, and missing values were imputed using data on parental occupation, family structure, and school community, as has been done in other national surveys (Kalton 1983; Ezzati-Rice, Khare et al. 2004). Parental education was defined using the highest level of education achieved for either parent, categorized as follows: <high school, high school/GED, some college, and college graduate or professional/graduate school. Young adult SES was defined using data from the Wave III survey. The measure of income for the young adult included total personal income from all sources (including but not restricted to wages) during the previous year, converted into \$1000 increments, while the highest grade or year of school completed was used to define young adult education.

4. Other variables

Young adult obesity, defined using the adult BMI cut point for obesity (30 kg/m²) (NHLBI 1998), was assessed using measured height and weight from Wave III. Self-

reported height and weight values were substituted when measured values were missing (n=330), including respondents in the analytic sample who weighed in excess of scale capacity (330lb, or 150 kg; n=33) at the Wave III assessment. The Add Health self-report values have been shown to correctly classify a large proportion of the sample (Goodman, Hinden et al. 2000). Self-designated race/ethnicity from Wave I was used to create mutually exclusive categories of Hispanic, non-Hispanic white, non-Hispanic black and Asian or Pacific Islander. For simplicity, we refer to these groups as Hispanic, white, black and Asian. Sex was self-reported at Wave III, and age was the reported age at the participant's last birthday at Wave III.

5. *Statistical analysis*

Phase I: Define “life course SES” groups.

Latent class analysis (LCA). LCA was used to identify: 1.) the optimal number of latent “classes” or groups necessary to capture the heterogeneity across young adult respondents in their values on the previously described life course SES indicators, and 2.) the size and characteristics of each group. These analyses were conducted using Mplus Version 4.0, accounting for complex survey design using a sandwich estimator for the clustering of respondents and post-stratification sample weights for the unequal probability of selection of respondents into the sample (Muthen and Muthen 1998-2006).

The latent class model assumes that responses to a set of manifest variables reflect an underlying latent variable with discrete “classes” or groups (Lazarsfeld and Henry 1968). That is, the relationships among a set of observed measures are due to some unmeasured discrete variable, and once this unmeasured “latent” variable, the true variable of interest, is

imposed on the model, all other measures are unrelated (McCutcheon 1987). The observed variables are said to be “locally independent” within each group defined by the latent variable, i.e. members of the same group cannot be distinguished from each other and are thus homogenous with respect to these observed variables (Clogg 1995; Hagenaars and McCutcheon 2002).

The parameters of the latent class model were estimated using maximum likelihood methods with robust standard errors (Goodman 1979; Muthen and Muthen 1998-2006). The model estimates two types of parameters: 1) latent class membership probabilities, or the probability for a given observation to be in a particular class, and 2.) conditional response probabilities, or the probability of a particular response pattern given membership in a particular class (McCutcheon 1987; Uebersax 2001-2003). In this study, the latent class membership probabilities summarize the distribution of respondents across the categories of the discrete latent variable representing “life course SES.” The conditional response probabilities describe the patterns of responses to the observed SES variables for each latent class, facilitating interpretation. The generated classes represent groups of young adults who share a common profile of parental and young adult SES characteristics or “life course SES” exposure. The continuous indicator specification of this model is summarized in the equation below (Hagenaars and McCutcheon 2002; Nylund 2007):

$$f(y_i) = \sum_k p(c = k) f(y_i | c = k), \text{ where}$$

y_i is the vector of observed manifest variables for case i
 c is the discrete latent variable (k denotes a class, i.e. $k=1, 2, \dots, K$), and
 $f(y_i | c = k)$ denotes the joint distribution specified for y_i given latent class $c = k$

The final latent class model was selected using several criteria. Although deciding on the number of classes was of primary interest, the typical likelihood ratio test for comparing models is not appropriate for mixture models of different numbers of classes. Thus, we examined several alternative model selection criteria, including: 1.) the visual plot of log-likelihoods of similarly specified models across numbers of classes to select models where the log-likelihoods “level off,” i.e. no longer show a substantial improvement in model fit (Nylund 2007); 2.) the Bayesian Information Criterion (BIC), a widely used goodness of fit criterion for comparing models regardless of their underlying distribution, with smaller values representing more parsimonious models (Schwartz 1978); and 3.) interpretability of model solution parameters, with specific attention to the meaningful interpretation of the pattern of response probabilities for each class, uniqueness of classes and non-triviality of class size. Once promising candidate solutions were identified, we examined their stability using different sets of random starting values. Obtaining the same results confirmed the identifiability of the model and ensured that we had reached global maximum likelihood estimates rather than local maxima solutions (Uebersax 2001-2003).

Finally, we classified respondents into “life course SES” groups based on the final latent class model solution. For ease of presentation, these groups were re-ordered and assigned brief labels based on distinguishing characteristics. The latent class model computes the posterior probability of an individual’s membership in each class, and the individual is traditionally assigned to the group for which they have the highest probability (i.e. “modal” assignment) (McCutcheon 1987; Uebersax 2001-2003). However, since we exported the final latent class membership data to a non-latent variable framework for subsequent analysis of the association between these “life course SES” groups and health, we

reasoned that incorporating the accuracy of class assignment into the analysis could partially address the inability to account for the measurement error of the latent classification variable (Pastor, Barron et al. 2006). Thus, we used the posterior probabilities of membership in each class (rather than the modal assignment) as the categories of a nominal group membership variable.

Social mobility. To define “life course SES” groups using the social mobility framework, we standardized income and education at each time point, i.e. adolescence (Wave I: parental SES) and adulthood (Wave III: young adult SES) to a mean of 0 and SD=1, permitting the combination of variables of different units. “SES” at each time point was defined as the row mean of non-missing standardized income and education variables, substituting the value of one variable if the other was missing to maximize the data, and then dichotomized at the sample median into “low” vs. “high.” These median split variables were then used to define an *ad hoc*, four-category SES mobility variable as follows: “Stable low”=low parental SES to low young adult SES; “Upwardly mobile”=low to high, “Downwardly mobile”=high to low; and “Stable high”=high to high.

Phase II: Multivariate modeling of a young adult health outcome example: obesity

Poisson regression models were used to directly estimate the relative risk of young adult obesity prevalence associated with: 1) LCA-defined and 2) mobility-defined SES group membership (Zou 2004) using Stata, version 9.2 (StataCorp 2007). For the LCA groups, posterior probabilities of membership in each latent class were entered into the model as the categories of a nominal predictor variable, omitting the most advantaged group as the

referent category. For the social mobility groups, the “stable high” category was the omitted referent of a four-level nominal exposure variable. Effect estimates reflect the risk of obesity associated with membership in a particular SES group. Given gender differences in obesity and in the influence of SES on obesity, all models were gender-stratified. Within gender, we assessed potential effect modification of the association between each SES group and obesity by race/ethnicity. For both the LCA and social mobility groups, significant interactions ($p < 0.10$ for Wald test of interaction terms) between race/ethnicity and the life course SES group membership variable were observed in females and used to calculate racial/ethnic-stratified estimates of the relative risk of young adult obesity, while estimates for males were pooled across racial/ethnic groups. The coefficients from the Poisson models were then used to predict adjusted obesity prevalence for each life course SES category, setting other SES groups equal to zero and the age equal to the sample mean (approximately 22 years). For predictions in males, the probability of being in a particular race/ethnicity was set to the sample mean, whereas in females (for ease of presentation, data not shown), predictions were done individually by race/ethnicity, setting the other race/ethnicities (and their interaction terms) to zero. Survey procedures in Stata were used to correct for unequal probability of selection and the underestimation of variance due to the clustered sample design.

C. Results

1. Descriptives

The mean age of respondents was 22 years, with a range from 18-28 years (**Table 4**). The prevalence of obesity in our young adult sample was high, especially among black and Hispanic females.

2. Latent class analysis

We tested a series of models specifying one to seven classes (**Table 5**). The log likelihoods and BIC values decreased with increasing numbers of classes, leveling off between the 4-class and 6-class solution. Despite the use of a large number of random starts for each model specification, classes of relatively trivial size (< 0.5% of the sample) and extreme values on several variables were observed for the 6-class and higher solutions. Further examination of model parameters, including the values of the LCA variables across classes, provided substantive support for the 5-class solution. In addition, between 90 and 95% of individuals were correctly classified across classes, indicating good prediction of class membership for this model. Taken together, these results recommended the LCA model specifying five classes.

Conditional response probabilities (for categorical indicators) and means (for continuous indicators) characterize the life course SES exposure for young adults in the five latent classes identified by the model (**Table 6**). The adolescent household for members of the class we labeled “persistent disadvantage” was characterized by low parental income and likely headed by a single mother working considerably less than full time. Neither parent was likely to have more than a high school education or to have a professional occupation, and these households were least likely to have health insurance while most likely to have received public assistance. Similarly, respondents reported the lowest income and years of education of any group as young adults and were least likely to be in the labor force, but had among the highest rates of enrollment in vocational school. Furthermore, these young adults

had the lowest rates of health insurance and social capital of any group and had low probability of access to financial independence.

The adolescent household for members of “disadvantage with autonomy” was characterized by below average income, despite the presence of two working parents. Although the low likelihood of a professional occupation for these parents was similar to that seen for “persistent disadvantage,” they had considerably lower probability of having at least a high school education. The SES of their young adult children was also depressed, though mixed. While these young adults had the second lowest average years of education, they had the second highest income. However, they were most likely to be earning that income in a manual occupation. While the probability of home ownership was low for this young population, members of this group were the most likely to own their own homes.

Respondents in “material advantage” were exposed to a more favorable SES pattern in their adolescence, characterized by the second highest average household income of any group and two working parents. While parental education and occupation status were relatively low, parents of these respondents did not suffer serious hardship and had average social capital. As young adults, members of this group had the highest values for personal income and were least likely to be unemployed, though they only had average years of education and occupation status. Further, young adults in this class were nearly as likely to be in vocational school as were members of “persistent disadvantage,” but they also had a non-trivial probability of being enrolled in higher education.

Adolescence for members of the class labeled “educational advantage” was typified by middle-income households headed by a single mother of at least a high school education and a sizable probability of having attended some college. Notably, as young adults, this

group had the second highest years of education and probability of being enrolled in higher education. They were among the least likely to be unemployed or in manual occupations and the most likely to be working in sales or service. Although they tended to have average values for the remaining indicators of SES, young adults in this group were also noteworthy for having the second highest probability of high social capital compared to other groups, as did their parents.

Membership in “highest overall advantage” clearly conferred the most privileged life course SES exposure on young adults in this study. These adolescent households had the highest income of all groups and were headed by two parents with the highest probability of having professional occupations. This parental background was further characterized by the highest rates of health insurance and the lowest rates of public assistance. Similarly, respondents had the highest years of education and probability of being in higher education as young adults. Although they were less likely to be in the labor force relative to “material advantage” and “educational advantage,” those that were working were most likely to be in managerial occupations. While these respondents did not have the highest personal income in young adulthood, they did have the highest probability of having financial access and health insurance. Both the parents of these respondents and the respondents themselves as young adults had the highest social capital of any group.

Population distributions for the LCA and social mobility groups are presented in **Table 7**. Whites were most highly represented in the “material advantage” and “highest overall advantage” groups as well as in the “stable high” social mobility group. Conversely, the highest proportion of blacks was observed in “persistent disadvantage” and in the “stable low” social mobility group. Hispanics were most represented in “disadvantage with

autonomy,” a group of considerable disadvantage despite the presence of two working parents in adolescence, as well as in the “stable low” social mobility group. Of note, Asians were most highly represented in the most clearly well off life course SES groups, i.e. “highest overall advantage” and the “stable high” social mobility group.

3. Associations with young adult health: The example of obesity

Model results are shown in **Table 8**. Among males, we observed an approximately 50% greater risk of young adult obesity for “disadvantage with autonomy,” “material advantage” and “educational advantage” relative to “highest overall advantage,” the high SES referent. In contrast, only the “stable low” social mobility group showed a marginally significant elevated risk of obesity vs. the “stable high” referent. We observed strong positive associations in white females across all LCA groups relative to the higher SES referent, while only the “upwardly mobile” and “stable low” mobility groups showed a substantial elevation in obesity risk. Among black females, members of “disadvantage with autonomy” were the only group to have significantly elevated risk of young adult obesity, with no associations for any of the SES mobility groups. Hispanic females from “persistent disadvantage” were nearly three times more likely to be obese in young adulthood than those with a high life course SES referent, while slightly weaker associations were observed for the “stable low” and both mobility groups compared to the “stable high” SES referent. However, these estimates showed considerable imprecision, a problem of even greater magnitude for Asian females.

We used the model coefficients to predict the probability of young adult obesity (expressed as a percentage) in each of the SES groups for an average, 22-year-old male

(Figure 3). While young adult males of “stable low” SES had the highest predicted obesity of the social mobility groups by a slim margin, membership in “disadvantage with autonomy” conferred a clearly higher obesity risk than the other LCA groups. Interestingly, the other more “disadvantaged” LCA group, i.e. “persistent disadvantage,” had the second *lowest* predicted obesity. In general, differences in obesity risk across the social mobility groups were minimal, while considerable variability was observed across the LCA groups. Although relatively small, the greatest disparities for the traditional social mobility approach were between the “stable low” (higher predicted obesity) and “downwardly mobile” (lowest predicted obesity), suggesting an important role for parental SES among males with low young adult SES. For the LCA groups, in contrast, there was a substantial difference between the group with the highest (disadvantage with autonomy) and lowest (highest overall advantage) predicted obesity. Finally, we note that disadvantaged males from a single mother household (persistent disadvantage) had considerably *lower* risk of obesity than those from a more advantaged single mother household (educational advantage).

D. Discussion

We used latent class analysis to characterize five distinct life course SES groups in young adults with finer detail than permitted by traditional methods of combining SES information. To our knowledge, this is the first study to attempt a typology of early life course SES exposure in this manner. Although fairly common in the classification of complex behaviors, such as depression, smoking, or labor force entry and exit (Patterson, Dayton et al. 2002; Rose, Chassin et al. 2007), the latent variable approach has not yet gained popularity in the study of life course SES and health, despite indications that

multidimensional methods could improve our understanding of these complex relationships. Associations with obesity, an illustrative health outcome of increased risk during the young adult period, demonstrated nuanced relationships not seen using a traditional social mobility measure of life course SES.

1. Composition of life course SES groups

The LCA method revealed several interesting subgroups that add to our knowledge of generational SES exposure across the transition from adolescence to adulthood. For example, we identified two distinct groups characterized by a single mother household in adolescence (i.e. “persistent disadvantage” and “educational advantage”). Despite their similar family structure, members of “persistent disadvantage” clearly had a more socially and economically deprived overall pattern of SES in adolescence as compared to members of “educational advantage.” Maternal education and occupational status likely played an important role in further distinguishing these groups on their SES characteristics as young adults, with respondents in “persistent disadvantage” remaining at low SES while the educational pursuits of those in “educational advantage” placed them on an upward SES trajectory.

The two “disadvantaged” life course SES patterns identified by LCA (i.e. “persistent disadvantage” and “disadvantage with autonomy”) are another example of seemingly similar SES subgroups with important differences. In addition to the single mother household structure already described, members of “persistent disadvantage” were from unstable poor adolescent households with high levels of unemployment and hardship, and the cycle of disadvantage continued with their own low education and high unemployment in young

adulthood. In contrast, respondents in “disadvantage with autonomy” came from two-parent, working poor adolescent households, but they were more likely to be both pursuing some education and earning an income in the labor force, albeit in a low-status occupation. The transitional patterns of this group seems most akin to the “fast starters” identified by Osgood et al. (Osgood, Ruth et al. 2004), experiencing early transitions in residence, employment and social roles at the detriment of further education. Thus, although both groups were “disadvantaged,” the overall patterns of life course SES are distinct.

The distribution of these distinct subgroups across race/ethnicity highlights the advantage of using LCA to define life course SES over traditional methods in several ways. For instance, although both blacks and Hispanics were most represented in the “stable low” social mobility group, their distribution across LCA groups suggests that their experience of disadvantaged SES was quite different. That is, blacks were more represented in unstable poor, single mother adolescent households (persistent disadvantage), while Hispanics were most likely to be in working poor, two parent adolescent households (disadvantage with autonomy). Similarly, although Asians were least represented in the “stable low” category, it was clear that the majority of low SES Asians were from working poor, two parent households (disadvantage with autonomy) rather than “persistent disadvantage.”

LCA also identified three distinct “advantaged” life course SES groups with considerable heterogeneity not captured in the traditional “upward” or “downward” mobility groups, providing a more detailed picture of what defines “advantage” in terms of life course SES exposure for young adults. While “highest overall advantage” clearly comprised the most well off group on a number of SES characteristics, they did not have the highest incomes in young adulthood, which may have misclassified them as “downwardly mobile”

using the traditional social mobility approach. Members of “material advantage” had a more mixed, yet still relatively “advantaged” SES profile; although they had the highest incomes as young adults, neither they nor their parents achieved particularly high education, raising questions as to whether they would be classified as upwardly or downwardly mobile. Again, examining distributions of these groups by race/ethnicity further illustrates the information gained using LCA. That is, both whites and Asians had their highest proportions in the “stable high” mobility group, but their largest proportions in the LCA groups split across “material advantage” and “highest overall advantage.” Finally, although we already discussed the relatively favorable profile of “educational advantage,” it bears mention that this group was an important “advantaged” group for blacks, as it was the only such group for which they had a sizable representation.

Although only select demographic characteristics of the young adults were included in the LCA because of their strong relationship and determination of SES exposure, these traits provide added insight on the profiles of these groups beyond SES. For instance, marriage rates in the “disadvantage with autonomy” group (mentioned above) were much higher than in “highest overall advantage.” In contrast, “living with parents” did not distinguish classes as clearly as may have been expected, suggesting that this has become a normative status for young adults in the US today. However, the other variables defining each group pattern suggest there may be different mechanisms driving the ultimately similar rates of living at home. Some of these include the potential inability of unemployed, low education young adults in “persistent disadvantage” to support themselves, whereas the recent trend of college graduates returning to the nest before launching into full independence may be driving the proportions seen in “highest overall advantage” (Shanahan,

Porfeli et al. 2004). Results for “income from family” are consistent with recent research on parental outlays, showing that parents with the most means are most likely to provide financial support to their children (Schoeni and Ross 2004). Interestingly, the middle SES, single mother adolescent household group (educational advantage) had substantially higher rates of supporting their children than the group with a working poor, two-parent adolescent household (disadvantage with autonomy).

2. Associations with obesity

A major objective of this study was to better capture SES exposure to enhance understanding of the relationships between SES and health outcomes during the turbulent young adult transition. It is clear that findings using LCA were more complex than those using the traditional social mobility indicators. In general, LCA identified more groups that had stronger associations with young adult obesity as compared to the social mobility groups. For example, while only the “stable low” social mobility group in males showed an elevated obesity risk, the LCA results suggest that these high-risk males were primarily from two-parent households of differing levels of advantage (i.e. “disadvantage with autonomy” and “material advantage”). Furthermore, “persistent disadvantage,” an impoverished group, did not show a substantial relationship with obesity risk among males. Similarly, white females were observed to have strongly elevated risk of obesity in the “persistent disadvantage” group and weaker associations in “disadvantage with autonomy,” suggesting a much more harmful influence of the single-mother, unstable poor SES pattern in these females. In black females, the only notable association was observed among the LCA groups, i.e. for “disadvantage with autonomy,” suggesting that the “stable low” group likely comprised a

blend of different types of disadvantaged young adults of differing obesity risk, thus reducing the ability of the traditional classification scheme to find any adverse associations.

3. Implications for conceptual models of life course SES and health

Although classic studies of life course SES and disease select one of several competing life course conceptual models (e.g. critical period, social trajectory and cumulative SES frameworks) to prove or disprove in a given dataset for their particular outcome (Pollitt, Rose et al. 2005), the current trend has involved the simultaneous testing of several of these competing hypotheses. However, mutual exclusivity remained the implicit assumption, such that only one of these conceptual models could be “correct” for a given outcome, until a very recent set of papers asserted that a.) these competing hypotheses cannot feasibly be disentangled (Hallqvist, Lynch et al. 2004), and b.) it is not clearly necessary to do so. Rosvall et al. found that statistical models of SES and mortality using three different conceptual models had a similar fit, concluding that none could be considered “superior,” and further, each provided slightly different yet useful information that could be combined to build a more complete story of the association between SES and health (Rosvall, Chaix et al. 2006). This perspective influences our overall interpretation of the current study.

We heavily relied on the social mobility and cumulative SES frameworks in the life course literature to conceptualize our use of LCA to combine parental SES with young adult SES into distinct groups. However, the complexity of SES exposure patterns identified and their strong associations with an important health outcome suggests that the techniques used in our work extend these frameworks in new and innovative directions. That is, our use of latent class analysis demonstrated an alternative and perhaps enhanced approach to using the

“cumulative” life course SES framework for studying health. These LCA groups permit classification based on a multidimensional and cross-generational set of SES characteristics, thus capturing heterogeneity in the cumulative SES experience of young adults. However, our results also suggest that the traditional social mobility approach is not completely at odds with the LCA results, since clearly disadvantaged SES groups defined using both approaches were generally at higher risk of obesity. Furthermore, among females of most racial/ethnic backgrounds, the “stable high” had a lower predicted obesity risk than the “stable low,” while both mobility groups generally had intermediate obesity prevalence (data not shown; for ease of presentation we showed a similar though less consistent results in males), supporting the cumulative framework used to define the LCA groups.

4. Limitations and Strengths

This study was not without limitations. Conceptually, we recognize that our application of life course theory to a relatively short time period may be questionable, since the scale of typical such research spans decades. However, we nevertheless defined an early life course measure of SES exposure because we combine parental SES information during the respondents’ adolescence (Wave I) with SES of the respondents themselves as young adults (Wave III), thus making an important cross of generations. Furthermore, while the time between these assessments is fairly short (approximately five years), dramatic and complex transitions in schooling, employment, residence and social roles during this period generate considerable variability in SES that warrants focused investigation. The traditional approach is likely to be most affected by this abridged period of study because the simple measures of income and education used to define mobility are not likely to adequately

represent the SES for young adults who have not yet completed their schooling or other training, which in fact provides greater support for the LCA approach.

In a similar vein, we acknowledge that the age range of our sample is relatively wide, from the perspective of this dynamic transitional period, and thus it is likely that older respondents have had a greater opportunity to define their own SES than have younger respondents. Although we partially addressed this by controlling for age in multivariate models of obesity, we expected that SES groups defined using the traditional social mobility approach would still be affected by this differential age effect. We thus explored an alternative specification of young adult SES to define social mobility groups, using a measure of years of education relative to same age peers, but found little difference in the end results (data not shown). In contrast, we did not expect age to be problematic for the LCA groups due to the large number of items summarizing multiple dimensions of SES that are relevant to young adulthood.

Methodologically, we recognize that the results of latent class analysis are contingent on the variables entered into the latent class model. However, inclusion of a large set of parental and young adult SES indicators covering a breadth of domains consistent with established theory (Krieger, Williams et al. 1997; Oakes and Rossi 2003) and the nationally representative sample provide confidence in our results. Moreover, our intention was primarily to explore hypotheses about the definition of SES in young adults and potential associations with health. Study strengths include the large population size, the wide range of data on SES indicators, and the ability to make nationally representative estimates. Furthermore, in contrast to many life course studies, the data were collected prospectively, such that we have little concern for recall bias.

5. Conclusion

LCA is a useful method for summarizing multiple dimensions of SES across generations that provides a more nuanced set of relationships with health than is permitted by a traditional approach to characterizing life course SES patterns. Of greatest importance, LCA provides a unique solution to the problems of capturing cumulative SES exposure during the understudied, complex transition from adolescence to adulthood.

Table 4. Demographic and background data on longitudinal analysis sample (N=13,432) from Wave I (1994-1995) and Wave III (2000-2001) of the National Longitudinal Study of Adolescent Health*

| Characteristic | Total (n=13,432) | |
|---------------------------------------|-----------------------------------|----------------|
| Mean age (Wave III) | Years (SE) 21.8 (0.1) | |
| Female | % (SE) 47.9 (0.6) | |
| White | 68.4 (2.9) | |
| Black | 15.8 (2.1) | |
| Hispanic | 11.8 (1.7) | |
| Asian | 4.0 (0.8) | |
| Young adult obesity (Wave III) | Total % (SE) 22.7 (0.8) | |
| | Males | Females |
| White | 21.0 (1.0) | 21.9 (1.3) |
| Black | 24.1 (1.7) | 34.7 (2.0) |
| Hispanic | 21.2 (1.6) | 27.8 (1.9) |
| Asian | 17.5 (3.4) | 9.6 (2.5) |

*Weighted and corrected for clustering to generate nationally representative estimates.

Table 5. Model fit for 1-7 class specification of latent class analysis model

| Number of classes | Log Likelihood | Number of parameters | BIC* |
|--------------------------|-----------------------|-----------------------------|-------------|
| 1 | -461408 | 35 | 923151 |
| 2 | -448424 | 66 | 897479 |
| 3 | -443729 | 97 | 888385 |
| 4 | -438166 | 128 | 877556 |
| 5 | -435678 | 159 | 872878 |
| 6 | -433783 | 190 | 869385 |
| 7 | -432225 | 221 | 866565 |

*BIC = Bayesian Information Criterion

Table 6. Latent class membership probabilities and conditional response probabilities for variables used in latent class analysis of life course SES in the longitudinal sample with weights (N=14,322) from the National Longitudinal Study of Adolescent Health

| | Persistent disadvantage n=2,713 (18.9%) | Disadvantage with autonomy n=2,293 (16.0%) | Material advantage n=3,913 (27.3%) | Educational advantage n=1,962 (13.7%) | Highest overall advantage n=3,442 (24.0%) | Total n=14,322* (100%) |
|-------------------------------------|--|---|---|--|--|-------------------------------------|
| Parental SES | | | | | | |
| <i>Continuous variables</i> | | | | | | |
| Income (thousands) | 19.7 (0.8) | 31.1 (1.1) | 43.5 (1.0) | 35.4 (1.4) | 72.8 (2.9) | 43.0 (1.4) |
| Hrs work/wk –Mom | 27.5 (0.9) | 29.0 (0.8) | 31.5 (0.5) | 36.2 (0.9) | 31.8 (0.7) | 31.3 (0.3) |
| Hrs work/wk –Dad | 0.63 (0.1) | 45.2 (0.4) | 46.2 (0.3) | 0.70 (0.1) | 46.2 (0.4) | 31.1 (0.7) |
| <i>Binary/Categorical variables</i> | | | | | | |
| Two parent household | 0.09 | 0.74 | 0.75 | 0.09 | 0.87 | 0.56 |
| Insurance 12 months | 0.64 | 0.65 | 0.86 | 0.85 | 0.97 | 0.81 |
| Public Assistance | 0.67 | 0.31 | 0.17 | 0.27 | 0.06 | 0.27 |
| Social capital | 0.27 | 0.29 | 0.50 | 0.61 | 0.79 | 0.51 |
| Mom Professional | 0.09 | 0.08 | 0.14 | 0.35 | 0.49 | 0.23 |
| Dad Professional | 0.07 | 0.07 | 0.09 | 0.22 | 0.53 | 0.24 |
| Mom ed <HS | 0.36 | 0.58 | 0.00 | 0.04 | 0.02 | 0.17 |
| Mom ed HS grad | 0.58 | 0.35 | 0.92 | 0.66 | 0.40 | 0.60 |
| Mom ed Some college | 0.06 | 0.07 | 0.08 | 0.30 | 0.58 | 0.23 |
| Dad ed <HS | 0.35 | 0.64 | 0.00 | 0.07 | 0.02 | 0.17 |
| Dad ed HS grad | 0.58 | 0.22 | 1.00 | 0.61 | 0.24 | 0.45 |
| Dad ed Some college | 0.04 | 0.10 | 0.00 | 0.22 | 0.40 | 0.55 |
| Dad ed Grad/Prof | 0.03 | 0.04 | 0.00 | 0.10 | 0.34 | 0.16 |
| Young adult SES | | | | | | |
| <i>Continuous variables</i> | | | | | | |
| Income (thousands) | 11.4 (0.6) | 13.9 (0.7) | 14.6 (0.5) | 13.8 (0.6) | 13.1 (0.6) | 13.4 (0.4) |

| | Persistent disadvantage n=2,713 (18.9%) | Disadvantage with autonomy n=2,293 (16.0%) | Material advantage n=3,913 (27.3%) | Educational advantage n=1,962 (13.7%) | Highest overall advantage n=3,442 (24.0%) | Total n=14,322* (100%) |
|--|--|---|---|--|--|-------------------------------------|
| Years of education | 11.6 (0.1) | 12.1 (0.1) | 12.9 (0.1) | 13.8 (0.2) | 14.6 (0.1) | 13.0 (0.1) |
| <i>Binary/categorical variables</i> | | | | | | |
| Manual occupation | 0.19 | 0.23 | 0.20 | 0.07 | 0.05 | 0.15 |
| Sales/service occupation | 0.36 | 0.35 | 0.38 | 0.41 | 0.35 | 0.37 |
| Managerial occupation | 0.07 | 0.13 | 0.17 | 0.26 | 0.27 | 0.18 |
| No job | 0.38 | 0.29 | 0.25 | 0.26 | 0.33 | 0.30 |
| Ever married | 0.22 | 0.28 | 0.22 | 0.15 | 0.09 | 0.19 |
| Live with parent | 0.40 | 0.44 | 0.45 | 0.37 | 0.37 | 0.41 |
| Income from family | 0.27 | 0.29 | 0.34 | 0.46 | 0.62 | 0.40 |
| In school (high ed) | 0.09 | 0.17 | 0.30 | 0.50 | 0.64 | 0.35 |
| In vocational school | 0.29 | 0.26 | 0.28 | 0.22 | 0.14 | 0.24 |
| Savings account | 0.40 | 0.55 | 0.65 | 0.72 | 0.77 | 0.62 |
| Credit card | 0.30 | 0.48 | 0.58 | 0.74 | 0.75 | 0.58 |
| Own residence | 0.13 | 0.17 | 0.16 | 0.12 | 0.08 | 0.13 |
| Hardship | 0.58 | 0.43 | 0.35 | 0.33 | 0.22 | 0.37 |
| Health insurance | 0.56 | 0.63 | 0.77 | 0.82 | 0.93 | 0.75 |
| Social Capital | 0.15 | 0.20 | 0.24 | 0.40 | 0.50 | 0.30 |

*N=14,322 is larger than final multivariate modeling sample shown in Tables 4, 7 and 8 because maximum likelihood methods in LCA software permitted retention of full sample with weights, whereas exclusions and listwise deletion of observations with missing values reduced sample size for final analyses using multivariate models

Table 7. Racial/ethnic distribution of life course SES groups in longitudinal analysis sample (N=13,432) from the National Longitudinal Study of Adolescent Health*

| | White n=7,370 | Black n=2,833 | Hispanic n=2,211 | Asian n=1,018 |
|-------------------------------|-------------------------|-------------------------|----------------------------|-------------------------|
| Life course SES groups | % (SE) | % (SE) | % (SE) | % (SE) |
| LCA groups | | | | |
| Persistent disadvantage | 13.6 (1.0) | 37.6 (2.5) | 22.5 (2.0) | 7.2 (1.8) |
| Disadvantage with autonomy | 12.9 (0.8) | 10.1 (1.0) | 39.0 (3.2) | 18.7 (2.9) |
| Material advantage | 31.1 (1.3) | 18.6 (1.1) | 17.0 (1.7) | 25.6 (3.2) |
| Educational advantage | 12.3 (0.4) | 23.3 (1.6) | 10.4 (1.1) | 13.8 (1.6) |
| Highest overall advantage | 30.1 (2.0) | 10.4 (1.7) | 11.1 (1.6) | 34.7 (3.1) |
| Social mobility groups | | | | |
| Stable low | 24.7 (1.9) | 46.3 (3.3) | 43.4 (2.8) | 19.5 (3.1) |
| Upwardly mobile | 17.1 (1.0) | 18.9 (1.6) | 26.4 (2.3) | 21.6 (2.5) |
| Downwardly mobile | 22.5 (1.3) | 17.2 (1.4) | 14.5 (1.8) | 25.5 (3.3) |
| Stable high | 35.7 (2.1) | 17.7 (2.7) | 15.7 (1.9) | 33.4 (4.1) |

*Weighted and corrected for clustering

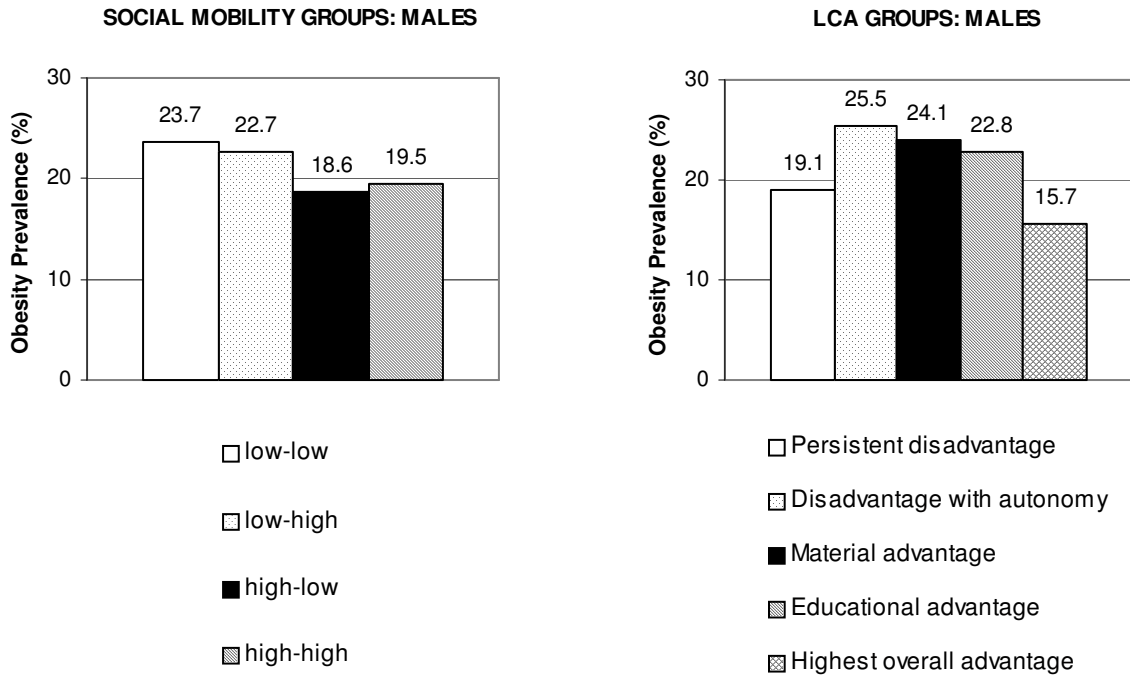
Table 8. The association between life course SES and young adult obesity prevalence in longitudinal analysis sample (N=13,432) from the National Longitudinal Study of Adolescent Health

| Life course SES groups | Males | Females ^a | | | |
|-------------------------------|-------------------|----------------------|-------------------|-------------------|-------------------|
| | | White | Black | Hispanic | Asian |
| LCA groups | | | | | |
| Persistent disadvantage | 1.21 (0.95, 1.54) | 2.85 (2.04, 3.97) | 1.30 (0.84, 2.00) | 2.76 (1.16, 6.59) | 4.79 (0.54, 42.8) |
| Disadvantage with autonomy | 1.62 (1.24, 2.12) | 2.71 (1.95, 3.76) | 1.56 (1.04, 2.35) | 1.82 (0.77, 4.31) | 0.77 (0.09, 6.94) |
| Material advantage | 1.54 (1.24, 1.89) | 2.18 (1.60, 2.96) | 1.22 (0.77, 1.92) | 2.25 (0.92, 5.53) | 3.28 (0.74, 14.6) |
| Educational advantage | 1.45 (1.12, 1.88) | 1.66 (1.22, 2.27) | 1.25 (0.81, 1.93) | 1.24 (0.45, 3.41) | 4.65 (1.15, 18.7) |
| Highest overall advantage* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Social mobility groups | | | | | |
| Stable low SES | 1.21 (1.01, 1.46) | 1.98 (1.57, 2.51) | 1.17 (0.89, 1.54) | 2.51 (1.41, 4.48) | 2.09 (0.64, 6.81) |
| Upward SES mobility | 1.17 (0.96, 1.41) | 1.54 (1.20, 1.98) | 0.95 (0.71, 1.27) | 2.19 (1.20, 4.00) | 0.28 (0.04, 2.13) |
| Downward SES mobility | 0.95 (0.78, 1.16) | 1.13 (0.88, 1.46) | 1.08 (0.77, 1.52) | 2.30 (1.11, 4.78) | 1.19 (0.34, 4.14) |
| Stable high SES* | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*"Highest overall advantage" was selected to be the referent category for the LCA groups because of the clearly advantaged pattern of SES exposure for members of that group; "Stable high SES" was selected as the social mobility referent.

^aSignificant interactions (p<0.10) between race/ethnicity and the life course SES group membership variable were observed in females and used to calculate racial/ethnic-stratified estimates of the relative risk of young adult obesity.

Figure 3. Predicted* obesity prevalence for young adult males (Add Health Wave III; 2000-2001) across life course SES groups



*Coefficients from Poisson regression model in males were used to predict the probability of young adult (Wave III) obesity for each life course SES category, setting other SES groups equal to zero and the age equal to the sample mean (22 years).

VI. Obesity, race/ethnicity and life course socioeconomic status across the transition from adolescence to adulthood

A. Introduction

The higher rates of obesity in racial/ethnic minorities have often been linked to their disproportionate representation in low socioeconomic status (SES) groups of elevated obesity risk (Sobal and Stunkard 1989; Ogden, Carroll et al. 2006). However, there is growing evidence that the simple inverse relationships between SES and obesity do not apply in racial/ethnic minorities (Kimm, Obarzanek et al. 1996; Gordon-Larsen, Adair et al. 2003). The life course perspective, which posits that social factors acting early in life accumulate and/or interact with factors in later life to influence adult health (Lynch, Kaplan et al. 1997; Smith and Hart 2002; Kuh, Ben-Shlomo et al. 2003), can help elucidate the complex relationship between race/ethnicity, SES and obesity. One life course stage of particular risk of obesity development is the transition from adolescence to adulthood, characterized by dramatic obesity incidence as well as divergent racial/ethnic trends (De Spiegelare, Dramaix et al. 1998; Gordon-Larsen, Adair et al. 2004).

The role of SES in racial/ethnic disparities across the transition to adulthood has been largely understudied due to several methodological challenges. First, traditional SES indicators are likely to misclassify the true SES of young adults because of delayed transitions in schooling, residence, employment and social roles (Shanahan, Porfeli et al. 2004). Second, research on this topic typically uses a single, static measure of parental SES

and thus misses the complex changes in social status that occur. Third, most of the longitudinal research on SES and obesity uses a “social mobility” framework to combine SES information into trajectories of income, education or occupation over two time points (Pollitt, Rose et al. 2005), but findings are relatively inconsistent (Langenberg, Hardy et al. 2003; Ball and Mishra 2006) with few studies in racial/ethnic minorities (James, Fowler-Brown et al. 2006; Bennett, Wolin et al. 2007).

In this study, we examined the relationship of SES with obesity in a racial/ethnically diverse sample of adolescents followed over five years into adulthood. Profiles of SES exposure over this early life course period were identified using latent class analysis (LCA), a person-centered, model-based technique that defines groups with distinct patterns of responses to multiple observed indicators (Lazarsfeld and Henry 1968; McCutcheon 1987). We hypothesized that there would be racial/ethnic differences in the associations of life course SES groups with obesity development across the transition from adolescence to adulthood.

B. Subjects and Methods

1. 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 school-aged youth (grades 7-12 at Wave I: 1994-1995), followed with multiple interview waves into young adulthood (Wave III: 2001-2002). 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 (Harris,

Florey et al. 2003). The sample was drawn from the pool of young adults in Wave III with post-stratification sample weights (N=14,322), excluding seriously disabled or pregnant respondents. Our final analytic sample included 12,940 respondents (47% female) interviewed in both Waves I and III, comprising four major racial/ethnic groups: non-Hispanic whites (n=7,144), non-Hispanic blacks (n=2,693), Hispanics (n=2,113) and Asians (n=990), aged 18 to 28 years (mean=21.7 years) at Wave III. The excluded sample had a higher proportion of females and blacks.

2. *SES variables*

Our desire to capture the heterogeneity of SES combinations across generations was balanced by convergence difficulties of the latent class model as the number of items increase. We chose variables to represent three domains of SES that 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 and Rossi 2003). Eleven indicators of parental SES were generated using information from surveys of parents and adolescents from Wave I. Fourteen indicators of SES in young adulthood were defined using data from the Wave III survey (see Appendix). Given our prior work on SES during the transition to adulthood, we expanded our selection of variables to capture dimensions of particular relevance to young adults, including enrollment in higher education and measures reflecting transitions in social roles, residence and employment.

3. *Other variables*

Obesity patterns. Young adult (Wave III) obesity was defined using the adult BMI cut point for obesity (30 kg/m²) (NHLBI 1998). Self-reported height and weight measures were used to maximize sample size and comparability with the self-reported adolescent values from Wave I (Field, Aneja et al. 2007). To deal with the discrepant obesity definitions for adolescents versus adults, the International Obesity Task Force (IOTF) reference, which links childhood and adolescent BMI centiles to the adult BMI cut point, was used to classify obesity at Wave I (Cole, Bellizzi et al. 2000). For multivariate modeling, obesity incidence (non-obese at wave I, obese at wave III) and persistence (obese at both points) were contrasted with the low-risk referent (non-obese at both periods).

Demographics. Self-designated race/ethnicity from Wave I was used to classify respondents into mutually-exclusive categories of non-Hispanic white, non-Hispanic black, Hispanic and Asian or Pacific Islander, or white, black, Hispanic and Asian. Gender was self-reported at Wave III, and age was reported at the participant's last birthday at Wave III.

4. *Statistical analysis*

We hypothesized that racial/ethnic differences in the benefit conferred from high SES (e.g. racial/ethnic differences in the value of education, purchasing power for a given level of education, etc.) differentially impact associations with obesity development. Statistically, this translated into assessing the interaction of race/ethnicity with life course SES in models of obesity. Since we view early life course SES as a latent construct summarizing the cumulative SES experiences from birth through early adulthood, we combined the available

information from adolescence (Wave I) and young adulthood (Wave III) into a single measure.

Latent class analysis (LCA). LCA was used to identify the number, size and characteristics of latent classes necessary to capture the heterogeneity of life course SES experience in young adult respondents, summarizing the observed SES indicators by an unmeasured, discrete variable (Clogg 1995; Hageaars and McCutcheon 2002). These analyses were conducted using Mplus Version 4.0 (Muthen and Muthen 1998-2006), correcting for clustering of respondents and using post-stratification sample weights to account for unequal probability of selection (Asparouhov 2005).

The final latent class model was selected using several criteria, including: 1.) the visual plot of log-likelihoods across number of classes, 2.) the Bayesian Information Criterion (BIC), and 3.) interpretability of model solution parameters (Schwartz 1978; Nylund 2007). These criteria supported a 5-class model solution, correctly classifying 90 to 95% of individuals in each of the five latent classes. This final model solution was then used to classify respondents into latent classes or “life course SES groups” representing young adults who share a common profile of parental and young adult SES characteristics. For ease of presentation, these groups were re-ordered and assigned brief labels based on distinguishing characteristics.

Multivariate modeling of obesity patterns. Multinomial (polytomous) logistic regression models were used to estimate the likelihood of (1) becoming obese (incidence); (2) staying obese (persistence); or (3) becoming non-obese (reversal; n=227, results not

shown) relative to (4) staying non-obese (outcome referent) associated with life course SES group membership using Stata, version 9.2 (StataCorp 2007). Coefficients from these models were exponentiated to obtain estimates of the relative risk ratio (RRR) of each obesity outcome as a function of the SES group. Posterior probabilities of membership in each latent class or “group” were entered into the model as the categories of a nominal exposure variable, omitting the most advantaged group as the referent category, as has been done previously (Pastor, Barron et al. 2006). Given gender differences in obesity and in the influence of SES on obesity, all models were gender-stratified. Within gender, we assessed effect modification of the association between the each SES group and becoming obese, staying obese, or becoming non-obese by race/ethnicity to explicitly test whether there were racial/ethnic differences in the association of SES groups with specific obesity patterns. Only significant SES group by race interactions ($p < 0.10$ for Wald test of interaction terms) were retained. The coefficients from the statistical models were then used to predict age-adjusted obesity patterns for each life course SES category. Survey procedures in Stata were used in multivariate modeling to correct for unequal probability of selection and the underestimation of variance due to the clustered sample design.

C. Results

The salient characteristics of the five life course SES groups identified using latent class analysis are summarized in **Table 9**. Those in the “persistent disadvantage” group were the most likely to be economically deprived, coming from poor, single mother households in adolescence and maintaining the cycle of hardship into adulthood. The “disadvantage with autonomy” group also faced adversity in youth, with a high probability of two working

parents with low income and education, though as young adults, their income, likelihood of marrying and owning a home was higher than average. The “material advantage” group was likely to be from two-parent adolescent households and had the highest income, but only average education in young adulthood. Those in the “educational advantage” group were characterized by adolescent households with a highly educated, working single mother and high educational trajectories in young adulthood. The “highest overall advantage” group was the most well off, with the highest probability of having a professional two-parent household in adolescence and the highest education, occupation and financial access as young adults, though their income was average.

Table 10 highlights the differences in distribution across life course SES groups and obesity status by race/ethnicity. While whites and Asians were most likely to be in relatively advantaged groups, blacks had their highest proportions in “persistent disadvantage” and Hispanics were most represented in “disadvantage with autonomy.” The prevalence of obesity nearly doubled during the transition from adolescence (Wave I) to early adulthood (Wave III) for the total sample, with similar trends across race/ethnicity. Obesity incidence exceeded 10% for all except for Asians, with considerable persistence. Blacks had the highest trends, followed by Hispanics.

No significant interactions between life course SES and race/ethnicity were observed for obesity incidence in males ($p=0.38$) or females ($p=0.60$) or for obesity persistence. Interaction assessment across whites and blacks only (i.e. the subgroup for which we had data to detect interaction for all obesity patterns) revealed no significant black-white differences ($p>0.10$). Thus, **Table 11** presents results from race/ethnic-pooled, multinomial logistic regression models estimating the relative risk of obesity incidence and persistence

versus staying non-obese (outcome referent) across the transition from adolescence to adulthood. Estimates for each SES group are relative to “highest overall advantage” (exposure referent). “Disadvantage with autonomy” was the only group significantly associated with higher risk of obesity incidence for males (RRR=1.64; 95%CI: 1.12, 2.40). For females, in contrast, the estimates for all groups excluded the null, with strongly positive associations for membership in the “Persistent disadvantage” group (RRR=3.01, 95%CI: 1.95, 4.66), and approximately 2.5 times higher risk of incidence for females in both “material advantage” and “educational advantage” groups. In general, group membership had stronger relationships with obesity persistence than incidence.

The model results are further illustrated in **Figure 4**, which shows age-adjusted predicted probabilities of total young adult obesity, separated into obesity incidence and persistence. For males, the “disadvantage with autonomy” group was at highest risk of young adult obesity, whereas, members of “persistent disadvantage” had the second *lowest* predicted incidence and persistence. For females, in contrast, membership in “persistent disadvantage” conferred the highest overall risk of young adult obesity, though specific obesity patterns reveal that this sizeable risk was primarily due to substantial incidence.

Although a large proportion of both white and black females in the “persistent disadvantage” SES group experienced obesity incidence and persistence across the transition to adulthood, the overall risk for blacks was clearly higher (**Figure 5**). A similar pattern was seen for “highest overall advantage”; the privileged life course SES experience of this group did not protect equally across race/ethnicity, evidenced by considerably higher obesity for black versus white females.

D. Discussion

Using five distinct life course SES groups representing the heterogeneity of life course SES experience from adolescence to young adulthood, we observed persistent racial/ethnic disparities in obesity risk across SES groups. Although the strongly positive associations observed between “disadvantaged” life course SES experiences and obesity risk were consistent with the inverse relationships in the literature, our complex measure identified specific subtypes of disadvantage that differentially influence obesity risk for males (disadvantage with autonomy) versus females (persistent disadvantage). Furthermore, the stronger associations observed for obesity persistence versus incidence support the influence of complex SES patterns on obesity development earlier in the life course.

A growing body of literature on life course SES and obesity uses a social mobility framework, examining the influence of SES trajectories (e.g. upward, downward, stable) on obesity and weight gain. However, the most consistent findings from this research, i.e. an intermediate obesity risk for the mobile (versus stable high or stable low) groups (Langenberg, Hardy et al. 2003; Ball and Mishra 2006; James, Fowler-Brown et al. 2006), more clearly support a “cumulative” life course framework (Hart, Smith et al. 1998; Singh-Manoux, Ferrie et al. 2004). This framework, which posits that the impact of negative SES experiences accumulate over time to influence adult disease risk, may be better suited for studying racial/ethnic minorities since they are likely to face a cumulative burden of socioeconomic adversity over the entire life course (Baltrus, Lynch et al. 2005). However, the SES index used in typical cumulative studies necessitates the tenuous assumption that specific negative life experiences have the same impact, regardless of type or when they occur (Hallqvist, Lynch et al. 2004; Pollitt, Rose et al. 2005). Our study used latent class

analysis to overcome these assumptions, permitting cumulative characterization of young adults on a large set of SES indicators at multiple time points.

We expected racial/ethnic minority respondents would not receive the same health benefits from SES as whites, given the societal discrimination that devalues SES attainment in minorities (Williams 1997; Luo and Waite 2005). Racial/ethnic differences in the value of an equivalent level of education, purchasing power for a given level of income, and so forth suggest that the same level of SES has different meaning by race/ethnicity, as has been documented in the literature on SES in US adults (Kaufman, Cooper et al. 1997; Braveman, Cubbin et al. 2005). Thus, we hypothesized that societal discrimination would restrict the ability of racial/ethnic minorities to translate advantaged early life course SES into better health, i.e. reduced risk of obesity development. However, in contrast to our central hypothesis, interactions of race/ethnicity with life course SES were not statistically significant for any longitudinal obesity patterns, and therefore we could not reject the possibility that the association between SES and obesity is the same across race/ethnicity. From a social perspective, this potential for minimal racial/ethnic differences in the health benefits of SES during the transition from adolescence to adulthood provides a promising contrast to the literature in adults. From a methodological perspective, it is possible that our notably complex and intergenerational measure of life course SES captured a substantial proportion of the heterogeneity between racial/ethnic groups, thus minimizing differences in association with obesity. Alternatively, correlation between race/ethnicity and life course SES suggests that stratification on race/ethnicity may have reduced our power to detect heterogeneity via interaction tests.

Regardless, we observed enduring racial/ethnic disparities. The overall burden of obesity was consistently higher in historically underprivileged racial/ethnic minorities (black and Hispanic) versus whites across several life course SES groups, including those heavily represented by minorities (e.g. “persistent disadvantage”). This suggests that SES and non-SES related factors not captured in our measure might influence racial/ethnic differences in obesity patterns starting earlier than our adolescent assessment. Regardless of race/ethnicity, the stronger relationships observed for persistence versus incidence suggest that many of the SES characteristics summarized by these groups started influencing the process of obesity development prior to adolescence and supported the maintenance of that process during the transitional period.

Despite the considerable hardship for the “persistent disadvantage” and “disadvantage with autonomy” groups, only the latter were notably associated with considerable predicted obesity for both males and females, while “persistent disadvantage” conferred substantial obesity risk (incidence, primarily) for females only. Members of “disadvantage with autonomy” came from working poor, two-parent households in adolescence, and appeared to grow up fast, i.e. a high proportion were married, less educated and earning income in manual occupations as young adults. These underprivileged yet busy lifestyles seemed to confer similarly elevated risk of obesity for males and females. In contrast, given the strong influence of maternal SES on weight change in young adult women (Ball and Mishra 2006), it is possible that females in the “persistent disadvantage” group, characterized by impoverished, single-mother households in adolescence, modeled improper weight loss or dieting attempts on their lower SES mothers, resulting in dramatic obesity incidence.

Our study has many strengths, including: the use of the complex LCA methodology to classify life course SES exposure, a diverse sample and detailed parental and adolescent data from an understudied life cycle period known for high obesity risk. However, it is important to be aware that the groups identified by LCA are driven by theoretical constructs; although individuals can be allocated to their most likely group using posterior probabilities from the LCA model, the majority of individuals have a non-zero probability of membership in every group identified. Further, there remains some individual variability within these groups, such that the patterns described may be less accurate for a small number of individuals in each group. Other limitations include use of self-reported height and weight values, which were necessary to maximize sample size and maintain comparability across surveys. However, the Add Health self-report values have been shown to correctly classify a large proportion of the respondents (Goodman, Hinden et al. 2000). Further, since our parental SES indicators are assessed during adolescence and thus can only approximate earlier exposure to socioeconomic conditions, and since obesity development is a process that unfolds over time, we are unable to fully capture the influence of early SES experiences on early obesity. That said, our examination of longitudinal obesity patterns does disentangle influences that occur during the transition to adulthood as opposed to before adolescence.

Overall, we observed interesting gender differences in the type of disadvantaged SES exposure most associated with obesity risk, underscoring the importance of examining complex characterizations of life course SES in the study of health risk. The observed absence of differences in association between our SES measure and obesity patterns by race/ethnicity suggests there are minimal racial/ethnic differences in the health benefits of SES during the transition to adulthood, a promising contrast to the literature in older adults.

The stronger associations with persistence and enduring racial/ethnic disparities in obesity risk across SES groups suggests that the characteristics captured by these groups and other unmeasured social factors play a larger role in disparities earlier in the life course.

Table 9. Brief description of life course SES groups defined using latent class analysis in longitudinal analysis sample (N=12,940) from Wave I (1994-1995) and Wave III (2000-2001) of the National Longitudinal Study of Adolescent Health

| Life course SES | % (n) | Description |
|--|------------------|---|
| Persistent disadvantage Age (yrs): 22.1 Female (%): 45.6 | 17.7 (2,223) | Parental SES <ul style="list-style-type: none"> • Low income, low education, single mother • No health insurance, receiving public assistance Young adult SES <ul style="list-style-type: none"> • Low income, low education, attend vocational school • Low health insurance, limited financial access |
| Disadvantage with autonomy Age (yrs): 22.1 Female (%): 44.9 | 15.0 (2,057) | Parental SES <ul style="list-style-type: none"> • Low income, less than HS education, two parents • Manual occupation, low health insurance Young adult SES <ul style="list-style-type: none"> • Middle/high income, low education • Low insurance, married, own home |
| Material advantage Age (yrs): 21.7 Female (%): 44.1 | 28.5 (3,438) | Parental SES <ul style="list-style-type: none"> • Middle income, HS educated, two parents • Minimal hardship, average social capital Young adult SES <ul style="list-style-type: none"> • High income, average education, minimal hardship • Attend vocational school or college |
| Educational advantage Age (yrs): 21.9 Female (%): 53.2 | 13.8 (1,989) | Parental SES <ul style="list-style-type: none"> • Middle income, middle/high education, single mother • Minimal hardship, high social capital Young adult SES <ul style="list-style-type: none"> • Middle income, middle/high education • Sales or service occupations, high social capital |
| Highest overall advantage Age (yrs): 21.7 Female (%): 59.9 | 25.0 (3,223) | Parental SES <ul style="list-style-type: none"> • High income, advanced education, two parents • Prof. occupation, high insurance, low assistance Young adult SES <ul style="list-style-type: none"> • Middle income, high education, managerial/prof. • High health insurance, high financial access |

Table 10. Distribution of life course SES groups and obesity characteristics across race/ethnicity in longitudinal analysis sample (N=12,940) from Wave I (1994-1995) and Wave III (2000-2001) of the National Longitudinal Study of Adolescent Health*

| Characteristic | Total n=12,940 | Race/ethnicity % (SE) | | | |
|-------------------------------------|-------------------|-----------------------|-------------------------|-------------------------|-------------------------|
| | | White n=7,144 | Black n=2,693 | Hispanic n=2,113 | Asian n=990 |
| Life course SES | | | | | |
| Persistent disadvantage | 17.7 (1.2) | 13.4 (1.0) | 36.2 (2.6) ^c | 22.3 (2.1) ^c | 7.2 (1.8) ^c |
| Disadvantage with autonomy | 15.0 (0.9) | 12.7 (0.8) | 10.0 (1.0) ^c | 38.5 (3.0) ^c | 18.8 (2.9) |
| Material advantage | 28.5 (1.2) | 31.1 (1.4) | 19.1 (1.1) ^c | 17.3 (1.7) ^c | 25.2 (3.0) |
| Educational advantage | 13.8 (0.5) | 12.4 (0.5) | 24.0 (1.6) ^c | 10.5 (1.1) | 13.6 (1.6) |
| Highest overall advantage | 25.0 (1.8) | 30.4 (2.1) | 10.6 (1.7) ^c | 11.4 (1.6) ^c | 35.1 (3.1) |
| Obesity status^a | | | | | |
| Adolescent obesity | 8.7 (0.4) | 7.9 (0.5) | 12.6 (0.9) ^c | 9.8 (1.1) | 4.0 (1.4) ^c |
| Young adult obesity | 18.3 (0.7) | 16.9 (0.9) | 24.9 (1.5) ^c | 20.3 (1.3) ^c | 11.2 (2.5) ^c |
| Obesity patterns^b | | | | | |
| Obesity incidence (-/+) | 11.4 (0.5) | 10.6 (0.6) | 15.0 (1.2) ^c | 12.7 (1.1) | 7.7 (1.5) |
| Obesity persistence (+/+) | 6.9 (0.4) | 6.3 (0.5) | 9.9 (0.8) ^c | 7.6 (0.7) | 3.5 (1.3) ^c |
| Obesity reversal (+/-) | 1.8 (0.2) | 1.6 (0.2) | 2.7 (0.5) ^c | 2.2 (0.6) | 0.5 (0.2) ^c |
| Stay non-obese (-/-) | 79.9 (0.7) | 81.5 (0.9) | 72.4 (1.3) ^c | 77.5 (1.5) ^c | 88.3 (2.6) ^c |

*Weighted and corrected for clustering

^aAdolescent obesity assessed at Wave I; Young adult obesity assessed at Wave III

^bLongitudinal obesity patterns summarized as follows: “-“ represents non-obese and “+” represents obese in the format “(Wave I/Wave III)”

^cp<0.05 for within-latent class difference between “white” and indicated race/ethnicity

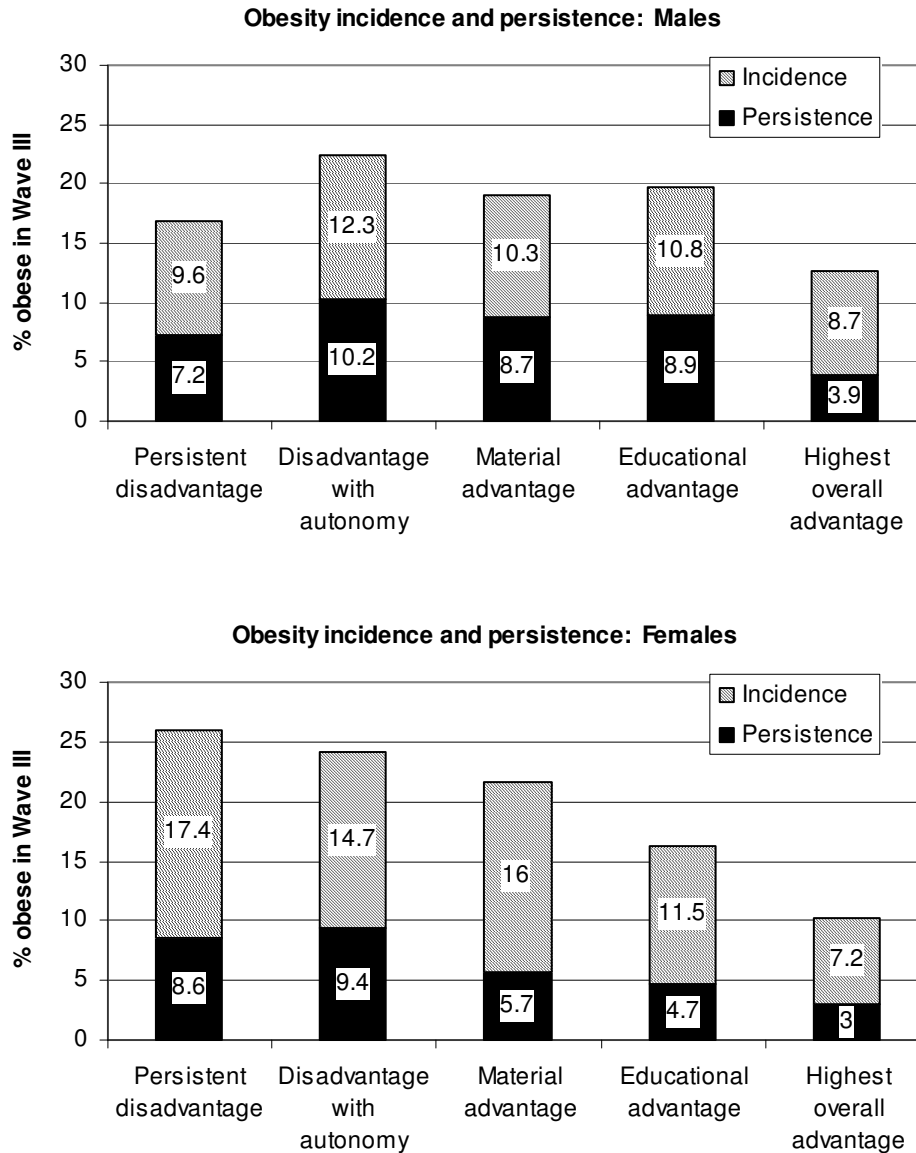
Table 11. Estimated associations between life course SES and obesity patterns from multinomial logistic regression models* in longitudinal analysis sample (N=12,940) from Wave I (1994-1995) and Wave III (2000-2001) of the National Longitudinal Study of Adolescent Health

| Life course SES | RRR (95% CI) ^a | |
|----------------------------|---------------------------|---------------------|
| | Obesity Incidence | Obesity Persistence |
| Males | | |
| Persistent disadvantage | 1.18 (0.82, 1.70) | 1.98 (1.25, 3.15) |
| Disadvantage with autonomy | 1.64 (1.12, 2.40) | 3.02 (1.82, 5.03) |
| Material advantage | 1.31 (0.88, 1.95) | 2.45 (1.61, 3.73) |
| Educational advantage | 1.38 (0.90, 2.11) | 2.51 (1.49, 4.24) |
| Highest overall advantage | 1.00 | 1.00 |
| Females | | |
| Persistent disadvantage | 3.01 (1.95, 4.66) | 3.56 (2.01, 6.30) |
| Disadvantage with autonomy | 2.42 (1.64, 3.58) | 3.71 (2.03, 6.77) |
| Material advantage | 2.58 (1.79, 3.71) | 2.17 (1.19, 3.96) |
| Educational advantage | 1.73 (1.10, 2.73) | 1.69 (0.95, 3.01) |
| Highest overall advantage | 1.00 | 1.00 |

*Gender-stratified, age-adjusted multinomial logistic regression models estimating relative risk ratio of obesity incidence (becoming obese from Wave I to Wave III) or obesity persistence (staying obese from Wave I to Wave III) versus staying non-obese (outcome referent) across the transition from adolescence to adulthood associated with membership in each life course SES group versus “highest overall advantage” (exposure referent)

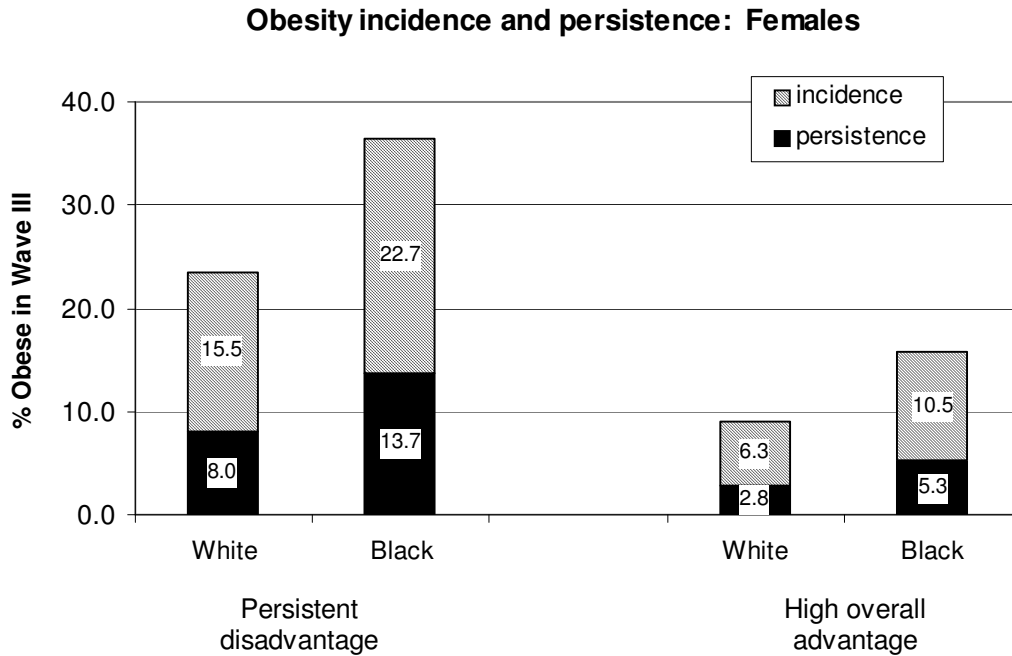
^aRRR: Relative risk ratio, CI: Confidence interval

Figure 4. Predicted* total young adult obesity, split into incidence and persistence from Wave I (1994-1995) to Wave III (2000-2001) for males and females from the National Longitudinal Study of Adolescent Health, across life course SES groups



*Coefficients from multinomial logistic regression models estimating relative risk of longitudinal obesity patterns in males and females were used to predict the probability of obesity incidence (becoming obese from Wave I to Wave III) and persistence (staying obese from Wave I to Wave III), for a 22-year old of specified race/ethnicity and life course SES groups, holding all other variables constant.

Figure 5. Predicted* longitudinal obesity patterns from Wave I (1994-1995) to Wave III (2000-2001) for white and black females from the National Longitudinal Study of Adolescent Health, across selected life course SES groups



*Coefficients from multinomial logistic regression models estimating relative risk of longitudinal obesity patterns in males and females were used to predict the probability of obesity incidence (becoming obese from Wave I to Wave III) and persistence (staying obese from Wave I to Wave III), for a 22-year old of specified race/ethnicity and life course SES groups, holding all other variables constant.

VII. Synthesis

A. Context and contribution

This work was primarily motivated by literature showing the persistence of racial/ethnic disparities in obesity at the same levels of income or education, suggesting that these measures of SES were not adequately capturing the dimensions of status and resources on which minorities were at greater disadvantage, and/or that unmeasured, non-SES factors reflecting societal forces were increasing the risk of obesity for minorities relative to whites. Since the parent study, the National Longitudinal Study of Adolescent Health (Add Health), was not designed to assess the macro-level forces, such as institutionalized racism, that could adversely influence the health of racial/ethnic minority groups, we avoided these and other inferential pitfalls of attempting to “explain” race disparities in obesity by SES alone.

However, the Add Health study has a wealth of SES data during the understudied transition to adulthood, including a wide range of indicators of parental SES in adolescence and the respondent’s own SES in young adulthood. We used these indicators to define multidimensional and inter-generational measures of SES that captured aspects of status and resources relevant for this complex transitional period, facilitating the identification of specific dimensions and patterns of SES over the early life course that strongly influence obesity risk in young adults. This work also revealed differences in association by race/ethnicity (and in some cases, an important lack of differences), enhancing understanding

of racial/ethnic differences in the “meaning” of SES as reflected in health benefits conferred by higher SES.

A related motivation for this study was borne of preliminary work (corroborating previously published findings on this dataset) showing that racial/ethnic disparities in obesity during the transition to adulthood were actually wider at higher levels of parental income and education, suggesting that the inverse relationships between SES and obesity observed in predominantly white populations did not uniformly hold for racial/ethnic minority adolescents in the US. These minorities experienced “diminishing returns” on higher parental SES, that is, they could not translate better socioeconomic conditions into better health (reduced obesity). This empirical evidence extends the economic literature on racial/ethnic differentials in the translation of educational attainment into material resources to the study of the impact of these differentials on health.

Given the dramatic increase in racial/ethnic disparities in obesity during the complex transition to adulthood, our study makes an important contribution to this area of research by investigating racial/ethnic differences in the relationships between comprehensive measures of SES over the early life course and obesity development. More detailed knowledge on racial/ethnic differentials in translating SES into reduced obesity risk across the transition to adulthood provides important information for the targeting of interventions to reduce racial/ethnic disparity by identifying specific SES dimensions or patterns most likely to have differential impact on the obesity risk of certain racial/ethnic groups as well as those that influence all groups, as detailed in the following sections.

B. Overview of findings

The overarching objective of this research was to investigate racial/ethnic differences in the dynamic association between socioeconomic status (SES) and the development of obesity across the transition from adolescence to adulthood using a nationally representative, racial/ethnically diverse sample from multiple survey waves of Add Health. We took advantage of the detailed data on: 1) SES in adolescence from parental and adolescent interviews in Wave I, and 2) SES that respondents created for themselves as young adults in Wave III, to identify comprehensive SES measures of particular relevance and utility for understanding racial/ethnic disparities in obesity risk during this complex transitional period.

Our first study focused on the young adult context, using exploratory factor analysis to define a multidimensional measure of young adult SES and characterizing racial/ethnic differences in the associations of these transition-relevant SES dimensions with obesity prevalence in young adulthood. For the remaining work, we expanded our focus to the longitudinal context, taking a life course perspective on SES and obesity development across the transition to adulthood. The second study used latent class analysis to identify groups with distinct patterns of SES exposure using indicators of both parental and young adult SES to characterize early life course SES. To illustrate the benefit of this approach, we compared these longitudinal SES exposure groups with traditional, limited combination measures of social mobility in predicting young adult obesity prevalence. Our final study investigated associations of these life course SES groups with longitudinal patterns of obesity (e.g. incidence, persistence) across the transition to adulthood. Specifically, we were interested in whether these relationships substantively differed by race/ethnicity, and thus might provide insights on racial/ethnic differences in the timing of SES influence on obesity development. Below, we briefly summarize our findings and provide a synthesis of our overall research.

1. Obesity, race/ethnicity and the multiple dimensions of socioeconomic status during young adulthood: A factor analysis approach

We used exploratory factor analysis to define SES in a diverse sample of US young adults (mean age = approximately 22 years), with the hypothesis that this measure would capture a number of SES dimensions of particular relevance during young adulthood. We then examined the association of this multidimensional SES measure with obesity in young adulthood, with the hypothesis that relationships would differ by race/ethnicity.

Four factors (Social capital; Schooling; Employment; and Economic hardship) were extracted from a principal factor analysis on 38 young adult SES indicators covering the spectrum of material, human and social capital, supporting the hypothesized multidimensionality of the SES construct during young adulthood. Furthermore, racial/ethnic variation was observed in scores for several factors, particularly in males.

Scores on these four SES dimensions were then 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 on each factor. The “Schooling” factor was significantly protective for females of all racial/ethnic groups, suggesting that efforts to increase enrollment in higher education, while beneficial in many respects, may also have a positive impact on obesity rates. The associations of the “Social capital” and “Economic hardship” factors with obesity differed by race/ethnicity ($p < 0.05$ for Wald test of interaction) in females. High social capital was inversely associated with obesity in white and Hispanic females (9-20% lower), but not black females, suggesting that the “diminishing returns” hypothesis, i.e. little reduction in obesity at higher SES as extended to this more complex SES measure, may in fact only apply to blacks. High scores on economic hardship were

positively associated with obesity (7-76% higher) in white and Asian females. The absence of strong associations for this factor in black and Hispanic females suggests that a history of such adverse conditions may have already exerted its influence in these groups on the development of adolescent obesity, which was controlled in the final models. These findings 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 may increase obesity risk early in life, as supported by their high rates of obesity in adolescence. Overall, these results facilitated understanding of the impact of multiple, distinct SES dimensions during the complex transition to adulthood and thus provided salient information for reducing racial/ethnic disparity in obesity during this important period for obesity development.

2. The use of latent class analysis to define patterns of life course socioeconomic status across the transition from adolescence to adulthood

Typical combinations of parental and young adult SES information are based on a “social mobility” framework, focusing on changes in SES. However, these measures are usually limited in the number of time points, indicators, and indicator categories, thus lacking sufficient detail to truly characterize heterogeneous life course SES exposure. We used a model-based Latent Class Analysis (LCA) framework to characterize five distinct life course SES groups with finer detail than permitted by these traditional methods of combining SES information. These groups captured heterogeneity in income, education and occupation of the parents and young adults, as well as family structure, public assistance, social capital and other indicators tapping multiple SES dimensions over the life course. To our knowledge, this is the first study to attempt a typology of early life course SES exposure in this manner;

although fairly common in the classification of depression, smoking, eating disorders and other complex behaviors, the latent variable approach has not yet gained popularity in the study of life course SES and health, despite indications that multidimensional methods could improve understanding of these complex relationships.

The LCA method summarized heterogeneity in the clustering of adolescent and young adult SES characteristics, providing a detailed picture of what defines “(dis)advantage” in terms of cumulative life course SES exposure for young adults. For instance, LCA identified two distinct groups characterized by a single mother household in adolescence (one more clearly advantaged on an array of characteristics than the other). Three distinct “advantaged” life course SES groups were also revealed, demonstrating considerable heterogeneity in income, education, public assistance, social capital, health insurance and other complex attributes not captured in traditional “upward” or “downward” mobility groups.

The relationship of this more detailed SES measure with obesity, an important health outcome of increased risk during the young adult period, demonstrated nuanced relationships not seen using a traditional social mobility measure of life course SES. In general, more of the LCA groups had strong associations with young adult obesity as compared to the social mobility groups. For example, while only the “stable low” social mobility group in males showed an elevated obesity risk, two distinct LCA groups showed strong positive associations in males, i.e. the “disadvantage with autonomy” group and the “material advantage” group – two very different patterns of SES exposure, thus requiring very different targeting strategies.

LCA permitted classification based on a multidimensional and inter-generational set of SES characteristics, thus capturing heterogeneity in the SES experience of young adults in a manner not possible by simple social mobility frameworks. In addition to providing a novel solution to the problems of capturing cumulative SES exposure during the complex young adult period, our findings suggest that groups identified by LCA provide more nuanced relationships with health outcomes than traditional approaches to characterizing life course SES patterns.

This approach thus has utility beyond obesity to include the study of relationships between SES and other outcomes of high risk during the young adult transition as well any research question with a focus on defining measures during this complex transitional period. The flexibility in the number and type (e.g. continuous, categorical, nominal) of variables that can be included in this approach make it well suited to the characterization of groups based on a wide range of indicators. Although other methods are available for the grouping of individuals based on the same measures over time, LCA is particularly useful for summarizing cumulative exposures that may be assessed in different ways across a relatively short period of time, as is the case across the transition to adulthood.

3. Obesity, race/ethnicity and life course socioeconomic status across the transition from adolescence to adulthood

In this final study, we examined the association of complex profiles of early adult life course SES, defined using multiple measures of parental and young adult social position, with longitudinal obesity patterns in a nationally representative, diverse sample of adolescents followed into young adulthood. We hypothesized that there would be

racial/ethnic differences in the relationship between SES and obesity development due to structural barriers that prevent minorities from translating higher SES into health benefits. .

Latent class analysis was used to classify respondents into groups based on longitudinal SES data of the parental household (adolescence) and self (young adulthood), as detailed in the previous study. In contrast to our central hypothesis, we did not find significant or substantive racial/ethnic differences in association between these life course SES groups and any of the longitudinal obesity patterns of interest (obesity incidence and persistence versus staying non-obese between adolescence and adulthood). However, we observed a continued presence of racial/ethnic disparities, such that the overall burden of obesity was consistently higher in historically underprivileged racial/ethnic minorities (black and Hispanic) versus whites across life course SES groups. This suggests that SES and non-SES related factors not captured in our measure likely influence racial/ethnic differences in obesity patterns starting earlier than our initial adolescent assessment. Furthermore, stronger relationships with obesity persistence than incidence were observed, indicating that many of the SES characteristics we did capture by these groups also started influencing the process of obesity development prior to adolescence and supported the maintenance of that process during the transitional period.

Racial/ethnic-pooled associations between “disadvantaged” life course SES experiences and higher obesity risk were strong, consistent with the inverse relationships in the literature. However, our complex measure identified specific subtypes of disadvantage that differentially influence obesity risk for males (i.e. low SES, two-parent households in adolescence and low occupational status, middle income in young adulthood) versus females (i.e. low SES, single-mother households in adolescence and low education in young

adulthood). These important gender differences underscore the importance of examining complex characterizations of life course SES in the study of health risk. Overall, our results indicate that the relationship between life course SES and obesity patterns may be the same across race/ethnicity during this period, which is a promising contrast to the literature in adults. However, the stronger associations with obesity persistence and the enduring racial/ethnic disparities in obesity risk across SES groups suggest that these SES profiles and other social factors play a larger role in disparities earlier in the life course, though our data preclude the precise elucidation of timing prior to the baseline adolescent assessment.

C. Strengths and limitations

Although the challenges of defining a measure of SES during the tumultuous transition from adolescence to adulthood may be considered limitations in other studies, we consider our in depth, multi-faceted approach to overcoming these issues as a major strength of this study. However, this research does have several other important limitations that bear mention.

1. Limitations

Pre-existing overweight in adolescence. The Add Health survey began in adolescence, when a significant proportion of youths were already overweight. Therefore, regardless of the sophistication of our modeling approach, we could not fully model or understand determinants of overweight already present at entry into the study. This limitation was particularly salient for the exposures of critical interest for our research questions, i.e. race/ethnicity and SES. Given our view of race/ethnicity as a social construct

reflecting macro-level societal forces that transmit inequality through individual and institutionalized discrimination, it is likely that these forces began exerting their influence on obesity risk as soon as these respondents entered the world as a particular race/ethnicity, and likely before that in the experiences of their parents. Furthermore, SES can and does fluctuate throughout the life course, such that assessing a snapshot of parental SES during adolescence does not necessarily reflect the full pattern of SES exposure during the 15 years before that assessment.

Results from our third study corroborate the importance of this limitation, showing that the relationships of our early “life course” SES groups were stronger for obesity persistence than incidence. However, we cannot disentangle the influence of these groups on the two processes that produce obesity persistence, i.e. the onset of obesity before adolescence and the maintenance of obesity through young adulthood. The observed racial/ethnic disparity in longitudinal obesity patterns regardless of “life course SES” further supports the influence of social factors acting earlier than the period of assessment. Since we do not have additional information on the extent of these macro-level forces in Add Health, our best recourse, then, has been to carefully interpret results in the context of these unmeasured influences prior to the study period.

Potential bi-directional association between SES and obesity. Most studies of the association between SES and obesity are cross-sectional (Sobal and Stunkard 1989), and thus do not allow causal inferences, particularly about the direction effect between SES and obesity. Given the cross-sectional nature of our first study (i.e. the association of young adult SES with young adult obesity), we cannot rule out the possibility that the observed

associations may in fact be the result of the effects of obesity on SES. There is a growing literature documenting the substantial stigmatization of obesity, resulting in discrimination against obese people in access to college education, employment, earnings, job promotions, and housing (Sobal 1991; Gortmaker, Must et al. 1993; Averett and Korenman 1999). Given that this research also suggests there are racial/ethnic differences in the extent to which concurrent (or prior) obesity influences wages and labor market opportunities, reflecting potential cultural differences in both self and employer perceptions of appropriate weights for different racial/ethnic groups, it is possible that these relationships may have biased our findings, and should be explicitly examined in future research.

The wide age range of the sample. From the perspective of the dynamic transitional period on which this study is focused, the age range of our sample was relatively wide, and thus older respondents had a higher likelihood of being obese and a greater opportunity to define their own SES than did the younger respondents. However, given the greater delay and variability in timing of transitions in the US today, the extent to which young adults take advantage of that “opportunity” to define their own independent SES status is likely to vary across demographic groups in manner that has not yet been fully explored. Thus, controlling for age in multivariate models of obesity, as we did in each study, could only partially account for the confounding influence of age, i.e. only among those who followed a predictable trend of increasing both their SES and weight status with age.

Examination of race/ethnicity. Despite the availability of a racial/ethnically diverse sample, most of our study conclusions regarding the role of racial/ethnic disparities contrast

the experiences of whites versus blacks. This tendency was likely the consequence of several factors: first, even though we were fortunate to have any data on understudied groups, such as Hispanics and Asians, we often did not have sufficient numbers to produce stable model estimates across the several other axes of comparison that were of interest in this study (e.g. gender, SES measure category, longitudinal obesity pattern). Secondly, much of the literature on racial/ethnic disparities on health has been focused on black-white differentials, and thus our *a priori* research hypotheses were primarily in the context of blacks versus whites. Finally, most of our descriptive data (and the modeling results for which the sample was large enough) identified Asians as being relatively advantaged in terms of SES, often on par with white adolescents, and at relatively low risk of obesity. Given our ultimate interest in the obesity risk of historically *disadvantaged* racial/ethnic groups, inferences about Asians were likely to be coupled with our discussion of whites. However, given the heterogeneity of the population that self-identifies as “Hispanic,” future work should endeavor to explore these subpopulations with greater detail.

2. Strengths

Novel approach to defining SES during the young adult period. This research also has a number of important strengths. As mentioned in the beginning of this section, we directly confronted the challenges of defining SES during the complex transitional period from adolescence to adulthood using two different and complementary approaches.

Although the methods themselves are not new, these studies are the first, to our knowledge, to capture the multidimensionality of SES during early adulthood using exploratory factor analysis, and also the first to define a multidimensional and multigenerational measure of

cumulative, early life course SES exposure using latent class analysis. The novel application of methods to create these richly complex measures greatly enhance understanding of how social position is related to obesity risk during this tumultuous period, and further, provide important insights on the extent to which these relationships differed by race/ethnicity.

Strengths of conceptualization. An overall strength of this research is the use of two distinct yet complementary strategies, factor analysis and LCA. This dual approach provides a much fuller picture of SES during the transition to adulthood than could be gleaned from either approach in isolation, or from traditional approaches. Although both factor analysis and LCA are typically used to summarize the relationships among a large set of data, their different perspectives permitted the investigation of somewhat different yet related research questions. Factor analysis, as a variable-centered technique, provided us with a deeper understanding of the patterning of young adult SES variables into dimensions of relevance for young adults. Latent class analysis, a person-centered technique, identified groups with distinct patterns of responses to multiple observed indicators, thus capturing the heterogeneity in early life course SES exposures. Together, these methods summarized the wealth of SES data in a manner that deepens understanding of SES during this period.

Strengths of sample and data. The large, nationally representative, racial/ethnically diverse nature of the Add Health sample is a significant strength of this research. The over-sampling of blacks with a college educated parent, and of different subgroups of Hispanics and Asians provided substantial socioeconomic and weight-related heterogeneity within racial groups, and allowed for within-group comparisons. While other national health

surveys (such as NHANES) include minorities, their minority adolescent and young adult samples are not nearly as large or diverse as those from Add Health.

The prospective, longitudinal data allowed us to examine dynamic relationships during the understudied transition from adolescence to young adulthood, an important period from a health perspective because many precursors of adult disease are already emerging. However, it is also an important time for prevention, since youths are in the process of making substantial changes in behavior and lifestyle. Further, the transition to adulthood is period is one in which health risk increases and disparities by race/ethnicity fluctuate (Harris, Gordon-Larsen et al. 2006).

Finally, perhaps the greatest strength of the data is the wide variety of detailed SES indicators from the parents in adolescence and from the respondents in both adolescence and young adulthood. The parental interview at baseline permitted the collection of considerably more SES data than could have been derived from report of the respondent alone, while the interview of the respondent in young adulthood collected information on a breadth of indicators beyond traditional measures of income and education or occupation, all of which were not likely to be representative of social position during this period. This wealth of data on multiple domains of SES that were relevant to young adults provided an excellent opportunity to examine the relationships of interest, and deepened our conceptualization of the SES measures that affect adolescent and young adult obesity.

D. Public health significance

1. Our findings indicate that SES in young adulthood comprises multiple dimensions of unique relevance for the young adult period

Results from our first study identified several unique dimensions of young adult SES that could serve as potential intervention targets for reducing obesity during this transitional period. However, since the factors identified in this paper reflect a complex pattern of SES characteristics, close examination of these patterns suggests that not all SES dimensions are attractive, feasible targets. For example, despite the promising inverse relationship between “social capital” and obesity in white and Hispanic females, the many indicators loading on this dimension, including measures of civic engagement, years of education, high status occupation, financial access, etc, generally reflect a “high status milieu” that would not be feasible to reproduce in an intervention setting. In contrast, the “schooling” factor was characterized by high loadings on select few indicators of young adult SES, including, most strongly, the current enrollment in higher education, and supported only by variables directly relevant to the status of being in school, such as having student loans, or receiving income from the family. The specificity of this dimension makes it both attractive and feasible as a potential target to reduce young adult obesity risk.

The lack of an association of “economic hardship” with obesity in racial/ethnic minorities has important implications for policy. We initially speculated that minorities are somehow unaffected by the influence of this disadvantaged SES dimension on obesity. However, a secondary analysis (i.e., removing the adolescent obesity control from the model) supported the possibility that the variables summarized by this pattern had already exerted an influence on obesity risk in these groups prior to young adulthood. From a policy perspective, these results suggest that to break the cycle of SES disadvantage and elevated

obesity, the multiple government programs designed to reduce hardship (several of which co-vary with the experience of hardship, as would be expected in a cross-sectional study) need to be targeted earlier in the life course through the support of families, especially though not exclusively in racial/ethnic minorities.

2. Our findings show that complex patterns of SES exposure across the transition from adolescence to adulthood are associated with health risk

Results from our second and third studies support the consideration of a fuller, more complex picture of cumulative exposure to SES over the early life course in assessing health risk. From a practical perspective, given the complexity of our approach as compared to traditional, simple characterizations of one or two indicators of SES in adolescence and adulthood, the onus is on us to show whether the more complex method is better at identifying groups at risk. We have demonstrated that this approach does provide an enhanced understanding of the patterns of life course SES exposure that confer the most benefit or consequence for obesity, with some important insights for public health.

For example, we found important differences by gender in the influence of life course SES exposure on obesity. Growing up in a disadvantaged single-mother household and continuing that disadvantage into adulthood (“persistent disadvantage”) was associated with substantially elevated obesity risk for females, but was relatively benign for males. In contrast, exposure to middle class, two-parent households in adolescence and continuing that comfortable advantage into adulthood (“material advantage”) was associated with nearly as high obesity as being in a group with a working poor background and early transitions into low status occupations (“disadvantage with autonomy”) in males, but a different pattern was observed in females.

These gender-specific findings underscore the importance of considering the combination of family structure along with other transition-related SES characteristics related for determining which groups need to be targeted to reduce obesity risk. Further, given the strong associations observed between these life course SES groupings and obesity, an important health outcome during the young adult period, this approach may provide useful insights for other health outcomes of high risk during the transition to adulthood.

3. Our findings suggest that SES variables and non-SES societal forces influence obesity risk for racial/ethnic minorities prior to adolescence

Perhaps the most critical public health message supported by this research is the need to identify intervenable social factors that increase the risk of obesity for racial/ethnic minorities *before* adolescence. Our data show that racial/ethnic minorities had higher obesity rates at all levels of SES in both adolescence and early adulthood, regardless of the sophistication of the SES measure. This disparity underscores the importance of unmeasured SES and non-SES social forces in shaping the obesity risk of these groups far earlier than our period of assessment. Furthermore, the stronger associations between measures of life course SES and obesity persistence than obesity incidence in the pooled racial/ethnic sample suggests that these complex patterns of characteristics play an important role in obesity development prior to adolescence across all racial/ethnic groups. Our measured SES characteristics during this transitional period may also be important for sustaining the higher rates of obesity in racial/ethnic minorities, but their influence may be swamped by factors acting earlier in the life course. That said, the effort to define these comprehensive measures of SES during this complex transitional period was not without value from the perspective of racial/ethnic disparities. This work also revealed differences in association by race/ethnicity,

including the aforementioned differences in the influence of social capital and economic hardship in young adulthood with obesity, enhancing the understanding of racial/ethnic differences in the “meaning” or value of SES as reflected in health benefits conferred by higher SES. Still, the lack of racial/ethnic differences in association between the early life course SES measures with longitudinal obesity patterns again reinforces the need to look beyond this transitional period to understand the higher rates of obesity in racial/ethnic minorities.

E. Directions for future research

Several possible extensions to this work could enhance understanding of the dynamic interplay of race/ethnicity, SES and obesity development during the transition to adulthood. Although one of the most important tasks not feasible with the present dataset, i.e. the exploration of social factors acting prior to adolescence to produce racial/ethnic disparities in health, has already been discussed, additional possible directions that *are* feasible with the current data are summarized below.

Our first study was partially motivated by the expectation that traditional measures of SES are not relevant during the tumultuous transition to adulthood and thus prone to both misclassification of social status and poor associations with health risk. However, this expectation begs the question – at what age *do* traditional SES indicators, such as income, education or occupation, accurately characterize the social position of individuals? Furthermore, given the recent secular changes in the nature of this transitional period in the US, including the greater delay and increased variability in timing of the multiple transitions, is it possible that these traditional SES measures will never be relevant for current young

adults? In other words, is this restructuring of SES an age effect, a cohort effect, or both?

While such processes are notably difficult to disentangle, we could enhance this knowledge using confirmatory (versus exploratory) factor analysis on the large set of SES indicators used in the first study, explicitly specifying a two to four dimensional SES structure based on traditional SES theories, and testing the fit of this model in younger versus older subsamples of our data. If age was the key determining factor of SES structuring, we would expect better fit in the older subsample, though a lack of good fit would not necessarily disprove the influence of age, given that our “older” sample may not be old enough.

There are several natural extensions to the work in our second and third studies that are possible with the available data. For instance, one important direction for future research is to examine how LCA-defined groupings of life course SES predict high risk outcomes other than obesity, such as mental health, substance use or reproductive outcomes, and whether these groups have an advantage over traditional grouping methods similar to what we observed with obesity. In addition, although we focused on how life course SES groupings predicted health, it would be interesting to explore possible predictors of membership in these groups. Given the interest in defining a “pure” measure of SES while capturing as much complexity as possible, we resisted the inclusion of indicators that did not plausibly fit the framework of representing material, human or social capital. However, modeling the prediction of group membership could shed light on those variables that are related to SES, though not properly considered part of SES. Some examples of possible predictors include characteristics of the family environment (beyond family structure), or indicators of the community context.

Finally, to advance knowledge of the relationships of race/ethnicity and SES in the production of obesity during the transition to adulthood, we might attempt to define racial/ethnic-*specific* young adult SES factors using exploratory factor analysis or life course SES groups using LCA. Although we would not be able to directly compare the ability of these measures to predict obesity across race/ethnicity in the manner required for the questions of interest in the present research, this strategy could address the alternative research question concerning racial/ethnic differences in the patterning of SES exposures over the life course. Using these “variable-centered” and “person-centered” techniques to summarize relationships in the patterns of SES data *within* racial/ethnic groups, we could assess whether differences in the “meaning” of SES are the result of differences in the composition and structure of SES by race/ethnicity.

In conclusion, racial/ethnic disparities in obesity during the transition to adulthood persist across levels of SES, regardless of the sophistication of the measures, underscoring the need to identify social forces beyond SES that shape these disparities earlier in life. However, consistent with our primary objective, we identified racial/ethnic differences in associations between obesity and dimensions of SES uniquely relevant to young adulthood. We also observed important associations between longitudinal obesity patterns and SES groups characterizing the heterogeneity of SES combinations across the early life course that did not differ by race/ethnicity, highlighting the utility of these measures in predicting health in all groups during this complicated stage of the life course.

APPENDIX

Description of parental and young adult SES variables in longitudinal sample with weights (N=14,322) from the National Longitudinal Study of Adolescent Health” used to define “life course SES” using social mobility framework (Chapter V) and latent class analysis (Chapters V and VI)

| Variable Name | Description | Coding | Mean |
|----------------------------|--|---------------------|------|
| <i>Parental SES</i> | | | |
| Continuous | | | |
| Household income* | Regression imputed family income variable ^{a,b} | 0-300, in thousands | 42 |
| Hrs work/wk-Mom | Hrs/week mom works (Wave 1); 0=no mom or no job ^a | 0-168 | 32 |
| Hrs work/wk-Dad | Hrs/week dad works (Wave 1); 0=no dad or no job ^a | 0-168 | 30 |
| Binary/Nominal | | | |
| Two parent HH | Two biological parent household ^{a,b?} | 0=no, 1=yes | 0.50 |
| Insurance 12 mo | Have you (parent)had health insurance last 12 months? ^a | 0=no, 1=yes | 0.81 |
| Parent Pub Assist‡ | # sources Public Assistance ^a | 0=none, 1=some | 0.29 |
| Social capital‡ | Sum of total social capital vars ^a | 0=none, 1=some | 0.50 |
| Mom Professional | Is mom a professional? ^{a,b,c} | 0= no, 1=yes | 0.24 |
| Dad Professional | Is dad a professional? ^{a,b,c} | 0= no, 1=yes | 0.24 |
| Mom ed <HS | Highest mother’s education variable ^{a,b,c} | 1=<HS | 0.18 |
| Mom ed HS grad | | 2=HS | 0.57 |
| Mom ed Some college | | 3=Some college+ | 0.25 |
| Dad ed <HS | Highest father’s education variable ^{a,b,c} | 1=<HS | 0.18 |
| Dad ed HS grad | | 2=HS | 0.53 |
| Dad ed Some college | | 3=Some college | 0.17 |
| Dad ed Grad/Prof | | 4=Grad/prof. school | 0.12 |
| P. ed <HS† | Highest education of either parent, mother’s education when available ^{a,b} | 1=<high school, | 14.2 |
| P. ed HS grad | | 2=high school/GED | 31.1 |
| P. ed Some college | | 3=some college | 26.3 |
| P. ed College grad | | 4=college graduate | 14.9 |
| P. ed Grad/Prof | | 5=Grad/prof. school | 8.9 |

| Variable Name | Description | Coding | Mean |
|------------------------|--|---------------------|------|
| Young adult SES | | | |
| Continuous | | | |
| Personal income* | Young adult income using best guess assignment when “don’t know”; truncated at 99 th percentile | 0-300, in thousands | 13.6 |
| Years of education* | Highest grade/year completed (Wave 3) | 6 to 22 | 13.2 |
| Binary/Nominal | | | |
| Ever married | # of marriages (Wave 3) | 0=none, 1=1+ | 0.19 |
| Live with parent | Live with parents (Wave 3) | 0=no, 1=yes | 0.41 |
| In school | Currently in college (AA/BA) | 0=not 1=in school | 0.36 |
| Vocational school | Currently in vocational school (Wave 3) | 0=no, 1=yes | 0.24 |
| Savings account | Do you have a savings account (Wave 3) | 0=no, 1=yes | 0.64 |
| Income from family | Do you get income from your family/friends (Wave 3) | 0=no, 1=yes | 0.40 |
| Own residence | Do you own a residence? (Wave 3) | 0=no, 1=yes | 0.12 |
| Credit card | Do you have a credit card? (Wave 3) | 0=no, 1=yes | 0.59 |
| Health insurance | Do you currently have health insurance (Wave 3) | 0=no, 1=yes | 0.76 |
| Hardship‡ | # sources pub assist and hardship (Wave 3) | 0 = none, 1 = 1+ | 0.36 |
| Social capital‡ | # volunteer org and social capital activities (Wave 3) | 0 = none, 1 = 1+ | 0.31 |
| | | 1=not working | 0.31 |
| | | 2=blue collar | 0.13 |
| Job description | Young adult job description (Wave 3) | 3=sales and service | 0.37 |
| | | 4=manage/prof. | 0.19 |

*Variable used in both LCA and traditional social mobility approach to defining “life course SES” (See Chapters V and VI)

†Variable used only traditional social mobility approach to defining “life course SES” (See Chapter V)

‡See text in Chapter V for further details on variable composition

^aSource data: Parent questionnaire; ^bSource data: In-home questionnaire; ^cSource data: In-school questionnaire

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