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US Trends in Body Mass in Adolescence and Young Adulthood, 1959–2002

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Abstract

Purpose—This study examined trends in body mass index (BMI) during the transition from adolescence to young adulthood by sex and race using national data from the US spanning over forty years from 1959–2002. While prior research has investigated BMI trends separately in childhood/adolescence or adulthood, this study uniquely focused on the transition to adulthood ages (12–26 years) to identify the emergence of the obesity epidemic during this critical life-stage.

Methods—Data came from multiple waves and cross-sections of data from four nationally representative surveys: National Health and Nutrition Examination Survey (NHANES); National Longitudinal Study of Adolescent Health (Add Health); National Health Interview Survey (NHIS); and National Longitudinal Surveys of Youth (NLSY79 and NLSY97). The analysis tracked age trends in BMI by time period, which allowed for the examination of how BMI changed during the transition to adulthood and whether the patterns of change varied by period. Data best suited for trend analysis were identified. Age trends in BMI by sex and race were graphed and regression analysis was used to test for significant differences in the trends using NHANES and Add Health.

Results—BMI increased sharply in the adolescent ages beginning in the 1990s and among young adults around 2000. This age pattern of BMI increase was more dramatic among females and blacks, particularly black females.

Conclusions—BMI increases during the transition to adulthood and these increases have grown larger over time. Obesity prevention efforts should focus on this high risk transition period, particularly among minority populations.

Keywords

adolescence; transition to adulthood; obesity; BMI trends

INTRODUCTION

The public health crisis of increasing body mass index (BMI) among adolescents has captured the attention of researchers and policymakers alike. Since the late 1960s, the prevalence of obesity among adolescents (ages 12–19) has quadrupled to about 18% [1–2]. Fueling concerns about the high levels of BMI among youth is evidence that obesity in adolescence tracks into adulthood [3]. Moreover, obesity risk increases in adolescence and early adulthood [4] as individuals' levels of physical activity decrease and energy/caloric intake increase, perhaps related to social and behavioral changes that occur as individuals

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transition into adulthood [5]. The transition to adulthood is a life-stage when young people move from being financially dependent on their family to completing their education, entering the labor force, moving out of the family home, forming cohabiting/marital unions and having children. Because obesity is associated with negative social, economic, and health consequences, such as poor physical health, lower levels of education and income, and a lower likelihood of marriage [6], and because longer duration of obesity increases the severity of these negative consequences [7–8], experiencing obesity during this period could seriously impair successful transitions into adulthood.

While the transition to young adulthood is a critical period for the study of BMI change, little research has used national data to examine BMI change during this life-stage. Prior research has documented trends in BMI and obesity for adults separately from children and adolescents [4, 8–15], usually lumping adolescence into childhood and young adulthood with adults of all ages, with little attention to patterns during this transitional stage in the life course. Focusing on the transition to adulthood as an important risk period for the incidence of obesity will inform obesity prevention efforts to reduce overall prevalence of obesity in both adolescence and adulthood.

The objective of this paper was to examine trends in BMI during the transition from adolescence to young adulthood (ages 12–26) using multiple national datasets from 1959–2002. We examined age trends in BMI by time period, allowing us to examine how BMI changes during the transition to adulthood and whether the pattern of change varies by period, and we did so for different sex and race groups across a period of over forty years.

BACKGROUND

The rise in BMI during the transition to adulthood is associated with a number of concomitant social trends that have redefined this life-stage in America. Over the last few decades there has been a lengthening of the adolescent transition to adulthood as young people extend years spent in education, delaying job entry, marriage, and childbearing to later ages [16]. An important consequence of the lengthening of the transition to adulthood has been to extend the period of time after young people have left the parental home and tend to have poor diets, less access to healthy food, poor sleep patterns, lack of healthcare or regular doctor visits, and continue to engage in risky health behaviors [5]. For example, inactivity historically increases with age [17]; over the last decade, however, the drop off in physical activity has migrated into the adolescent and young adult ages [18]. These health habits increase the risk of weight gain during the transition to adulthood.

At the same time that the developmental stage involving the transition to adulthood has shifted up in age to occupy the third decade of life in the 20s, disease onset and prevalence has shifted down the age spectrum for a number of crucial health conditions, largely due to the rise in obesity among the young. Young adults are at increased risk of metabolic syndrome, high blood pressure, and premature coronary artery disease [19–20].

There are known disparities in BMI by various demographic factors such as race, gender [2], and socioeconomic status [9, 14]. Among girls, blacks have the highest prevalence of obesity [21]. Similar patterns are found within the adult population, with black females experiencing the highest prevalence of obesity compared to all other race/gender subgroups [2, 22]. While previous studies have documented disparities in BMI during either childhood or adulthood, there has been little research investigating how these disparities have unfolded during the transition to adulthood. Our research fills this gap. By focusing on this stage in the life course as a risk period for obesity incidence and examining age and time patterns by race and gender, we will identify vulnerable ages and populations for whom interventions

may be especially effective in reducing the obesity burden before it worsens or becomes intractable throughout the adult years [23].

DATA AND METHODS

Sample

Data came from four nationally representative surveys: National Health and Nutrition Examination Survey (NHANES) [24], National Longitudinal Study of Adolescent Health (Add Health) [25], National Health Interview Survey (NHIS) [26] and National Longitudinal Surveys of Youth (NLSY79/NLSY97) [27]. For this analysis, we identified national datasets that either covered a wide time span (e.g., NHANES, NHIS) or were longitudinal (e.g., NLSY, Add Health) and that were often used by interdisciplinary researchers interested in child/adolescent health.

NHANES—Data included six of the NHANES cross-sectional surveys: NHES I (1959–62) and NHES III (1966–70) and NHANES I (1971–75), NHANES II (1976–80), NHANES III (1988–94), NHANES 1999–2000 and 2001–02. Each NHANES survey was collected during the entire time period indicated using a complex, stratified, multistage probability cluster sampling design to select a nationally representative sample of the US civilian non-institutionalized population. At all waves anthropometric measurements were administered by trained health technicians, using standardized procedures and equipment. The age range for NHES I was 18–79 years and for NHES III only 12–18 years. All other NHANES samples contain information on individuals aged 1 year and older, and some have data on infants less than 1.

Add Health—Add Health is a longitudinal school-based study of US adolescents in grades 7–12 (ages 12–19) beginning in 1994–95. In 1994, a sample of 132 schools was selected using a stratified cluster design. From school rosters, an adolescent and a parent were selected for an In-Home Interview in 1995. This study used data from Wave I (WI) in 1994–95, and follow-up Waves II (1996) and III (2001–02) [28]. Height and weight were self-reported at WI, but measured by trained interviewers using standardized protocols and equipment in following waves.

NHIS—Data included six NHIS cross-sectional surveys: 1980, 1990 and 2000–03. Each NHIS survey was collected using a multistage area probability design that allowed the representative sampling of households and non-institutional group quarters. One sample adult and child were randomly selected from each household. Adult respondents self-reported their height and weight via personal interview. The non-restricted NHIS data contain information for individuals ages 17 and up.

NLSY79—NLSY79 is a longitudinal sample of individuals who were first surveyed in 1979 when they were 14–21 years old. The NLSY is comprised of three independent probability samples that represent the entire population of youth aged 14–21 as of December 31, 1978. From 1979–86, interviews were administered in person. While height questions were asked in 1981–83, and 1985, weight questions appear in the 1981–82, 1985–86, 1988–90, and 1992–2004 waves. Therefore, we used the 1981–82, 1985 waves of the NLSY79. In these years, height and weight were self-reported.

NLSY97—NLSY97 is a longitudinal sample of individuals aged 12–16 as of December 31, 1996. In 1997 both the eligible youth and one of the youth's parents received personal interviews. Respondents self-reported their height and weight. This analysis used data collected in 1997 and 2001 for period comparability with other data sets used in this study.

Like the NLSY79, the NLSY97 is a complex survey composed of multiple nationally representative samples.

For all data we limited our analysis to non-Hispanic black, non-Hispanic white and Hispanic respondents (with the exception of Add Health, which included Asians, and NHIS, which included an “other” race category) who were between the ages of 12–26 and had valid measures of height and weight (pregnant females were excluded). Analytical sample sizes varied by dataset. The total combined sample size for NHANES was 28,818 and 18,858 for Add Health. The sample sizes for NHIS and NLSY samples ranged from 7,600–18,000 respondents. Sampling weights were calculated to take into account unequal probabilities of inclusion resulting from sampling design and nonresponse.

This study was approved by the University of North Carolina at Chapel Hill Public Health-Nursing IRB# 05-1164.

Measures

BMI was computed by dividing body weight in kilograms by the square of height in meters (kg/m^2). BMI is defined differently for children and adults. In childhood and adolescence, percentiles are used because BMI normally increases due to normal growth [29]. We used raw BMI score because we needed a consistent measure across both adolescence and young adulthood and percentiles do not exist in adulthood. However, to account for this, we adjusted for age.

Our analysis focused on three demographic measures: sex, age, and race. Datasets differed somewhat in their collection of demographic information. We highlight these differences and explain our efforts to standardize the measures across datasets below. In addition to these measures, the impact of calendar year periods was also explored [4].

Race/ethnicity categories differed by study and year of survey collection. Given Hispanic ethnicity and “other” race were not measured or labeled consistently across studies and study years, these racial/ethnic groups were only included in descriptive graphs of aggregate trends in BMI by age and by sex. Trends by race were only shown for Non-Hispanic blacks and whites.

For our concatenated NHANES dataset series, we created time period indicators for regression analysis. We created narrow and wide interval period indicators. The narrow interval period indicators included: 1959–62 (reference category), 1966–70, 1971–75, 1976–80, 1988–94 and 1999–2002. The wide interval period indicators included: 1959–80 (reference category), 1988–94, 1999–2002.

Analytic Strategy

We plotted the trends in BMI by age across total samples and sex-, race-, and sex/race-specific samples in a series of graphs. In our examination of aggregate trends in BMI by age and period, we compared the data using self-reported height and weight to data using measured height and weight to determine the data best suited for trend analysis. Numerous studies have assessed the validity of self-reported height and weight in the US, indicating an underestimation of BMI [30–31], but none have examined the trends.

Panel 1 in Figure 1 shows that around 1980 self-reported BMI among adolescents and young adults in NHIS were only slightly lower than measured BMI from NHANES. Ten years later self-reports of BMI seemed markedly downwardly biased. Panel 2 in Figure 1 shows that self-reported adolescent and young adult BMI in NHIS 1990 were considerably lower than measured BMI in NHANES III (1988–94) and Add Health WI (1994–95). A sharper

contrast between self-reported and measured BMI appears in studies that were carried out around 2000. Self-reported BMI from NHIS 2000–03 and NLSY 1997–2001 were markedly lower than measured BMI in NHANES 1999–2002 and Add Health WIII (2001–02).

Thus, there seems to be a dramatic increase in the downward bias in self-reported BMI relative to measured BMI over a twenty-year period from 1980–2000. Researchers that use self-reported height and weight data such as the NLSY and NHIS should use correction approaches to account for this bias [32], we note however, that such adjustments increase error that may vary over time in trend analyses. Based on these findings, we only used NHANES and Add Health data in subsequent analysis of BMI trends for the years spanning 1959–2002.

Regression analysis was then employed to test whether the age trends in BMI shown in graphs were statistically significant. For the NHANES data, multiple regression models were estimated with pooled cross-sectional data [33]. For the Add Health data, which have repeated measures of BMI for each respondent, we used growth curve models [34] to evaluate changes in BMI over time (i.e., age). The model fits a developmental trajectory for changes in BMI as youth age into young adulthood by sex and race.

RESULTS

BMI Trends

Figure 2, Panel 1 (BMI by Age) shows the trends in BMI in adolescents and young adults using NHANES from 1959–2002. Over this period, average BMI increased by about 2kg/m^2 in early adolescence and by about 3kg/m^2 in young adulthood. The increase in BMI over the period was not gradual. Hardly any increase was noticeable in the first four studies ranging from 1959–80. Large increases in early adolescence appeared around 1990 in NHANES III (1988–94). However, dramatic increases among young adults did not take place until around 2000 in NHANES 1999–2002. For example 18-year olds had an average BMI of about 22kg/m^2 between 1959–80 that was stable during this period. This increased to about 23kg/m^2 in 1990 to about 25kg/m^2 in 2000. Similarly, for 12-year olds between 1966–80 average BMI was stable during this period at about 19kg/m^2 . This increased to about 20kg/m^2 in 1990 to about 21kg/m^2 in 2000.

Panel 2 in Figure 2 (BMI by Sex) explores gender differences in the trends of BMI increase. Although increases in BMI were present among males and females; significant differences existed between the sexes. Compared with male young adults, BMI increases among female young adults were larger and started earlier, appearing first in NHANES III (1988–94). Panel 3 in Figure 2 (BMI by Race) investigates differences in the trends between whites and blacks. The black increase in BMI was larger than the white increase and started earlier. Around 1990 (as shown in NHANES III) black BMI was already $2\text{--}3\text{kg/m}^2$ higher than BMI around 1980. In contrast, the large increase in BMI among white young adults did not appear until around 2000.

Panel 4 in Figure 2 (BMI by Sex and Race) investigates the interactions between sex and race. Although the general trends in the increase of BMI over the decades were similar across the four sex/race groups, increases for black females were the most dramatic throughout adolescence and young adulthood, especially in young adulthood in the late 1990s. These findings were supported by both NHANES and Add Health.

Regression Analysis

The regression models shown in Table 1 were designed to replicate the findings described in Figure 2. To simplify the NHANES regression models; the periods up to 1980 were

collapsed into a single period because the findings in Panel 1 in Figure 2 suggested little changes in levels of BMI prior to 1980.

Column 1: BMI by Age in Table 1 shows a marked upward trend in BMI since the reference period of 1959–80, relative to which the BMI in the period of 1988–94 was up by 1.09kg/m^2 and the BMI at 1999–2002 was up by 2.43kg/m^2 . Column 2: BMI by Sex in Table 1 investigates the role of sex in the upward trend in BMI. The results indicate that although females on average had a lower BMI than males (-0.54kg/m^2), the increase in BMI in the period of 1999–2002 relative to the period of 1959–1980 was larger (0.89kg/m^2) for females than males.

Column 3: BMI by Race in Table 1 investigates the role of race. Relative to whites, blacks on average had a higher BMI (0.31kg/m^2). In addition, the BMI among blacks increased at a faster rate than whites in both the period of 1988–94 (1.06kg/m^2) and 1999–2002 (1.15kg/m^2). Column 4: BMI by Sex and Race in Table 1 attempts to replicate the upward swing in BMI among black females detected in Panel 4 in Figure 2. Black females on average had the highest BMI (1.37kg/m^2) and the BMI among black females also increased at the fastest rate (1.34kg/m^2) in the period 1999–2002. Unlike NHANES data, Add Health data were restricted to the periods of 1994–2002, so the analysis was designed to examine the roles of sex and race in this period. The regression findings from Add Health (Column 5: BMI by Sex and Race) were similar to those based on NHANES. Because Add Health data are longitudinal and follow the same individuals over time, we gain confidence that the patterns found in the NHANES data are not simply due to birth cohort differences.

In summary, findings from regression-based models of trends in BMI using NHANES and Add Health were consistent with our descriptive graphical findings. The increase in BMI during the transition to young adulthood has grown larger over time. Increases were larger for females, blacks, with black women the most vulnerable, especially during 1999–2002.

DISCUSSION

This study examined trends in race/ethnic and gender disparities in BMI during the transition from adolescence to young adulthood using nationally representative data that spanned the period from 1959–2002. We tested for significant differences in age trends in BMI by time period, and found that the widely-documented recent rise in BMI occurred during the adolescent ages in the 1990s, followed by a rise in BMI in the young adulthood ages a decade later in 2000. This pattern suggests that when BMI increased in the 1990s, that increase was greater for adolescents, and they carried a higher BMI with them into young adulthood ten years later. However, we cannot sort out how much of the increase in BMI among young adults beginning in 2000 was due to higher BMI among adolescents moving into the young adult ages or increasing BMI among young adults, but it is likely both processes were operating over time.

Our findings furthermore indicated that the age pattern of increasing BMI in the adolescent ages beginning in the 1990s and in the young adult ages in 2000 was more dramatic for females and blacks, particularly black females. These groups were therefore especially important in driving the rise in BMI/obesity over the last several decades. Black females, in particular, experienced the greatest rise in BMI since the 1990s. Why BMI would rise so dramatically for black females is not clear, but these findings portend adverse health consequences for black females if this trend persists across the life course and across birth cohorts into the future.

From a historical perspective, our trend analysis implies that the recent and dramatic increase in obesity among black females cannot be due to solely biological factors. It is

more likely that recent changes in the physical and social environments in which black females reside are important causes of obesity. Perhaps race- and gender-specific social forces, also increasing during this period, such as rising unemployment, neighborhood and school segregation and crime, single motherhood, increasingly disadvantaged childhood conditions (e.g., absent fathers due to rise in mass incarceration) have served to increase stress and poor health behaviors related to obesity such as overeating and physical inactivity among this group [35–37]. Interventions and clinical care for these populations needs to be tailored to reflect these circumstances such as the work being done in the Bayview Child Health Center as highlighted in the New Yorker [37].

This study contributes to the research on BMI by examining age and period trends in BMI during an increasingly vulnerable stage in the life course when adolescents transition to young adulthood. Recent research has identified this life-stage when young people leave the parental home and begin to establish their own health habits and behaviors in early adulthood as a period of poor health habits and behavioral choices, and a time in which individuals are more likely to be uninsured or underinsured with less access to primary and preventative care [5]. Weight gain during this transition can set trajectories of BMI into adulthood with negative consequences for metabolic processes and cardiovascular health [20, 38]. Increasing BMI at any age is a serious health concern, but it is especially alarming early in life because of earlier and longer exposure to these health-threatening conditions and their associated morbidity and disability [6–8, 20].

Future research needs to focus on this early part of the life course to identify the factors that initiate trajectories of BMI increase among young people, an aspect our research did not address. Although obesity is a consequence of complex factors, the prevalence and rapid increase in BMI among young people over these decades is likely due to changes in the social and physical environment, including reduced funding for physical activity programs in public schools, changes in food advertising for children and adolescents, urban sprawl and lower neighborhood walk-ability, and rising income inequality, and race-specific factors discussed above, as well as reduced access to grocery stores in poor and minority neighborhoods [39]. National studies such as Add Health with rich environmental data will provide key insights into the obesity epidemic of the last few decades among young people [40].

Our results align well with other research that has combined multiple years of cross-sectional data to examine trends in obesity and BMI across the age spectrum [4, 8, 11–12, 15]. By also incorporating longitudinal data from Add Health, our results represent new findings on changes in BMI for the same individual during their transition to adulthood. Our results bring important attention to adolescence as a critical period for the development of obesity. Our findings help inform public health programs designed to curb this epidemic with interventions focused on the young, when BMI changes begin to emerge, rather than in later adulthood when health habits have been established and physical health is already compromised.

IMPLICATIONS AND CONTRIBUTION SUMMARY STATEMENT

Trends in BMI show the transition from adolescence into early adulthood is a critical life-stage for weight gain, during which the obesity epidemic emerged in the 1990s. Interventions to reduce health and social costs of obesity must occur during the transition to adulthood, before obesity trajectories are set in adulthood.

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Figure 1.
Comparing National Datasets: BMI, 1975–2003

Figure 2.
Trends in BMI, by Age, Sex and Race

Table 1

Trends in BMI in the US: Linear Regression Results, 1959–2002 (Confirming Figure 2)

	NHANES				Add Health
	1: BMI by Age	2: BMI by Sex	3: BMI by Race	4: BMI by Sex and Race	5: BMI by Sex and Race
1959–1980 (Reference)					
1988–1994	1.089 (0.132) ***	0.902 (0.191) ***	0.884 (0.156) ***	0.726 (0.225) **	
1999–2002	2.428 (0.143) ***	1.981 (0.193) ***	2.200 (0.164) ***	1.915 (0.225) ***	
Age	1.134 (0.090) ***	1.145 (0.089) ***	1.136 (0.090) ***	1.154 (0.089) ***	0.936 (0.045) ***
Age (Squared)	−0.020 (0.002) ***	−0.021 (0.002) ***	−0.020 (0.002) ***	−0.021 (0.002) ***	−0.010 (0.001) ***
Female		−0.538 (0.080) ***		−0.721 (0.086) ***	−0.363 (0.093) ***
White (Reference)					
Black			0.314 (0.118) **	−0.394 (0.151) *	0.193 (0.122)
Black Female				1.369 (0.234) ***	1.504 (0.170) ***
Interaction with period					
Sex × Period					
Female × 1959–1980					
Female × 1988–1994		0.369 (0.264)		0.312 (0.312)	
Female × 1999–2002		0.891 (0.286) **		0.564 (0.328)	
Race × Period					
Black × 1959–1980					
Black × 1988–1994			1.058 (0.238) ***	1.129 (0.328) **	
Black × 1999–2002			1.154 (0.308) ***	0.488 (0.381)	
Race × Sex × Period					
Black Female × 1959–1980					
Black Female × 1988–1994				−0.146 (0.474)	
Black Female × 1999–2002				1.342 (0.604) *	
N	23687	23687	23687	(0.604) 23687	48701

Notes: NHANES: Only whites and blacks included, sample size reduces from 28818 to 23687 when Hispanics are excluded; Add Health: Hispanics and Asians also included, coefficients are not shown; the N represents person-wave observations. Standard Errors (SE) included in parentheses. Data are weighted.

100<*p*

10<*p*
**

p<.05 (two-tailed test).
*