Obesity in the Transition to Adulthood: Predictions across Race-Ethnicity, Immigrant Generation, and Sex

Kathleen Mullan Harris
Krista Perreira
Dohoon Lee

Carolina Population Center
University of North Carolina at Chapel Hill

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Please Address Correspondence to:
Kathleen Mullan Harris, Ph.D.
University of North Carolina at Chapel Hill
Carolina Population Center
CB# 8120 University Square
123 W. Franklin Street
Chapel Hill, NC 27516-3997
Phone: (W) 919-966-5560; (H) 919-942-0148; Fax: 919-966-6638
Email: kathie_harris@unc.edu

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Kathleen Mullan Harris, Ph.D, Krista Perreira, Ph.D, and Dohoon Lee
University of North Carolina

Abstract

Our paper fills a void in the research on obesity by using national longitudinal data from Add Health to study race, ethnic, and immigrant disparities in body mass index among young people aged 11-28, and to trace how disparities change as adolescents age into young adulthood. We use growth curve modeling to estimate the pattern of change in body mass index beginning in adolescence and extending through the transition to adulthood. Findings indicate significant differences in both the level and change in BMI across age by sex, race-ethnicity, and immigrant generation. In particular, females, second and third generations, and Hispanics and blacks experience more rapidly increasing BMI as adolescents age into young adulthood than males, first generation, and whites and Asians. Overall, disparities in both raw BMI and the percent overweight and obese tend to widen with age as adolescents leave home and begin independent lives as young adults.

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Obesity is poised to overtake tobacco as the No.1 cause of preventable death in the United States (US Department of Health and Human Services 2001). Exacerbated by a modern lifestyle of poor nutrition and physical inactivity, the rising trend of obesity has affected Americans of all ages, but is perhaps most disconcerting among young people. The percentage of children who are overweight (body mass index [BMI]>95th percentile for age and sex) has tripled in the last two decades to current estimate of 15% among those 6 to 19 years of age (Ogden et al. 2002). The Surgeon General's Report state that the health problems resulting from obesity threaten to reverse the major improvements in health accomplished in the 20th century (US Department of Health and Human Services 2001).

Overweight children are likely to become overweight adults (Dietz 1998; Serdula et al. 1993; Whitaker et al 1997; Reilly et al 2003), and are at increased risk for a number of negative health outcomes, including hypertension, high cholesterol, abnormal glucose tolerance, type 2 diabetes, kidney disease, coronary heart disease, congestive heart failure, stroke, osteoarthritis and some types of cancer, and death (Pi-Sunyer 1991; Dietz 1998; Reilly et al. 2003; Weitzman et al. 2005). Overweight adolescents also complete fewer years of education, are less likely to marry, and have a lower household income as adults, independent of their family's socioeconomic status (Gortmaker et al. 1993; Sobal and Stunkard 1989). Moreover, obesity-attributable medical expenditures reached $75 billion in 2003 and taxpayers financed about half of these costs through Medicare and Medicaid (Finkelstein, Fiebelkorn and Wang 2004).

Because the dramatic rise in overweight and obesity among children and adolescents is relatively recent, few studies focus on the young ages, and research on obesity among young people is typically cross-sectional (as is most obesity research on older adults as well) (e.g., McMurray et al. 2000; Troiano et al. 1995; Wang 2001). The cross-sectional picture does not allow the study of developmental trends in obesity as people age and experience different life stages in which lifestyle and health habits change. We are therefore limited in our understanding of individual trajectories in overweight and obesity and disparities in these trajectories over time.

In addition, although much is known about race differences in obesity among adults, there is less known about race and ethnic differences among young people. Research that does examine race differences focuses mainly on black-white differences (e.g., Haas et al. 2003; Kimm at al. 1996; Ogden et al. 2002; Patterson et al. 1997; Paeratakul et al. 2002; exceptions are Must, Gortmaker and Dietz 1994; and Winkleby et al. 1999), failing to capture the increasing diversity of the US population with continuing high rates of immigration primarily from Latin America and Asia (Goel et al. 2004). Our research addresses this void by examining race and ethnic disparities in body mass index among young people aged 11-28, and tracing how disparities change as adolescents age into young adulthood. We use national representative data from Add Health that permits the examination of Latino and Asian youth and the identification of immigrant generation.

Although immigrants constitute an increasing proportion of the US population each year (Rumbaut 1998), national data on the health of immigrants are hard to come by, and even less is

known about children in immigrant families and their prospects for health and well-being as they enter adulthood in America. Some research has documented differences in obesity among immigrant adults (e.g., Goel et al. 2004) and immigrant adolescents (e.g., Harris 1999; Gordon-Larsen at al. 2003), but no research that we know of has traced trajectories in overweight and obesity status through time among young people in immigrant families. Immigrants are of particular interest because America seems to be leading the upward trend in obesity among industrialized countries, although there are hints that some rapidly developing countries, such as China, are witnessing increases in obesity as they adopt western ways (Iwata et al. 2003; Cheng 2003). For the most part, immigrants to the US come from countries in which average body mass is lower, and thus they are less likely to be overweight and obese than native-born Americans (Harris 1999). However, with acculturation both across generations and time in the US for first generation youth, the adoption of American diet and lifestyle increases risks of overweight and obesity among immigrant youth (Harris 1999). Thus, it is important to examine immigrant disparities in body mass index over time, as adolescents age into young adulthood, to better understand acculturation processes that may occur with increasing assimilation of American lifestyle norms.

We use growth curve modeling to estimate the pattern of change in body mass index across age beginning in adolescence and extending through the transition to adulthood, examining differences by race-ethnicity and immigrant generation, as well as by sex. These data represent the first evidence of longitudinal disparities in body mass index by immigrant generation among young people.

Data

Data come from the National Longitudinal Study of Adolescent Health (Add Health), an ongoing nationally representative, school-based study of adolescents in grades 7 to 12 that began in 1994 who have been followed with multiple interview waves into young adulthood. Add Health was designed to explore the causes of health-related behaviors, with an emphasis on the influence of social context. In 1994-95 Add Health administered an In-School Questionnaire to every student attending school from a nationally representative sample of schools. A sample of 80 high schools and 52 middle schools from the U.S. was selected using a stratified cluster design. Over 70% of the schools originally selected for the survey participated.

Using the school rosters of selected schools, a random sample was selected for in-home interviews with adolescents and a parent in 1995, constituting Wave I data. A number of special samples, including oversamples of various ethnic groups, were also selected on the basis of in-school responses. As a result of high immigration to the US during the 1990s and the Add Health design that oversampled relatively rare ethnic groups (e.g., Cuban, Puerto Rican, and Chinese), Add Health contains a large number of adolescents in immigrant families—one out of four adolescents lived in an immigrant family (first and second generation). Of the adolescents selected for the in-home interviews, 79% participated in Wave I resulting in a sample size of 20,745 adolescents aged 11-19.

All adolescents in grades 7 through 11 in Wave I were followed up one year later for the Wave II in-home interview in 1996, with a response rate of 88.2%. In 2001-02 a third in-home interview was conducted with the original respondents from Wave I as they were now aged 18-28 and

experiencing the transition to adulthood. Over 15,000 Add Health respondents were re-interviewed at Wave III (77.4% response rate) with longitudinal data over the various waves of interviews. See Harris et al. (2003) for more details on the Add Health design and longitudinal data.

We use data from all three in-home interviews by pooling observations across the waves, resulting in a sample size of 48,737. Thus, respondents contribute anywhere from one to three observations on body mass index to our analysis sample for growth curve models.

Measurement

Body Mass Index (BMI). We measure raw BMI at Wave I using self-reported data on height and weight. We measure raw BMI at Waves II and III using measured height and weight. Even though BMI z-scores have been identified as optimal measures of andiposity at a single-point in time, raw BMI scores are best used in evaluated adiposity change in growing children (Cole, Faith, Pietrobelli, and Hero 2005).

Race-Ethnicity. Race and ethnicity are self-reported at Wave I. We use a four-category classification: non-Hispanic white, non-Hispanic black, Non-Hispanic Asian, and Hispanic. We drop the small number of adolescents who listed race as "other" (largely Native American or unknown). Because Add Health oversampled selected ethnic groups there are sufficient sample sizes of Hispanic and Asian youth to analyze their body mass index (despite their small proportions that are representative of the national youth population).

Immigrant Generation. We defined immigrant generation with a three-category variable signifying that the adolescent is foreign-born to foreign-born parents (1st generation), U.S.-born to foreign-born parents (2nd generation) and U.S.-born to U.S-born parents (3rd+generation or native) (Harris 1999). Foreign-born adolescents with foreign-born parents are those children who were not born in the United States nor were they born U.S. citizens abroad. They migrated to the U.S. as children (in most cases with their immigrant parents).

Sex. Female sex is coded as 1, with males the reference category.

Methods

To determine differences in BMI by race-ethnicity, immigrant generation, and sex, we first examined the BMI scores for each age group (11-15, 16-19, 20-24, and 25-28). We then explored mean differences in age-grouped BMI scores by race-ethnicity, immigrant generation, and sex.

To evaluate demographic differences in the risk of becoming overweight and developing obesity, we fit both a linear and non-linear growth curve model with BMI as the continuous outcome and the categorical variables race-ethnicity, immigrant generation, and sex as the primary independent variables.

Growth curve models allow us to evaluate changes over time (i.e. age) for individuals. The model fits a developmental trajectory for changes in BMI as youth age into adulthood (Level 1 model or the intercept model) and allows race-ethnicity, immigrant generation, and gender to

shift that trajectory (Level 2 model or the slope model). Using the notation by Byrk and Raudenbush (1992), our Level 1 model can be written as:

$$BMI\ score_{ti} = \pi_{0i} + \pi_{1i}(age)_{ti} + e_{ti} \quad (1)$$

for each individual (i) at time (t). With three waves of data, we have up to three time observations for each person in the sample. The intercept, π_{0i}, of the growth curve model gives the expected level of BMI at the earliest observed age (11 years old). The slope of the model, π_{1i}, provides the expected change in BMI with a 1-year increase in age. The second level of the growth curve model can be written as:

$$\pi_{0i} = \beta_{00} + \beta_{01}(Female)_{1i} + \beta_{02}(1^{st}\ generation)_{2i} + \beta_{03}(2^{nd}\ generation)_{3i} + \beta_{04}(Asian)_{4i} + \beta_{05}(Black)_{5i} + \beta_{06}(Hispanic)_{6i} + r_{0i}$$
$$\pi_{1i} = \beta_{10} + \beta_{11}(Female)_{1i} + \beta_{12}(1^{st}\ generation)_{2i} + \beta_{13}(2^{nd}\ generation)_{3i} + \beta_{14}(Asian)_{4i} + \beta_{15}(Black)_{5i} + \beta_{16}(Hispanic)_{6i} + r_{1i} \quad (2)$$

The estimated β_{0i} and β_{1i} provide information on how each individual characteristic affects the intercept and slope parameters, respectively. The growth curve model presented here was estimated as a linear growth curve model. In sensitivity analyses, we estimated quadratic and log-linear models. Results were consistent across all specifications of the time dimension, age.

Using the estimated growth curve model, we then predicted each individual's BMI from adolescence through early adulthood (age 11-28), and examine disparities in the BMI trajectories by sex, immigrant generation, and race-ethnicity. Based on these predictions and using the international cutoff points for BMI by sex for overweight and obese (Cole, Bellizi, Flegal, and Dietz 2000), we estimate the % of our sample that would be considered overweight or obese at each age. The work of the International Obesity Task force (Cole et al. 2000) provides cutoff points for overweight and obesity in children that are linked to adult cutoff points.

For all analyses, estimates were adjusted for clustering in the sample design and analyzed using M-Plus version 3.0 (Muthen and Muthen 2005). Bivariate analyses were weighted to reflect the national population estimates. To maximize the power of our analysis, growth curve model were estimated without weights. All growth curve models were recalculated using the weighted data. There were no substantial differences in adjusted odds ratios when the weighted data were used but the results were less precise.

Results

Table 1 presents weighted descriptive statistics on the central variables of our analysis. These results are based on pooled observations across the three interview waves. Results show that BMI increases with age, reflecting developmental growth during adolescence up to age 20. Similar proportions of males and females are present in the data. The majority of observations are native-born with native-born parents in the third and higher immigrant generation (84%), followed by 11% who are native-born with foreign-born parents in the second generation, and 5% foreign-born in the first generation. The race and ethnic distribution reflects sufficient proportions for analysis across the four groups, with the majority non-Hispanic white (68%), followed by 16% Non-Hispanic black, 12% Hispanic, and 4% Asian.

Table 2 presents the results from our linear growth curve model. The results in the first panel ("Intercept" model) indicate that the first generation has a significantly lower BMI at the initial age (age 11) compared to the third+ generation. Females also have lower BMIs than males in early adolescence. Hispanic youth and black youth have higher BMIs than whites at the initial age. The constant reports a BMI of 19.9 at the initial age across all groups.

The second panel ("Slope" model) presents significant results in the change in BMI across age for each of the groups. Results indicate that the growth rate in BMI is lower for both the first and second generation compared to the third+ generation. Females experience a greater increase in BMI than males over these ages, as do Hispanics and blacks compared to whites. The constant term indicates that the average growth rate across all ages is .55. We plan to model interactions between generation and race-ethnicity and between sex and race-ethnicity in subsequent analysis for the final version of the PAA paper.

We show these disparities in BMI trajectories in a series of graphs that plot predicted BMI by age using the model presented in Table 2. Figure 1.1 shows predicted BMI by sex. Females have a lower BMI at the initial age 11, but their increase in BMI is more rapid across age than it is for males, surpassing males in BMI at around age 25. Though these differences are slight, they are significant (Table 2).

Figure 1.2 shows predicted BMI by immigrant generation. Most noticeable is the lower BMI among the first generation. First generation youth have lower BMIs in adolescence, and the increase in BMI as they age into young adulthood is slower than both the second and third generations. Although native-born youth in both the second and third generations have similar BMIs in early adolescence, as they age into young adulthood, BMI among the third generation increases more rapidly than the second generation, and this difference is significant (slope coefficient in Table 2). Thus, not only does immigrant status protect youth against higher BMIs at a point in time (i.e., age), but the increase in BMI as young people age into young adulthood is also slower among immigrants, especially those in the first generation.

Figure 1.3 shows predicted BMI by race-ethnicity. Hispanic and black adolescents have higher BMIs than white and Asian youth in adolescence, and their trajectories indicate increasing disparities over time, especially among Hispanics. Whites and Asians experience the same pattern of change in BMI as they develop from adolescence into young adulthood. In Figure 1.4 we show the generation disparities in BMI within race and ethnic groups. Although the levels of BMI are somewhat higher for Hispanic and black youth, the pattern of change by generation is nearly identical across race and ethnic groups, with first generation experiencing a slower rate of increase in BMI over time compared to second and third generation youth.

The next set of figures displays our transformation of raw BMI into standardized percentile distributions using the international cutoff points for BMI by sex for overweight and obese. These results are useful because they provide an additional perspective on these disparities according to standardized definitions for overweight and obese, by showing the percent of our sample that would be considered overweight or obese at each age by sex, generation, and race-ethnicity. Figure 2.1 shows the percent overweight and Figure 2.2 the percent obese by sex. The

sex disparity in the percent overweight is minor until after age 22 when men outnumber women in the percent overweight. Sex differences in the percent obese do not appear until age 20 when women begin to show equal or slightly higher percentages obese.

Disparities in overweight and obese by immigrant generation in Figures 2.3 and 2.4 are consistent with trends in rave BMI. The first generation is less likely to be overweight or obese at any age from early adolescence into young adulthood. Differences between the second and third generations, however, are not as evident in the percentile distributions, and second generation even surpasses the third generation in the percent obese in the later 20s.

Finally, overweight and obesity disparities by race-ethnicity are shown in the final two figures 2.5 and 2.6. Throughout these ages, Hispanics and blacks are more likely to be overweight than whites, and Asians are the least likely. Disparities in obesity, however, emerge mainly after adolescence, when the percent obese among Hispanic and black young adults begins to increase, while the percent obese among whites increases only slightly, and the percent among Asians even declines in some ages.

Summary of Findings

Overall, disparities in both raw BMI and the percent overweight and obesity tend to increase with age. In particular, disparities tend to widen when adolescents leave the home and begin independent lives as young adults in their 20s. This suggests lifestyle changes may accompany this change in BMI, and may especially explain the generation and race and ethnic differences over time. Future analysis will examine interaction effects between race-ethnicity and immigrant generation, and also interactions with sex.

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Table 1. Descriptive Statistics of Variables Used in the Analysis (Weighted)

Variable	Mean/Distribution	Standard Error
BMI at age 11-15	21.92	0.10
BMI at age 16-19	23.43	0.09
BMI at age 20-24	26.35	0.13
BMI at age 25-28	26.98	0.27
Female	48.57%	0.01
1st Generation	5.38%	0.01
2nd Generation	10.71%	0.01
3rd+ Generation	83.91%	0.02
Hispanic	12.01%	0.02
Asian	4.27%	0.01
Black	15.83%	0.02
White	67.89%	0.03

Note: N = 45,078 pooled observations across three waves.

Table 2. Intercept and Slope Coefficients of a Linear Growth Curve Model Predicting Raw BMI Scores (N = 48,737)

	Dependent Variable					
	Intercept			Slope		
Independent Variable	Coefficient		Standard Error	Coefficient		Standard Error
Immigrant Generation						
1st Generation	-0.888	***	(0.207)	-0.119	***	(0.020)
2nd Generation	0.044		(0.156)	-0.053	***	(0.015)
3rd+ Generation (ref)						
Gender						
Female	-0.251	**	(0.087)	0.022	**	(0.008)
Race/Ethnicity						
Hispanic	0.660	***	(0.153)	0.095	***	(0.015)
Asian	0.035		(0.208)	0.000		(0.019)
Black	0.811	***	(0.109)	0.028	**	(0.010)
White (ref)						
Constant	19.898	***	(0.074)	0.554	***	(0.007)

* $p<.05$ ** $p<.001$ *** $p<.0001$

Note: 3rd+ generation, male, and white are reference groups.

Figure 1.1 Predicted BMI by Sex

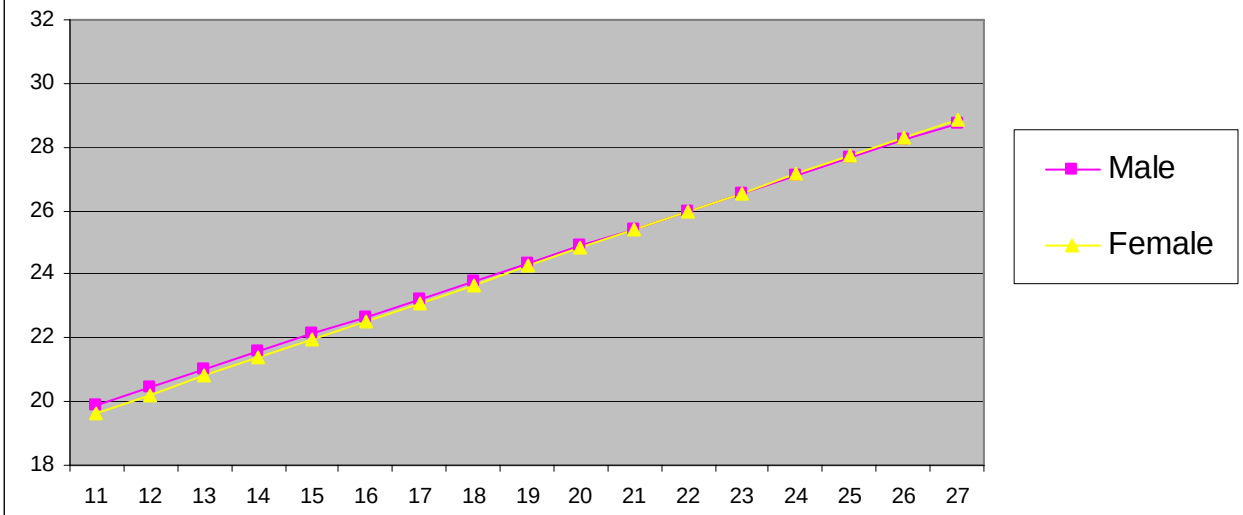
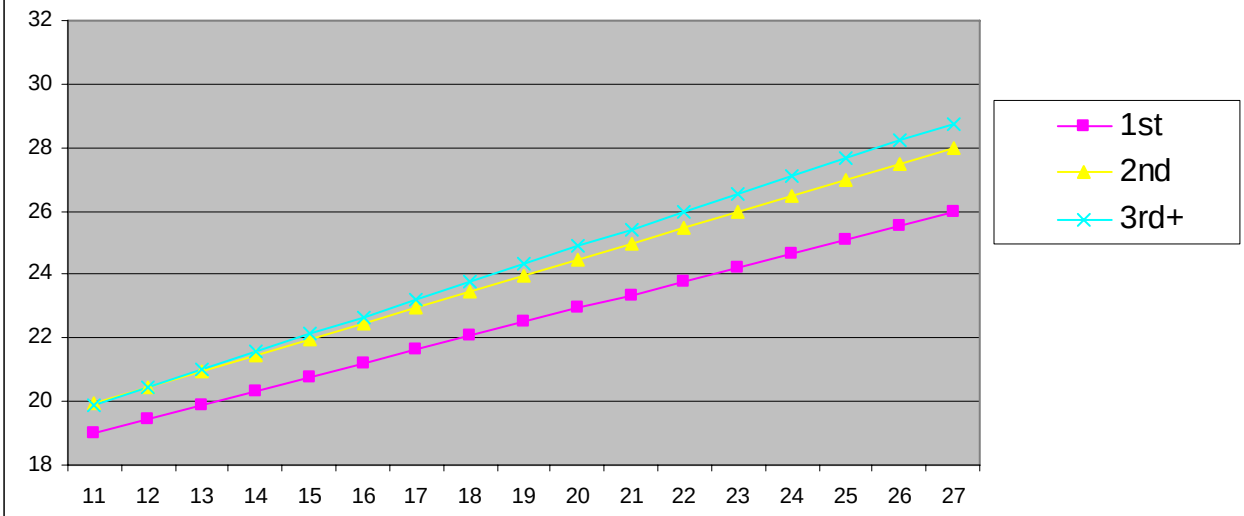


Figure 1.2 Predicted BMI by Immigrant Generation



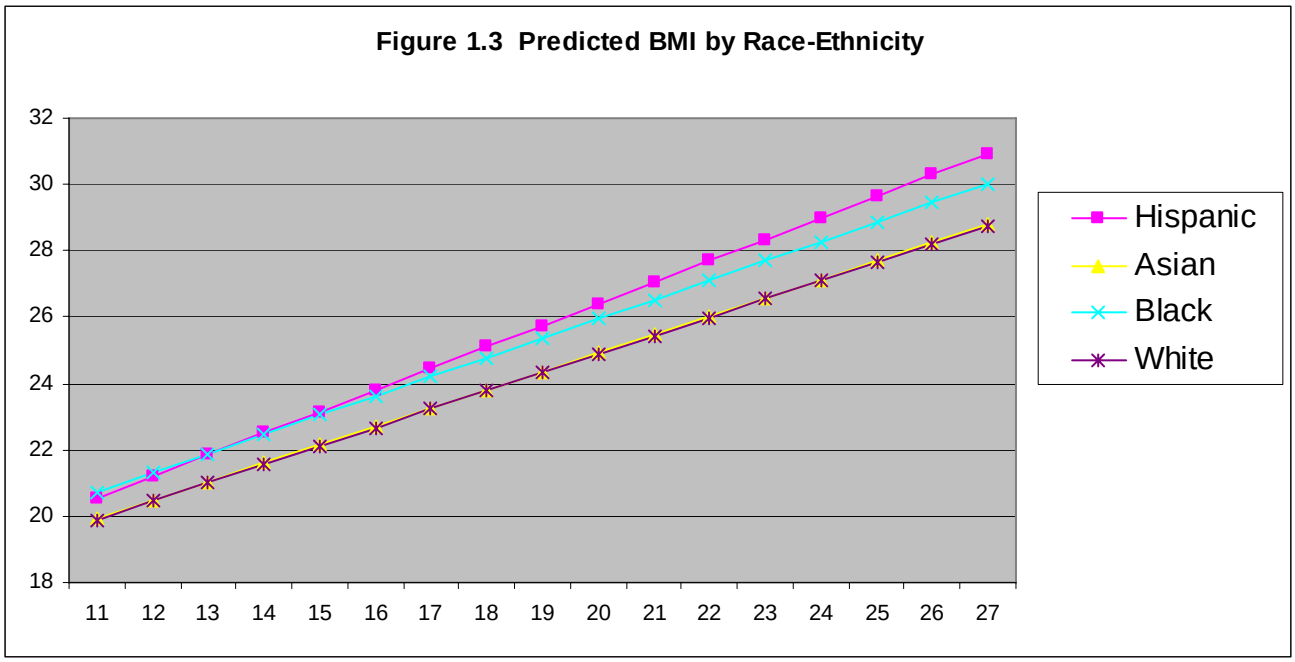


Figure 1.3 Predicted BMI by Race-Ethnicity
32
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Hispanic
Asian
Black
White

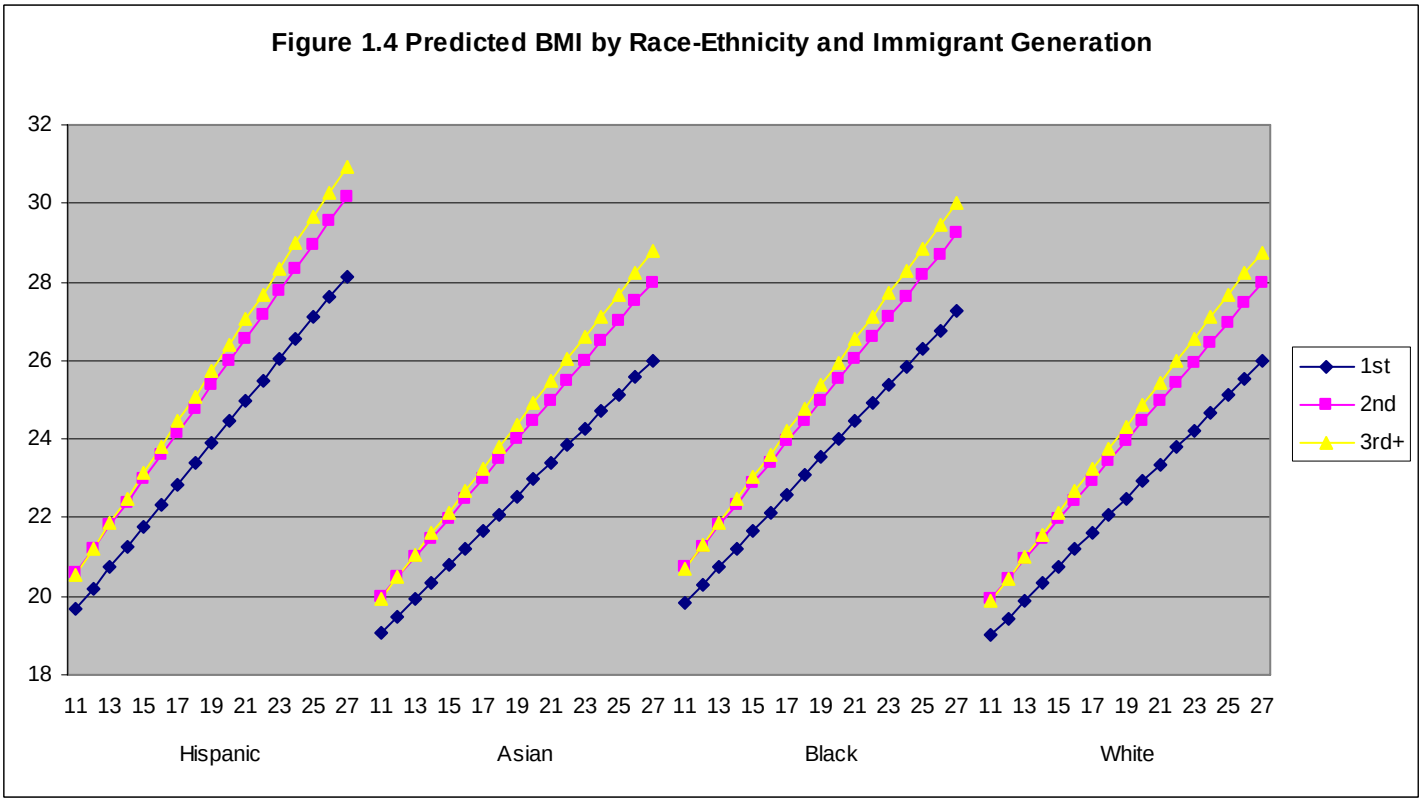
Figure 1.4 Predicted BMI by Race-Ethnicity and Immigrant Generation
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Hispanic
Asian
Black
White
1st
2nd
3rd+

Figure 2.1 Percent Overweight by Sex

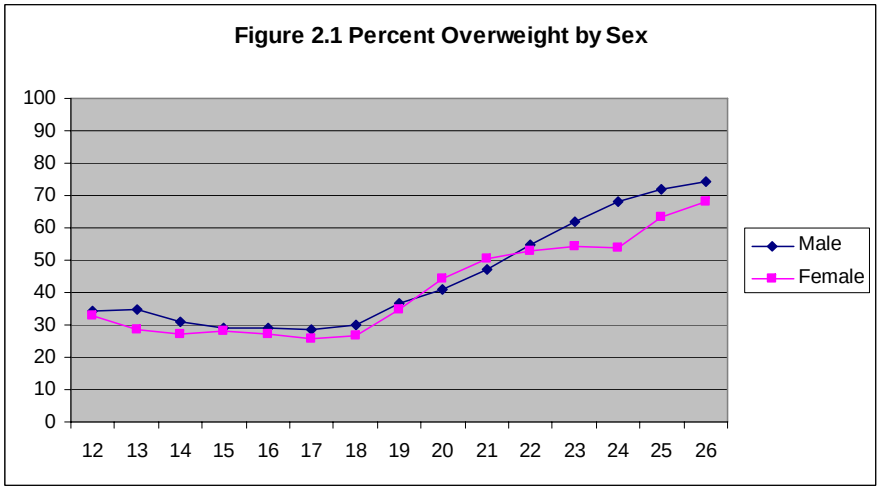

Figure 2.2 Percent Obese by Sex

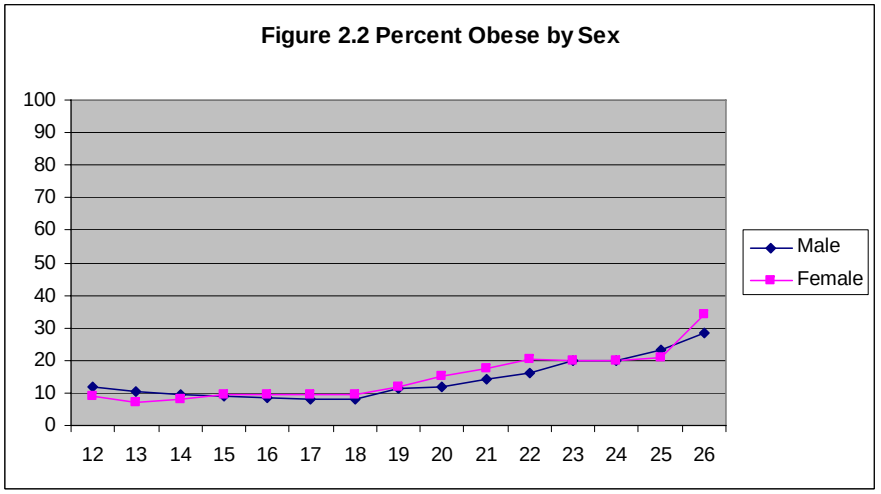

Figure 2.3 Percent Overweight by Immigrant Generation

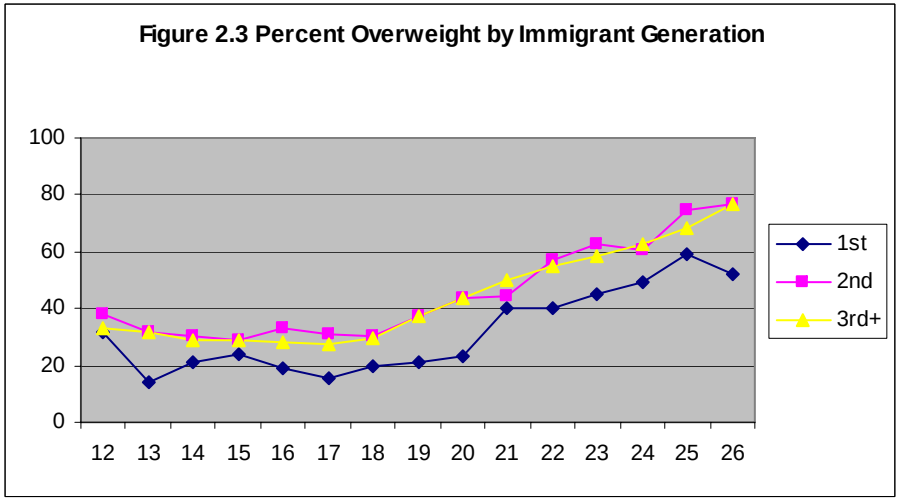

Figure 2.4 Percent Obese by Immigrant Generation

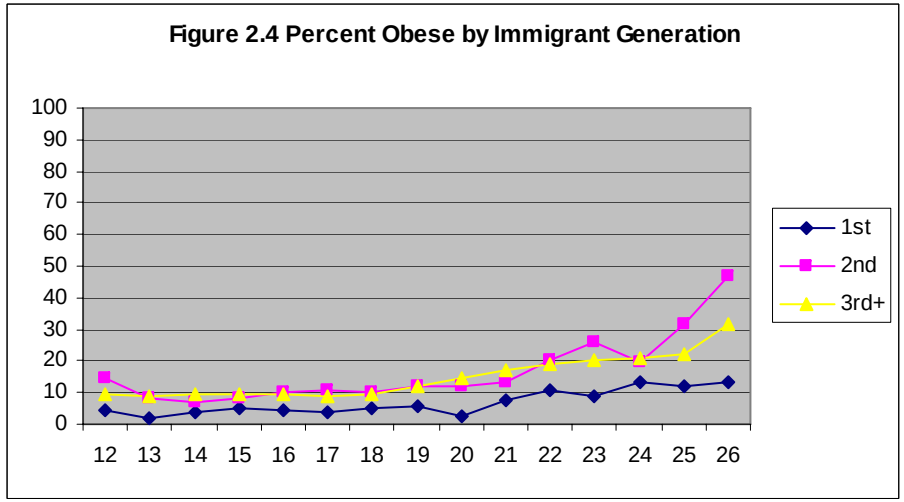

Figure 2.5 Percent Overweight by Race-Ethnicity

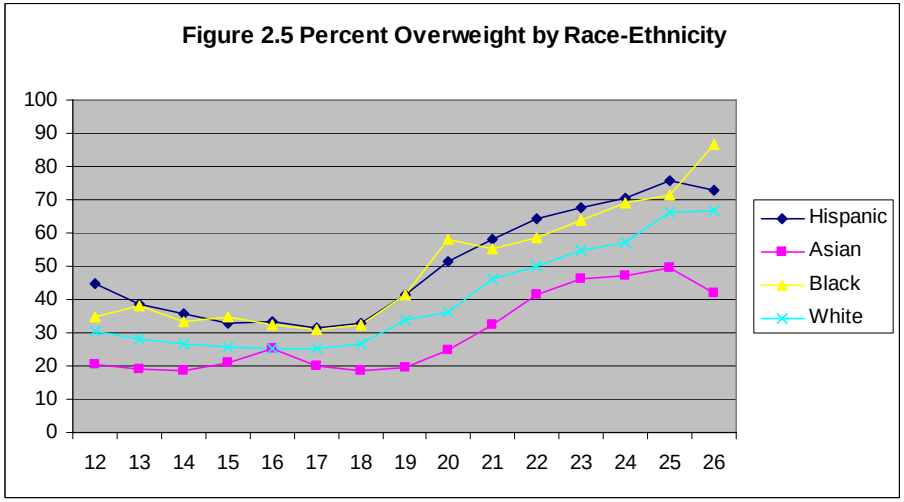

Figure 2.6 Percent Obese by Race-Ethnicity