Age, Period and Cohort Effects on Overweight and Obesity in a Nationally Representative Sample of Adults

by

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Studies of the U.S. population have consistently shown a dramatic upswing in overweight and obesity over the past two decades (1-9). According to direct measures of height and weight in the Third National Health and Nutrition Examination Surveys (NHANES), the prevalence of adult obesity was about 15 percent in 1976-80 (3). As of 1999-2000, NHANES estimates indicated that nearly 31 percent of adults in the U.S. were obese, an increase of over 100 percent (2). The sharp rise in overweight and obesity has affected every demographic group in the U.S., including children and adolescents (8-9) and adults of all ages (1-5, 7), males and females (1-9), all educational groups (5-6), all major racial and ethnic groups (1-9) and every geographic region within the U.S. (4).

Given the widespread and rapid increase in obesity rates, scholars have tended to adopt an epidemic interpretation. Insofar as the term epidemic is used to describe obesity rates that are "clearly in excess of normal expectancy" (10, p. 42), this interpretation is undeniably correct. However, it is premature to conflate the epidemic with secular trends (i.e., period effects), since no study to date has disentangled period effects from age *and* birth cohort effects in a study of the U.S. population. Rather, existing research tends to assume that the increase in age-adjusted obesity rates is due to period effects (6). Although this assumption is plausible, the importance of secular change relative to cohort membership is currently unknown.

Neither period nor cohort effects are direct causes of obesity, but rather surrogates for underlying processes (11). Epidemiologists and social scientists have devoted considerable thought to understanding how environmental and behavioral changes in recent history may have led to the obesity epidemic (12-15). By comparison, virtually no attention has been given to plausible cohort related processes. Newer cohorts are generally more likely than older cohorts to adopt new technologies and lifestyles (16), which may place them at greater risk for obesity. If so, then rising obesity rates could be due in part to a form of "demographic metabolism" (16, p. 843) in which older, leaner cohorts are replaced with newer, heavier cohorts. Such speculation about the etiology of the obesity epidemic will benefit from an improved understanding of age, period and cohort effects. Toward this end, this study will conduct age-period-cohort (APC) analyses of overweight and obesity among U.S. adults using data from the National Health Interview Survey (NHIS), 1976-2002 (17-18).

MATERIALS AND METHODS

Study populations

The National Health Interview Survey (NHIS) is a repeated cross-sectional household survey of the noninstitutionalized civilian population in the U.S. (19). Its primary functions are to monitor the prevalence and distribution of disease and disability in the U.S. and assess patterns of health care utilization. Details regarding the design and methods of NHIS have been described previously (20). Although NHIS extends back to 1957, it did not begin collecting data on weight and height until 1976. This study merged NHIS data from 1976-2002 into a single database consisting of approximately 1.65 million adults aged 18 and over. Although NHIS also investigated the health of children and adolescents, it did not include estimates of their height or weight. Even if this information were available, integrating children and adolescents into a study of adult obesity would pose serious challenges since overweight is assessed differently among children and adolescents than adults (21).

In addition to NHIS, this study incorporated National Health and Nutrition Examination Survey (NHANES) data from 1976-1980 (NHANES II) and 1999-2000 (NHANES Continuous). Like NHIS, NHANES has utilized probability sampling techniques to study the health of the noninstitutionalized civilian population in the U.S. (22). Unlike NHIS, NHANES contains direct anthropometric measures of several health indicators, including height and weight. Despite this advantage, NHANES was not conducted annually from 1976 to 2002, so it cannot match NHIS in regard to level of detail on time period. But since direct measures of height and weight are known to be more accurate than self-reported measures (23-26), NHANES was used to assess whether NHIS correctly estimated the rate of mean BMI change over the period 1976-80 to 1999-2000.

Measures

Self-reported measures of height and weight in NHIS were used to calculate body mass index (BMI), which equals weight in kilograms divided by height in meters, squared (kg/m^2). Additionally, direct measures of height and weight in NHANES were used to calculate BMI. To protect the confidentiality of respondents, NHIS began to censor unusual values of height and weight in 1997 (27). Fortunately, NHIS also provided a variable for BMI from 1997-2002 that was based on reported values of height and weight rather than the censored values. Due to suspected measurement error, subjects reporting a BMI value of less than 10 were eliminated from the NHIS sample; BMI values this low have only been observed among a handful of patients during the peak of the 1992-93 Somali famine (28). Classifications identified by the National Institutes of Health (29) were used to create indicator variables for overweight (BMI $\geq$ 25), obesity (BMI $\geq$ 30) and class II obesity (BMI $\geq$ 35). Although it is legitimate to treat these categories as separate entities (e.g., overweight BMI = 25-29.9) in certain applications, they are actually not mutually exclusive. To avoid underestimating the odds of overweight and obesity, this analysis requires conceptualizing obesity and class II obesity as subsets of overweight, not as entirely separate categories.

Age was subtracted from period (i.e., year of study) to identify birth cohorts, which ranged from 1877 to 1984. Cohorts were arranged into five-year groups, with the exception of the initial cohort (1877 to 1899), which covered a broader range of years to ensure a sufficient number of subjects. After constructing birth cohorts, age was collapsed into three-year intervals (e.g., 18-21) and a final category of 84 and over. Because each wave of NHIS is relatively large, period was left in single year increments. To permit estimation of the unique effect of each age group, birth cohort and time period, indicator variables were constructed based on these categorizations.

Measures of sex, race and education were also extracted from NHIS. Sex and race were used to construct stratified APC models. In each year from 1976-2002, NHIS included a racial identification variable that categorized respondents as white, black or other. Due to substantial changes in the measurement of Hispanic ancestry during this period, ethnic classifications were not utilized. Because education is a key indicator of socioeconomic status and closely tied to health behaviors (30), it is important to consider its influence on age, period and cohort effects. Education was recoded into less than high school (0-11 years of education), high school (12 years of education), some college (13-15 years of education) and college or more (16 or more years of education). Indicator variables were subsequently created for each educational category.

Statistical analyses

Before constructing APC models, two issues had to be resolved. First, it was necessary to determine whether NHIS and NHANES yielded comparable estimates of BMI change. This was accomplished by comparing mean BMI values in NHIS and NHANES during the periods 1976-80 and 1999-2000. Research suggests that self-reported BMI values are biased downward but valid for detecting relationships in population-based studies (23). Furthermore, because this study is not concerned with accurately assessing prevalence but rather relative differences and change, the downward bias in self-reported BMI values is not problematic as long as it has remained consistent from 1976-2002. However, if the bias has diminished or grown substantially over this period, then APC models based on self-reported height and weight may produce misleading estimates, particularly of period effects.

Second, it was necessary to resolve the identification problem posed by APC analysis. Traditionally, APC analyses have arranged aggregate data into tables where column and row variables represent period and age, respectively, and diagonals identify birth cohorts (31). In such tables, an exact linear dependency exists between age, period and cohort, confounding visual interpretation and causing underidentification of model parameters (32). A classic solution to this problem is to hold two parameters along one of the dimensions (e.g., age) constant, thereby breaking the linear dependency. Although this approach yields stable estimates of model fit (32-33), parameter estimates can be highly sensitive to the choice of equality constraint. Fortunately, with micro-level survey data such as NHIS, it is possible to group age, period and cohort into different time intervals, which effectively resolves the identification problem (34). This obviates the need to impose equality constraints, but various model specifications were nevertheless compared to test the stability of parameter estimates. Overall, these specifications resulted in highly consistent parameter estimates, including models without any equality constraints (results not shown). Because models without equality constraints make fewer assumptions of the data, they are the preferable and will be employed throughout the rest of the study.

Data management and analyses were conducted with SAS 8.02 (35). For each outcome, Age-period-cohort models of overweight, obesity, class II obesity and BMI were constructed for the entire population. Models of obesity were also stratified by race (white and black, only) and sex. Each APC model was evaluated both with and without education as a control variable. Except for descriptive statistics of the NHIS sample, survey weights provided by NHIS and NHANES were used to adjust for response probabilities and sampling design. Since cohort effects may manifest themselves through compositional changes over time (16, 36-37), period specific weights were used rather than imposing a single standard. Given the large sample size and possibility that standard errors are often underestimated in APC models (34), conservative tests of statistical significance were employed ($p < 0.0001$, one-sided for Wald Chi-Square tests in logistic regression models, two-sided for t tests in ordinary least-squares regression models).

RESULTS

Unweighted statistics were used to describe the combined NHIS samples (table 1). To simplify interpretation, table 1 presents age, period and cohort variables in wider increments than the APC models. A robust number of subjects are present in each category for age, period, sex, race and education. Although less than one percent of the sample belonged to either the 1877-99 or 1980-84 cohort, the sample sizes of 14,662 and 6,359, respectively, are nevertheless quite large. The prevalence of obesity increased sharply with age and period, except for a notable decline from the 55-64 (17.2 percent) to the 65 and over (13.3 percent) age categories. Birth cohorts showed no clear pattern, but it is important to note that the prevalence of obesity was higher in the 1980-84 cohort (13.0 percent) than its predecessor (11.0 percent). Obesity decreased as the level of education increased and it was more prevalent among women (14 percent) than men (12.7 percent) and blacks (21.2 percent) than whites (12.5 percent).

BMI change in NHIS and NHANES

As expected, self-reported height and weight in NHIS underestimated mean BMI. For instance, NHIS estimated that the mean BMI of the U.S. population was 24.3 in 1976-80, which was lower than the NHANES estimate of 25.2. However, between 1976-80 and 1999-2000, the rate of mean BMI change was roughly similar in these studies. For the entire population, mean BMI increased by a factor of 1.09 and 1.11 in NHIS and NHANES, respectively. An individual with a BMI of 25 in 1976-80 would, on average, report a BMI of 27.3 in the 1999-2000 NHIS and record a BMI of 27.7 in the 1999-2000 NHANES. Discrepancies between NHIS and NHANES were slightly smaller among men (1.08 and 1.09, respectively) than women (1.10 and 1.12, respectively). Due to slight underestimation of mean BMI change in NHIS, period effects should be interpreted as conservative estimates, particularly for women.

Parameter estimates for the U.S. population

The effects of age in APC models of overweight (BMI ≥ 25), obesity (BMI ≥ 30) and class II obesity (BMI ≥ 35) are presented in table 2. Net of period and cohort effects, the odds of overweight, obesity and class II obesity increased rapidly through young adulthood, plateaued during middle age and then declined in later life. Overweight, obesity and class II obesity generally peaked during the early to mid 50s. In models without education, respondents 51-53 years of age were 4.0 times more likely to be overweight ($p < 0.0001$), 3.6 times more likely to be obese ($p < 0.0001$) and 3.7 times more likely to exhibit class II obesity ($p < 0.0001$) than respondents 18-20 years of age. When education was introduced, the odds of overweight, obesity and class II obesity increased among younger age groups and declined among older age groups. Interestingly, holding education constant caused the odds of class II obesity to peak at 42-44 (odds ratio = 4.2, $p < 0.0001$) rather than 51-53 years of age. Ordinary least-squares (OLS) regression models corroborated these findings, since BMI increased rapidly with age, plateaued and then declined in later life (results not shown). In a model controlling for education, BMI peaked among respondents aged 51-53, who were an average of 3.2 BMI units higher than respondents aged 18-20.

From 1976 to 2002, the odds of reporting overweight, obesity and class II obesity increased substantially (table 3). Independent of age and cohort effects, U.S. citizens in 2002 were approximately 2.5 times more likely to be overweight ($p < 0.0001$), 3.5 times more likely to be obese ($p < 0.0001$), and 4.4 times more likely to exhibit class II obesity ($p < 0.0001$) than U.S. citizens in 1976. Introducing education caused the odds ratios for overweight, obesity and class II obesity in 2002 to increase to 2.8 ($p < 0.0001$), 4.1 ($p < 0.0001$) and 5.3 ($p < 0.0001$), respectively. Although all of these coefficients are significant, it is clear that the likelihood of obesity and particularly class II obesity has increased at a faster pace than the likelihood of overweight. Ordinary least-squares models also indicate that BMI has increased steadily over this period. Controlling for education, U.S. citizens were an average of 3.1 ($p < 0.0001$) units higher in BMI in 2002 than they were in 1976.

Relative to age and period, few cohort parameters met the criterion of statistical significance (table 4). Nevertheless, there are some interesting and somewhat surprising results in table 4. First, the odds of overweight, obesity and class II obesity tended to *decline* among cohorts born in the early to mid 20th century. Second, relative to the cohort born in 1877-99, the cohort born in 1960-64 consistently exhibited the lowest odds of overweight, obesity and class II obesity. In APC models without education, the 1960-64 cohort was 71 percent as likely as the 1877-99 cohort to be overweight ($p < 0.0001$), 66 percent as likely to be obese ($p < 0.0001$) and 70 percent as likely to exhibit class II obesity ($p > 0.0001$). Third, when education was introduced, six of nine statistically significant coefficients in models without education became insignificant. Fourth, the odds of obesity and class II obesity have increased for cohorts born after 1964. Models (without education) that omitted the 1960-64 cohort rather than the 1877-99 cohort indicate that persons born in 1980-84 were 1.4 times more likely to report obesity ($p < 0.0001$) and 1.5 times ($p < 0.0001$) more likely to report class II obesity than persons born in 1960-64. Although education slightly weakened these odds ratios to 1.3 and 1.4, respectively, they remained statistically significant ($p < 0.0001$).

As expected, education exerted a strong protective effect against overweight and obesity. With increasing levels of education, the odds of overweight obesity monotonically decreased (table 1). For instance, relative to persons who did not complete high school, the odds of obesity were 0.68 ($p < 0.0001$) among persons who completed high school, .58 ($p < 0.0001$) among persons with some college and .37 ($p < 0.0001$) among persons with a college degree. Moreover, the protective effects of education became more evident as the type of overweight increased in severity. Compared to persons without a high school degree, for example, persons with a college degree were 52 percent as likely to be overweight ($p < 0.0001$), 37 percent as likely to be obese ($p < 0.0001$) and only 29 percent as likely to exhibit class II obesity ($p < 0.0001$).

Models stratified by race and sex

Age effects in APC models of obesity (without education) for white women, white men, black women and black men are shown in figure 1. All four groups exhibited a similar pattern of rising odds of obesity through young adulthood and declining odds in later life. However, there were also several interesting differences. For instance, the odds of obesity peaked at later ages and higher levels among women. The odds of obesity peaked at 4.7 ($p < 0.0001$) among both black and white women aged 54-56. By comparison, the odds of obesity peaked at the age of 48-50 among white men (odds ratio = 2.8, $p < 0.0001$) and 33-35 among black men (odds ratio = 3.1; $p < 0.0001$). Also interesting is the finding that until the age of 33-35, the odds of obesity among black men increased at a pace comparable to both black and white women. After that age, however, a sharp divergence occurred in which the odds of obesity began to decline for black men but continued to increase for women. Finally, beginning in the late 50s and early 60s, the odds of obesity fell at a faster pace among black men and women relative to white men and women. This difference subsequently stabilized and persisted throughout the rest of the lifecourse.

Consistent with previous results, the odds of obesity among blacks and whites of each sex increased substantially over the period 1976-2002 (figure 2). This increase was particularly sharp for black men, who were 4.9 times ($p < 0.0001$) more likely to report obesity in 2002 than they were in 1976. White men were also strongly affected (odds ratio = 4.3, $p < 0.0001$). By comparison, white women (odds ratio = 2.9, $p < 0.0001$) and black women (odds ratio = 2.9, $p < 0.0001$) were not as strongly affected by period changes. Although these estimates are by no means small, it is important to reiterate that they are probably conservative, particularly for women.

Whereas age and period have affected men and women in a similar fashion, cohort membership has affected blacks and whites in a generally similar fashion. The odds of obesity among black cohorts born between 1915-19 and 1955-59 fell sharply relative to earlier black cohorts, especially among men. By comparison, the odds of obesity among white cohorts born between 1915-19 and 1955-59 remained relatively stable. Among black men and women, the odds of obesity reached its lowest point in the 1955-59 cohort, which was 40 ($p > 0.0001$) and 50 percent ($p > 0.0001$), respectively, as likely as the 1877-99 cohort to report obesity. Subsequent black cohorts have shown a general pattern of increasing odds of obesity. Importantly, this trend is also evident among white women. Although the odds of obesity has also increased among white male cohorts born after 1964, the pace of increase among white males is clearly less pronounced than the other three groups.

DISCUSSION

These results support previous findings that weight increases rapidly through young adulthood but subsequently increases at a slower pace (6, 38-39). Since physical activity tends to decline during young adulthood (40-41) but dietary behaviors may include frequent fast food consumption and other unhealthy practices (42), it is not surprising to observe increasing odds of overweight and obesity among young adults. The plateau observed during middle age may result from more careful monitoring of calorie intake (6), since available evidence suggests that energy expenditure and physical activity continue to decline at these ages (43-44). These results are also consistent with findings that weight loss is common at older ages (39, 45). This is not necessarily encouraging since weight loss in later life may result from muscular atrophy (45-47) and is associated with increased risk of illness, hospitalization and mortality (45, 47-48).

Importantly, this study confirms that period effects are principally responsible for the obesity epidemic. Independent of age and cohort effects, the odds of overweight, obesity and particularly class II obesity have increased substantially since 1976. Secular changes responsible for strong period effects may include an increasing reliance on technology for work (12-13), food preparation (15) and leisure activities (12), declining food costs and economic incentives to engage in physical activity (13-14), and excessive marketing and consumption of high calorie foods (12, 49).

Relative to cohorts born toward the end of the nineteenth century, cohorts born during the latter half of the twentieth century were not significantly more likely to report overweight or obesity. Instead, the likelihood of obesity has remained relatively stable for white cohorts and actually declined noticeably for certain black cohorts, particularly those born during the 1940s and 50s. However, since the late 1950s, birth cohorts have shown an increasing tendency to report obesity. This trend was particularly evident for blacks and white females. This key finding is consistent with assertions that newer cohorts permit social change through various mechanisms, including technological adaptation (16). Unfortunately, the rapid adoption of modern technologies may facilitate lifestyles that ultimately place newer cohorts at increased risk for overweight and obesity.

Consistent with previous studies (4-5, 7, 13), education showed a strong protective effect against overweight and obesity. This protective effect was most pronounced for class II obesity. This is important, since it indicates that education is particularly helpful in preventing more serious forms of overweight and their corresponding health complications (7). It is also interesting to note that period effects increased substantially when education was introduced as a control variable. Continuing a trend that began in the late 1940s, educational attainment in the

U.S. improved over the period of observation in this study (50). Evidently, this improvement has limited increases in overweight and obesity caused by secular change.

Strengths of this study include a large nationally representative sample, micro-level data and refined measures of age, period and cohort. Also, the initial period of observation in this study (1976) preceded the sharp increase in obesity rates (3), suggesting that estimates for period effects were not attenuated by the inability to include earlier periods. As discussed previously, a limitation of this study is that self-reported measures of height and weight in NHIS slightly underestimated the rate of mean BMI increase. Consequently, period effects may be biased downward, particularly for women. Another limitation of this study is the inability to isolate non-Hispanic whites from Hispanic whites. Since the prevalence of overweight and obesity is somewhat higher among Hispanics than non-Hispanic whites (2-5), increasing odds of overweight and obesity among whites may be partly due to changing ethnic composition rather than secular change. Furthermore, this study cannot address whether the odds of obesity has continued to increase among cohorts born after 1984. Clearly, this is a pressing question.

Increasing odds of overweight and obesity during young adulthood emphasize the importance of developing strategies to prevent excessive weight gain at this stage of life. This task is daunting, particularly since secular changes are unlikely to reverse course and the odds of obesity appear to be increasing among newer cohorts. Fortunately, this study suggests that education holds considerable promise in addressing this problem. Beneficial aspects of education may be accentuated by incorporating material on diet and physical activity into existing curricula, developing targeted public health campaigns, and working to improve access and retention in higher education.

Future research should address whether cohorts born since 1984 have continued to experience increasing odds of overweight and obesity, independent of age and period effects. If possible, future APC studies should also utilize direct measures of height and weight and account for both race and ethnicity. Additionally, because period and cohort effects are simply proxies for underlying processes, future APC studies should attempt to incorporate variables (e.g., food prices) that may directly account for rising rates of overweight and obesity. If the inclusion of such variables led to the attenuation of period effects, it would contribute much to understanding the etiology of the obesity epidemic. Because this epidemic has such serious consequences for the health (51-54), economy (55) and quality of life (56-57) of the U.S. population, every effort should be taken to improve our collective understanding of its causes and potential solutions.

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TABLE 1. Descriptive statistics for National Health Interview Study data, 1976-2002

Variable	*n*	Percent of NHIS Sample (n = 1,645,845)	Percent Obese
Age			
18-24	231,733	14.08	6.70
25-34	366,367	22.26	11.24
35-44	322,492	19.59	15.22
45-54	246,590	14.98	17.64
55-64	206,657	12.56	17.21
65 and over	272,006	16.53	13.30
Period			
1976-79	193,061	11.73	9.27
1980-84	369,004	22.42	10.02
1985-89	364,062	22.12	12.22
1990-94	417,664	25.38	14.68
1995-99	209,771	12.75	18.67
2000-02	92,283	5.61	22.97
Cohort			
1877-99	14,662	0.89	5.41
1900-19	192,940	11.72	11.47
1920-39	409,403	24.87	16.19
1940-59	654,690	39.78	13.84
1960-79	367,791	22.35	10.99
1980-84	6,359	0.39	12.93
Sex			
Males	763,088	46.36	12.71
Females	882,757	53.64	14.06
Race			
White	1,390,635	84.49	12.45
Black	200,397	12.18	21.24
Other	54,813	3.33	9.77
Education			
Less than h.s.	399,528	24.27	17.70
High school	608,543	36.97	13.45
Some college	326,737	19.85	12.27
College or more	296,488	18.01	8.90
Missing	14,549	0.88	13.71

TABLE 2. Effects of age and education in APC models of overweight, obesity, class II obesity and body mass index, National Health Interview Study data, 1976-2002

	Overweight†		Obesity†		Class II Obesity†	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Age						
18-20‡	1.00	1.00	1.00	1.00	1.00	1.00
21-23	1.42*	1.53*	1.43*	1.59*	1.57*	1.78*
24-26	1.83*	2.01*	1.84*	2.12*	1.94*	2.31*
27-29	2.24*	2.46*	2.22*	2.58*	2.37*	2.84*
30-32	2.57*	2.81*	2.54*	2.94*	2.78*	3.32*
33-35	2.83*	3.08*	2.79*	3.21*	3.01*	3.58*
36-38	3.08*	3.33*	3.01*	3.44*	3.18*	3.76*
39-41	3.29*	3.53*	3.12*	3.54*	3.31*	3.89*
42-44	3.56*	3.79*	3.38*	3.79*	3.62*	4.19*
45-47	3.68*	3.89*	3.40*	3.79*	3.64*	4.18*
48-50	3.90*	4.09*	3.52*	3.88*	3.61*	4.08*
51-53	4.04*	4.19*	3.59*	3.91*	3.69*	4.09*
54-56	4.07*	4.18*	3.50*	3.78*	3.47*	3.81*
57-59	4.00*	4.08*	3.41*	3.64*	3.38*	3.67*
60-62	3.97*	3.99*	3.27*	3.43*	3.26*	3.49*
63-65	3.80*	3.78*	3.16*	3.27*	3.01*	3.17*
66-68	3.55*	3.51*	2.89*	2.96*	2.72*	2.82*
69-71	3.26*	3.18*	2.66*	2.69*	2.38*	2.42*
72-74	2.94*	2.83*	2.28*	2.27*	2.03*	2.04*
75-77	2.55*	2.44*	1.95*	1.91*	1.50	1.50
78-80	2.10*	1.99*	1.59*	1.55*	1.20	1.17
81-83	1.67*	1.56*	1.21	1.16	0.91	0.88
84+	1.18	1.09	0.90	0.84	0.60	0.56
Education						
Less than h.s.‡		1.00		1.00		1.00
High school		0.75*		0.68*		0.63*
Some college		0.67*		0.58*		0.53*
College or more		0.52*		0.37*		0.29*

* $p < 0.0001$

† Reported estimates are odds ratios. Overweight, BMI ≥ 25; obesity, BMI ≥ 30; class II obesity, BMI ≥ 35.

‡ Parameter omitted from the model.

TABLE 3. Effects of period and education in APC models of overweight, obesity, class II obesity and body mass index, National Health Interview Study data, 1976-2002

	Overweight†		Obesity†		Class II Obesity†	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Period						
1976‡	1.00	1.00	1.00	1.00	1.00	1.00
1977	1.00	1.00	1.05	1.05	1.05	1.05
1978	1.00	1.01	1.09	1.10	1.01	1.01
1979	1.02	1.03	1.12*	1.14*	1.09	1.10
1980	1.05	1.07*	1.17*	1.20*	1.17	1.19
1981	1.05	1.07*	1.22*	1.25*	1.21	1.24*
1982	1.07*	1.10*	1.22*	1.25*	1.20	1.24*
1983	1.10*	1.13*	1.26*	1.30*	1.31*	1.36*
1984	1.13*	1.17*	1.29*	1.35*	1.31*	1.38*
1985	1.18*	1.24*	1.37*	1.44*	1.44*	1.52*
1986	1.24*	1.30*	1.44*	1.53*	1.51*	1.61*
1987	1.26*	1.33*	1.51*	1.61*	1.63*	1.75*
1988	1.29*	1.36*	1.51*	1.62*	1.60*	1.72*
1989	1.33*	1.41*	1.62*	1.75*	1.68*	1.82*
1990	1.38*	1.48*	1.64*	1.78*	1.73*	1.90*
1991	1.45*	1.56*	1.78*	1.95*	1.92*	2.11*
1992	1.52*	1.64*	1.91*	2.09*	2.13*	2.35*
1993	1.62*	1.75*	2.03*	2.25*	2.30*	2.56*
1994	1.65*	1.79*	2.07*	2.31*	2.31*	2.58*
1995	1.72*	1.88*	2.16*	2.43*	2.51*	2.84*
1996	1.77*	1.95*	2.27*	2.56*	2.55*	2.91*
1997	2.05*	2.27*	2.68*	3.04*	3.24*	3.70*
1998	2.14*	2.39*	2.83*	3.25*	3.31*	3.85*
1999	2.26*	2.53*	3.04*	3.51*	3.62*	4.22*
2000	2.28*	2.57*	3.07*	3.56*	3.82*	4.47*
2001	2.42*	2.74*	3.28*	3.83*	4.04*	4.77*
2002	2.47*	2.82*	3.46*	4.11*	4.40*	5.28*
Education						
less than h.s.‡		1.00		1.00		1.00
high school		0.75*		0.68*		0.63*
some college		0.67*		0.58*		0.53*
college or more		0.52*		0.37*		0.29*

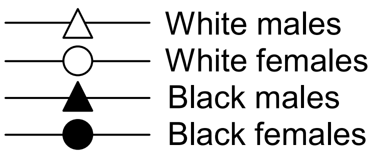
* $p < 0.0001$
† Reported estimates are odds ratios. Overweight, BMI ≥ 25; obesity, BMI ≥ 30; class II obesity, BMI ≥ 35.
‡ Parameter omitted from the model.

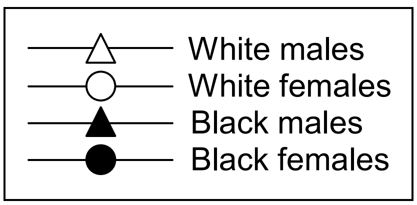
TABLE 4. Effects of cohort and education in APC models of overweight, obesity, class II obesity and body mass index, National Health Interview Study data, 1976-2002

	Overweight†		Obesity†		Class II Obesity†	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Cohort						
1877-99‡	1.00	1.00	1.00	1.00	1.00	1.00
1900-04	0.99	0.99	1.02	1.01	1.01	1.06
1905-09	0.95	0.96	0.98	0.99	0.98	1.03
1910-14	0.95	0.96	0.95	0.96	0.96	1.01
1915-19	0.90	0.92	0.88	0.91	0.88	0.95
1920-24	0.88	0.91	0.84	0.88	0.84	0.92
1925-29	0.87	0.90	0.83	0.86	0.83	0.92
1930-34	0.85*	0.88	0.82	0.88	0.83	0.93
1935-39	0.84	0.88	0.80	0.85	0.82	0.93
1940-44	0.81*	0.85	0.77	0.85	0.81	0.95
1945-49	0.77*	0.83	0.74	0.85	0.80	0.97
1950-54	0.73*	0.78*	0.71	0.81	0.77	0.94
1955-59	0.71*	0.74*	0.67*	0.74	0.72	0.85
1960-64	0.71*	0.72*	0.66*	0.71	0.70	0.80
1965-69	0.75*	0.76	0.72	0.78	0.75	0.86
1970-74	0.78	0.78	0.79	0.84	0.87	0.98
1975-79	0.77	0.76	0.84	0.87	0.95	1.05
1980-84	0.77	0.73	0.91	0.89	1.08	1.12
Education						
less than h.s.‡		1.00		1.00		1.00
high school		0.75*		0.68*		0.63*
some college		0.67*		0.58*		0.53*
college or more		0.52*		0.37*		0.29*

* $p < 0.0001$
† Reported estimates are odds ratios. Overweight, BMI ≥ 25; obesity, BMI ≥ 30; class II obesity, BMI ≥ 35.
‡ Parameter omitted from the model.

LEGEND OPTIONS FOR FIGURES 1-3





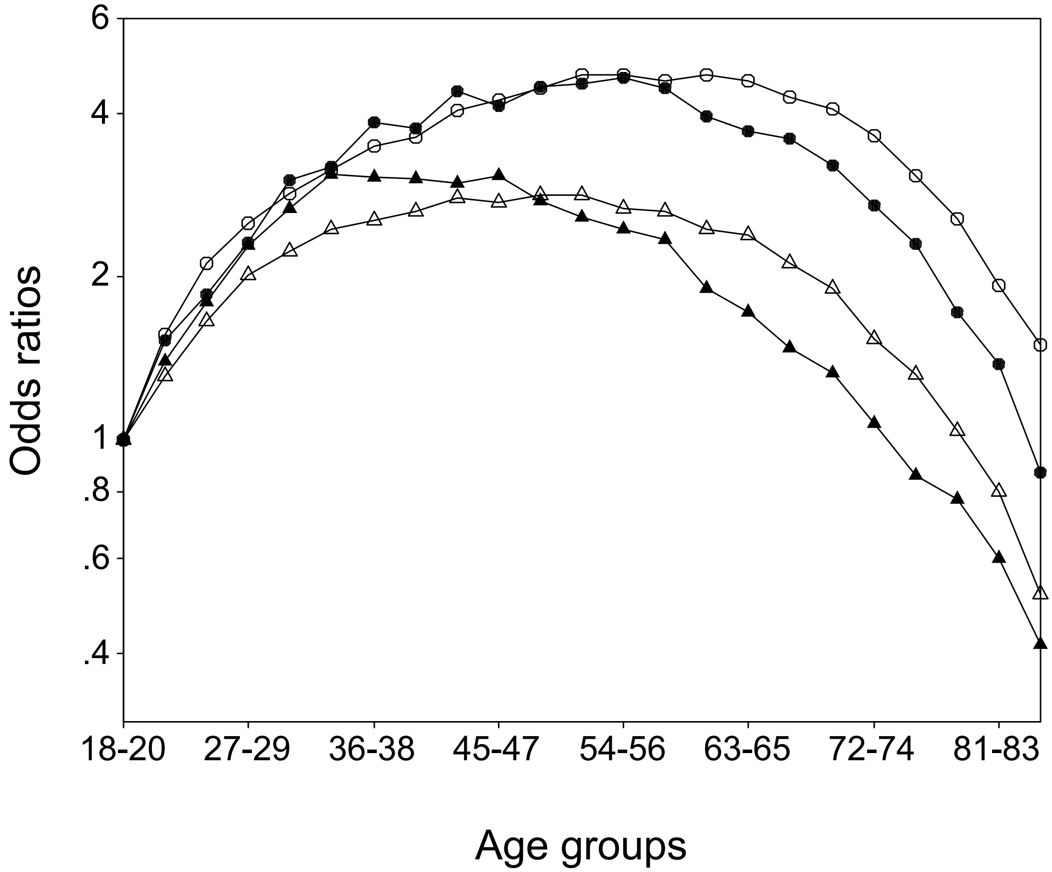


Figure 1: Age effects by race and sex in APC models of obesity, NHIS data 1976-2002

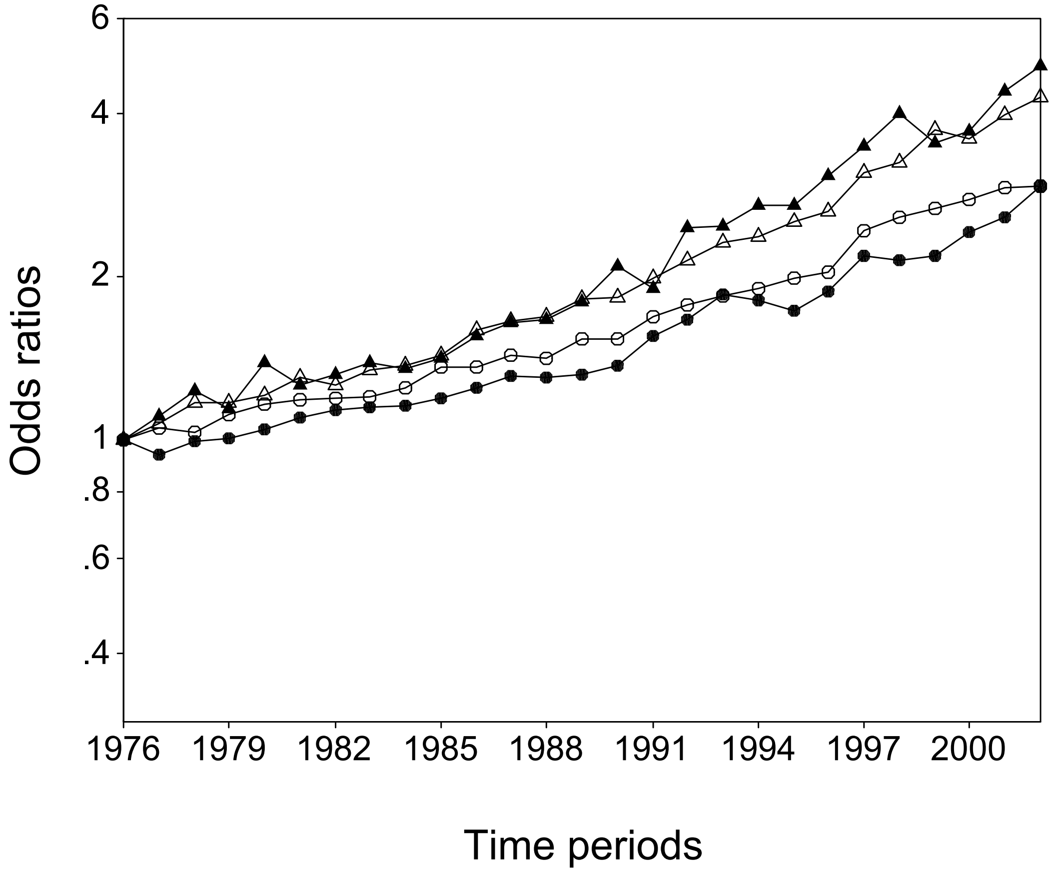


Figure 2: Period effects by race and sex in APC models of obesity, NHIS data 1976-2002

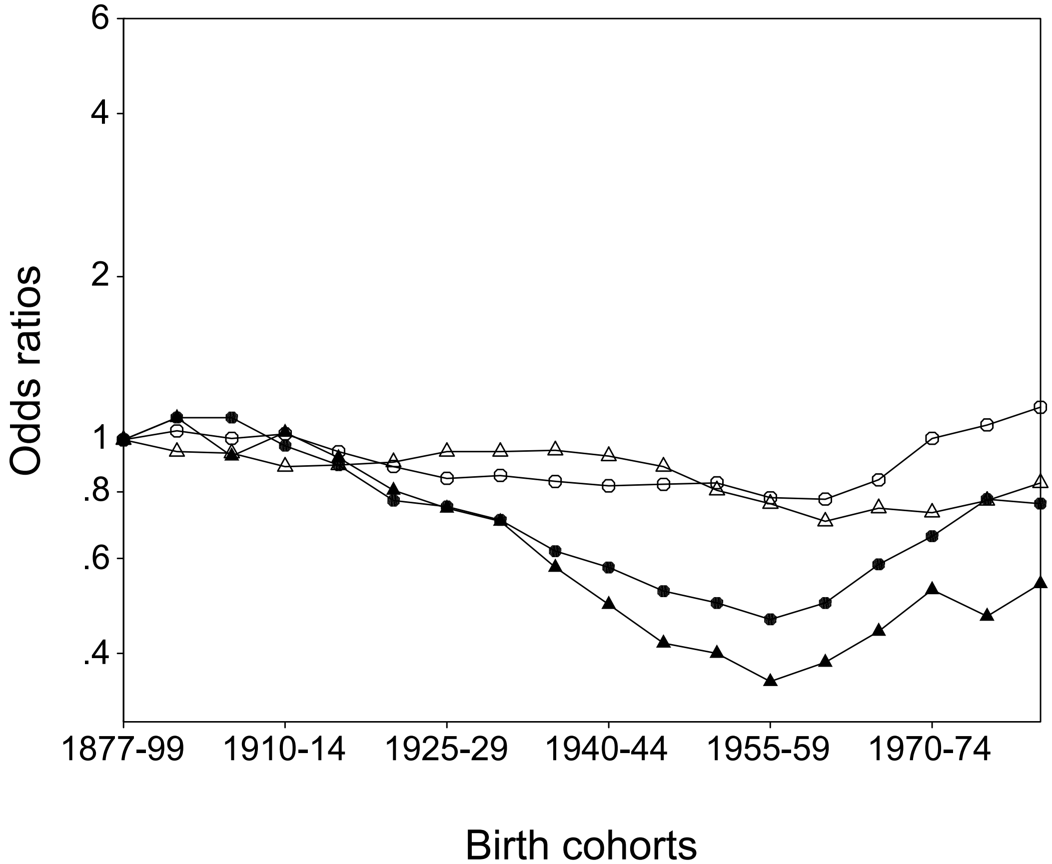


Figure 3: Cohort effects by race and sex in APC models of obesity, NHIS data 1976-2002