The Incidence of Overweight and Obesity in Southern Adolescents

Mellie L. Warner, Ph.D.
Clemson University

Presented at

Food Assistance and Nutrition Research Small Grants Program Conference
USDA Economic Research Service, November 20-21, 2003

Funded by

Food Assistance and Nutrition Research Small Grants Program
USDA Economic Research Service
Through
The Southern Rural Development Center
Mississippi State University, Starkville, MS

This research uses data from Add Health, a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris, and funded by a grant P01-HD31921 from the National Institute of Child Health and Human Development, with cooperative funding from 17 other agencies. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Persons interested in obtaining data files from Add Health should contact Add Health, Carolina Population Center, 123 W. Franklin Street, Chapel Hill, NC 27516-2524 (www.cpc.unc.edu/addhealth/contract.html).

Introduction

Obesity is a growing problem among all age groups and ethnic groups in America. The increasing weights of children and adolescents are of particular concern. Strauss and Pollack (2001) found that between 1986 and 1998 the percentage of overweight children increased for Hispanics, African-Americans, and non-Hispanic whites. “By 1998, 21% of African-American and 22% of Hispanic children were overweight, compared to 12% of white children.” They also found that overweight increased more rapidly in the southern states than in other regions. They used the National Longitudinal Survey of Youth. Earlier analysis of NHANES data by Troiano, et.al. (1995) had already found increasing incidence of overweight among the three ethnic divisions.

This project uses the National Longitudinal Survey of Adolescent Health (ADD Health) to investigate causes of overweight and obesity with particular emphasis on the southern region. Factors under consideration that may be associated with obesity/overweight include region of the US, ethnicity, age, sex, economic status, and place on the rural/urban continuum. The data also allow the consideration of the effects on weight of sports participation, previous weight loss activities (shown by Stice, Cameron, Killen, Hayward and Taylor (1999) to be associated with weight gain), participation in non-sport after school activities, and strength of social support networks. Also, racial/ethnic groups are delineated that are not available in the National Longitudinal Survey of Youth.

Groups (ethnic and otherwise) which have high incidences of overweight and obesity, especially in the South, are identified. Given that participation in organized sports declines as children approach adolescence, the purpose of the study is to identify non-sports activities that might affect the incidence of obesity/overweight, including participation in non-sport after school activities, whether they are clubs, school publications, hobbies, or other activities. If these factors are important, it is important to find ways to keep students involved in such activities that promote self-esteem and community involvement in addition to sports.

Data. Although not designed specifically for the study of eating habits and weight loss behaviors, the National Longitudinal Survey of Adolescent Health contains questions about these topics as well as many questions about physical activities, social life, family life, mental health, physical health, risky behaviors, physical development, after school work, etc.[1] Data were obtained by a school-based cluster sample in three waves: September 1994-December 1995, April-August 1996, and August 2001-April 2002. The samples were drawn to be representative of students in grades 7 through 12 in the 1994/95 school year. A total of 20,445 students answered the home administered questionnaire. Of these, about 7,600 attended schools located in the Southern region.

[1] For detailed information on the data, see the ADD Health website http://www.cpc.unc.edu/projects/addhealth/.

WAVE I

Dietary and Health Patterns

In Wave I (1994-95) the subjects were asked for their height and weight and whether they were currently trying to lose, gain, or maintain their weight. In Wave II and Wave III height and weight were measured. They rated themselves as very underweight, slightly underweight, about right, slightly overweight or very overweight. They rated their general health. The girls described their own changes in breast size and changing curvaceous body and their overall relative physical development. They reported if they had ever menstruated and, if so, at what age had they begun. Also, the interviewer assessed the physical maturity of the respondents.

The students reported how many times they had consumed various food groups on the previous day. In the first wave these groups were dairy products, fruit/fruit juice, vegetables, bread/potato/rice, and pastry products. Separate questions were asked about breakfast foods consumed the previous day. These foods were milk, coffee/tea, cereal, fruit/juice, eggs, meat, snack foods, bread/toast, "other", or nothing. (In the second wave, the food consumption questions were much more specific with the previous day's consumption of dozens of individual foods or two- to three-food groups being queried. The number of days that they ate in a fast food restaurant in the last week was reported. They were asked how many days that they ate each of the three main meals and about drinking water and various other beverages and about taking vitamins.)

Daily Activities

A large number of questions were asked that pertain to how after school hours are spent. The students were asked how many times in the past week they did work around the home or participated in hobbies. They were asked how many times in the past week they watched TV or videos, rollerbladed or cycled, participated in an active sport, exercised, and hung out with friends. They were asked how many hours they spent watching TV, watching videos, playing computer games, and listening to the radio. They were asked how many hours per week they worked for pay during the school year. They were asked if they used a recreation center in their neighborhood. They were asked whether or not they felt safe in their neighborhood.

The students were asked how many days a week they attended physical education classes. They were also asked how many minutes of each p.e. class were actually spent in physical activity.

Mental Health/Family Relations

A large number of mental health questions were asked, ranging from did they feel sad in the last week to whether they had contemplated or attempted suicide in the last year.

Family relationships were explored in detail, especially the relationships with biological and/or resident parents. They were asked if Mom/Dad was warm and loving, encouraged independence, communicated well with them, and had a good relationship with them. They were asked if they wanted to leave home, does their family understand them, does the family have fun together, and does their family pay attention to them. They were

asked about the presence of Mom/Dad when they left for/returned from school and at bedtime.

At Wave I there were also questionnaires for a parent and for a school administrator.

An in school questionnaire answered at the time of Wave I included more specific questions about after school clubs and activities. These include language clubs, book club, computer club, debate team, Future Farmers of America, drama club, band, cheerleader, and school publications as well as numerous sports. Although sports participation has been linked to lower BMIs, many American children drop out of organized sports when they reach middle school or high school. Pellai, et. al.(2001) found that in Northern Italy a decline in self-esteem among preteen and teen girls led to their abandonment of sports activities. Perhaps other activities provide indirect benefits by keeping kids off the sofa and out of the refrigerator. Maybe having a hobby or a place to go after school can keep kids from the instant gratification of food and provide a sense of worth.

WAVE II

The Wave II questionnaire (1996) included more specific questions about diet as well as new areas such as sun exposure. However, I chose to concentrate on the changes in BMI percentile and Wave II interviews occurred less than a year later than Wave I on average. This could be an important data source for further research.

WAVE III

The third wave (2001-2002) occurred when the subjects had moved into early adulthood. Questions that had related to the parents, such as income, shifted to the subjects' own characteristics. Many of the questions that are of interest to this project were largely unchanged.

Using this rich database, several explanatory econometric models were developed to test for associations between BMI, after school activities, demographic variables, family variables, and dietary and health variables. In contrast to earlier studies, these analyses use a comprehensive set of control variables to assess the effects that sports and non-sports activities have on obesity/overweight.

Data Analysis. First, the Body Mass Index (BMI) was calculated for individuals at Wave I and at Wave III. Age and gender specific BMI were calculated using a program from the Center for Disease Control's website[2] to determine the classification of individuals as very underweight, underweight, normal weight, overweight or obese. Frequencies of the weight categories were calculated for demographic groups in the South and, for comparison, the other regions.

Application of Research Results. Although sports obviously can help to keep kids in good physical shape, they can sometimes contribute to eating disorders in sports such as

[2] Centers for Disease Control. http://www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm

gymnastics where there is an emphasis on a certain body type (Stoutjesdyk and Jevne, 1993, and Beals, et.al., 1999). Moreover, a large percentage of children abandon sports as they reach adolescence. (Pellai, et.al., 2001) Even children who do not drop out of organized sports near puberty will probably not continue them indefinitely. Society needs to look for other activities that keep people healthy and involved in their communities. If it is shown that non-sport activities are associated with reductions in overweight and obesity, there will be a strong argument to promote non-sports activities that foster self-esteem. An example of a large scale program of this kind is the Venezuelan national system of youth and children's orchestras and choirs which was profiled on CBS' 60 Minutes (2001). In this program, poor children are given intense training in classical music performance. The Venezuelans involved believe that the orchestra makes both musicians and better citizens out of the poorest children in their nation. While these children were not at a high risk for obesity and the program was not designed to fight obesity, it did help to raise self-esteem. White (2000) found a negative relationship between weight and self-esteem.

Literature review

There is no doubt that Americans, both adults and children, are getting fatter. The academic and popular media are full of stories about the fattening of America (Strauss and Pollack, 2001, and Strauss and Pollack, 2002). There are numerous studies concerning the causes of overweight among children and adolescents in the US and elsewhere. Most of these studies examine a narrow range of possible influences.

The effect of puberty on adiposity

Sexual maturation has been shown to have a large impact on the adiposity of girls in particular. Kim, et.al. (2001) used skinfold testing and BMI in their study of white and black girls from households with wide ranges of income and parental education. This was a longitudinal study and ten annual observations were made on three skinfold locations, weight, height, sexual development, energy intake, and energy expenditure. They found that prepubescent black girls are leaner than age matched white girls, but that 20 year old black women are considerably heavier than 20 year old white women. At every age, a larger percentage of black than white girls had reached pubescence or menarche (two measures of sexual maturity.) The sum of the skinfold measurements (SSF) was found to increase by 2.99mm for every year earlier that menarche occurred for black girls and by 3.71mm for white girls. Because black girls on average reach puberty sooner, they are more adipose than white girls. The divergence occurs at age 12 which is the average age of menarche for black girls. (The average menarche for white girls is 12.7 years.) "The effect of pubertal maturation on the gain in adiposity, therefore, was cumulative and the racial difference widened with age and became evident on completion of pubertal maturation, ie, menarche." They found that puberty and early adulthood were the periods of greatest risk of increasing overweight.

Kaplowitz, et.al. (2001) also examined the relationship between BMI and early onset of puberty. They used cross-sectional data from the Pediatric Research in Office Settings. They found that the relationship was stronger for white girls than for black girls.

However, they relied only on BMI which Kim, et al (2001) found to be higher in prepubescent black girls because of greater lean body mass. Neither study was able to establish the direction of causality, but the widening gap between black and white adiposity found by Kim, et al gives some credence to the theory that earlier menarche leads to more overweight rather than the opposite direction of causality.

Wang (2002) looked at boys as well as girls using data from NHANES III for his analysis. Consistent with others' findings, he found that early maturing girls were more likely to be overweight. He also found a relationship between sexual maturity and overweight in boys, but it was of the opposite sign. Early maturing boys were less likely to be overweight than other boys. The sample included 1501 American boys and 1520 nonpregnant American girls aged 8 to 14 years. Overweight and obesity were based on the CDC BMI cutoffs of 85% and 95% respectively. The main covariates were age, race and ethnicity, socioeconomic status, energy intake, physical activity and urban versus rural residence.

He found that sexual maturity led to gains in height and weight for girls, but only gains in height for boys. Thus boys tended to slim down while girls did not. Early maturing boys were taller, but no heavier than their later maturing peers. He found that adjusting for height in girls rendered the association between early sexual maturing and obesity insignificant. After controlling for sexual maturity and other covariates, most ethnic differences became insignificant or nearly so. Therefore, he believes racial differences in obesity stem from racial differences in sexual maturity.

But before attributing increased childhood obesity to earlier sexual maturity, it is important to consider whether earlier sexual maturity is indeed a fact. Herman-Giddens, et al (1997) studied 17,077 girls between the ages of 3 and 12 who were patients of 225 pediatricians participating in the Pediatric Research in Office Settings. They found that early pubertal changes, pubic hair and breast buds, are showing up in younger girls than before. However, they found no change in the age of menarche which is the gold standard of sexual maturity in girls. Viner (2002) reviewed other studies and found that the secular trend toward earlier menarche has leveled off in the developed countries in the last 40 years. He dismisses the findings of Herman-Giddens, et al as being seriously flawed by selectivity bias, observer bias, and the cross-sectional nature of the study which work together to lower the apparent age of sexual maturity. He finds that their study may signal a lengthening of the pubertal process. It appears that earlier sexual maturity is not a cause of the overall increase in overweight/obesity although it does impact individuals.

The interplay between overweight, activity levels and self esteem

Lack of physical activity plays a large role in the development of overweight in children. Gordon-Larsen, et al (2000) used the 1996 National Longitudinal Study of Adolescent Health to examine the impact of socioeconomic and environmental factors on adolescent activity and inactivity levels. They found that hours per week of inactivity (defined as TV or video viewing and video or computer game playing) were positively associated with non-Hispanic black or Hispanic ethnicity and negatively associated with mother's

education and family income. They found that levels of moderate to vigorous physical activity were positively related to participation in daily PE classes and the use of a community recreation center. High family income was associated with increased levels of physical activity. A high crime rate discouraged a high level of physical activity. Among modifiable factors, different factors affected activity than affected inactivity. Environmental factors were related to activity levels and sociodemographic factors were related to inactivity levels. They acknowledged that the impact of community center use may be subject to selectivity bias since there was no data on the availability of such facilities, only on their use. More active persons are more likely to use them.

Faith, et al (2002) found that children who receive negative comments about their weight during exercise (WCA) have negative attitudes toward sports and have lower physical activity levels. However, some coping skills can attenuate the effects. Teaching these skills may be a useful intervention.

Strauss (2000) used the children of participants in the National Longitudinal Survey of Youth to examine the relationship between obesity and self-esteem in young adolescents. Scholastic and global self-esteem were assessed using the Self-Perception Profile for Children at age 9-10 and age 13-14. White, black, and Hispanic racial groups were used as well as family income.

He found that there was no significant difference in the levels of scholastic or global self-esteem between obese and non-obese children when they were initially assessed at age 9-10. Four years later, obese white girls and obese Hispanic girls exhibited significantly lower levels of global self-esteem. Black girls did not. These declines were similar in both upper and lower income classes for white girls; there were insufficient observations of high income, obese Hispanic girls to evaluate any differences.

Obese boys experienced a lesser decrease in global self-esteem over the four years. There were no significant racial or income differences for boys. Obesity was not found to be related to scholastic self-esteem in any gender or racial group.

Children whose self-esteem decreased had significantly higher rates of sadness, loneliness, and nervousness. They were also significantly more likely to report smoking or alcohol consumption.

There was no examination of children who became obese over the four year period, probably because there were too few in the sample. The direction of causality was not established.

Impact of the home environment on development of obesity

Television viewing has been associated with increased levels of obesity. Gortmaker, et al (1996) found that television viewing in excess of five hours per day resulted in a five-fold increase in the likelihood of overweight compared to 0-2 hours per day. They obtained similar results when they accounted for baseline overweight, mother's race, mother's education, gender, child's scores on the Peabody Picture Vocabulary Test, PIAT-reading,

and PIAT-mathematics at baseline, household poverty, number of children in the household at baseline, Mother's score on the Armed Forces Qualifying Test, marital status of the mother, and mother's work status. Children who were normal weight at baseline were about 8 times as likely to become overweight over the four years if they watched more than 5 hours of TV per day compared to those who watched 0-2 hours. This held true whether or not the other variables above were included in the analysis. While the relationship between baseline overweight children becoming normal weight over the four year period and TV viewing was not significant, higher levels of viewing were associated with smaller likelihood of achieving normal weight.

The only baseline variable to have a significant relationship to TV viewing was maternal AFQT score. Higher scores were associated with lower levels of TV viewing. Baseline overweight of child, maternal overweight and employment status of the mother were not significant predictors of TV viewing. Therefore, the direction of causality seems to be that TV viewing causes overweight, not that overweight causes TV viewing.

Strauss and Knight (1999) used data from the National Longitudinal Survey of Youth to investigate family characteristics that were associated with the onset of overweight over a six-year period. The children were 0 to 8 years old at the beginning of the study and 6 to 14 years old at the end. They examined race, marital status, maternal education, family income, parental occupation in addition to standard measures of the home environment in relationship to the development of childhood obesity. The home environment was measured using the Home Observation for Measurement of the Environment—Short Form (HOME—SF). Two environmental scores were obtained, one for cognitive stimulation and one for emotional support. The study confirms that low or average family income, overweight or obese mother, nonprofessional occupation, living with a single mother, mother with less than high school education and black race are associated with higher rates of obesity in children. The cognitive stimulation HOME score was also found to be associated with obesity in that children in low and average homes were more likely to be obese. The emotional support variable was not associated with more or less obesity.

In multivariate logistic regression analysis that controlled for "maternal BMI, child's initial weight-for-height z-score, gender race, maternal education, maternal marital status, family income, occupation, HOME-SF cognitive scores, and HOME-SF emotional scores," they found the HOME cognitive stimulation score was still significant. There was no independent risk from race, marital status, maternal education, parental occupation or HOME emotional score. They found that while children in homes with high cognitive stimulation scores tended to watch less television, the effect of the HOME cognitive score remained even after accounting for television watching.

HOME cognitive stimulation scores were relatively stable over the six-year period. For those homes where the score fell over time, the children were at greater risk of becoming obese even after adjusting for the initial score. Children in homes where the HOME cognitive score increased were at significantly lower risk for developing obesity than those in homes where the score decreased.

They conclude that parental education programs may have positive impacts on rates of obesity as well as on cognitive development and socialization. This lends some credence to the idea that a bored child tends to eat more than one who is occupied in worthwhile pursuits.

The Impact of Sugar-Sweetened Drinks

Ludwig, et al (2001) examined the association between sugar-sweetened drinks and childhood obesity. They examined 548 ethnically diverse 6th and 7th grade students in four schools in the Boston, Massachusetts, metropolitan area that did not take part in an intervention program called Planet Health. Data were obtained in October, 1995, and in May, 1997. Height and weight were measured, and BMI calculated. Triceps-skinfold was also measured. If both BMI and triceps-skinfold exceeded the 85th percentile of age and sex specific reference data, the child was classified as obese. The only measure of sexual maturity available was self-reported menarcheal status in girls. A student food questionnaire and an activity questionnaire were administered to obtain measures of dietary intake, physical activity, and television viewing. The children answered questions about soda, sweetened fruit drink, sweet tea, fruit juice, and diet soda consumption.

They found that over the 19-month period between observations, intake of sugar-sweetened drinks and BMI both increased. They found a statistically significant relationship between the increase in sugar-sweetened drink consumption and the incidence of obesity when confounding variables were taken into consideration. "In the fully adjusted model the odds of becoming obese increased significantly for each additional daily serving of sugar-sweetened drink consumption."

Analysis of Wave I Data

The initial focus of this research was to test the hypothesis that an increase in non-athletic student activities will reduce the incidence of obesity in the adolescent population. For the analysis of Wave I data, the individuals whose schools were located in the south were selected.[3] Then age and gender specific BMI percentiles were calculated using a CDC SAS program. It was necessary to use percentiles rather than simple BMI because the distribution of BMIs changes with age as shown in Table 1. The 50th percentile falls over the first 4 or 5 years of life and then begins to climb. Wave I of the data includes individuals aged 11 to 21 years. However, the CDC program only goes to 240 months, so individuals over that age had missing values for the variable and were not used in the regressions for Wave I. Fortunately, there were only a few of these older individuals. BMI percentiles were used rather than the four categories of weight (underweight, normal, overweight, and obese) because these categories are so broad. Therefore it would be harder to detect the impact of many variables on BMI.

[3] Initial regression on the entire database that included a regional variable found no significant differences between the regions.

Table 1. 50th and 90th Percentile BMIs for Males and Females by Age

	50th percentile BMIs		90th percentile BMIs	
Age	Male	Female	Male	Female
11	17.20	17.47	23.21	24.14
12	17.81	18.10	24.23	25.26
13	18.47	18.74	25.18	26.30
14	19.16	19.35	26.05	27.26
15	19.86	19.93	26.84	28.12
16	20.56	20.45	27.56	28.91
17	21.24	20.91	28.26	29.63
18	21.90	21.28	28.96	30.33
19	22.50	21.55	29.73	31.03
20	23.02	21.72	30.59	31.76

Incidence of Overweight and Obesity in the National, Non-Southern, and Southern Samples

Table 2 displays the incidences of underweight, normal weight, overweight, and obesity for the entire US sample, the non-South, and the South at Wave I. For the standard distribution against which comparison is made, we would expect 5% underweight, 80% normal weight, 10% overweight, and 5 % obese. For all U.S. groups except white males, we observe more underweight individuals than expected. Only female Asian Americans have 80% (or more) in the normal weight category.

Table 2. Percentages by Weight Category, Gender, and Race, Wave I (1994-1995).

	US Sample		Non-South		Region 3= South	
All Races	Male	Female	Male	Female	Male	Females
Underweight	6%	7%	5%	6%	6%	7%
Normal	68%	71%	70%	72%	66%	69%
Overweight	14%	13%	14%	13%	15%	13%
Obese	12%	9%	11%	8%	14%	10%
White	Male	Female	Male	Female	Male	Female
Underweight	5%	6%	5%	6%	5%	7%
Normal	70%	75%	72%	76%	66%	74%
Overweight	14%	12%	13%	12%	15%	12%
Obese	11%	7%	10%	6%	14%	8%
African American	Male	Female	Male	Female	Male	Female
Underweight	6%	7%	5%	7%	7%	7%
Normal	68%	64%	69%	66%	67%	62%
Overweight	14%	16%	14%	17%	13%	16%
Obese	12%	13%	11%	11%	13%	15%
Native American	Male	Female	Male	Female	Male	Female
Underweight	7%	6%	6%	6%	8%	7%
Normal	61%	67%	62%	67%	58%	70%
Overweight	15%	13%	14%	13%	18%	14%
Obese	18%	13%	18%	15%	17%	9%
Asian American	Male	Female	Male	Female	Male	Female
Underweight	6%	7%	6%	6%	13%	12%
Normal	70%	80%	71%	80%	70%	80%
Overweight	12%	8%	12%	8%	12%	7%
Obese	11%	5%	12%	6%	4%	1%
Other race	Male	Female	Male	Female	Male	Female
Underweight	7%	7%	6%	6%	10%	9%
Normal	62%	69%	64%	69%	59%	69%
Overweight	16%	15%	16%	16%	15%	13%
Obese	15%	9%	14%	9%	16%	9%

A quick glance at this table shows that the differences between the South and other regions are small. Overall the South has slightly more underweight, fewer normal weight, about the same overweight, and more obese adolescents (in percentages) than the non-Southern regions. The two groups that differ the most between the South and non-South are white males and African American females; there are more obese and fewer normal weight among these two groups in the South. More Native American males are overweight in the South, but fewer Native American females are obese. More Asian American males and females are obese in the non-Southern regions; more are underweight in the South. More “other race” males and females are underweight in the

South; fewer "other" males are of normal weight in the South; fewer "other" females are overweight in the South.

Regression Analysis of Factors Affecting BMI Percentile

Regression analysis was used to test the hypothesis that non-sports activities have a negative impact on BMI percentile. Based on previous research (cited in the literature review), BMI percentile is also a function of demographic variables, family characteristics, and health and dietary variables. These characteristics are used as controls in the econometric models so that the effects of student activities on BMI percentile (obesity level) can be determined, *ceteris paribus*. Lists of these variables follow. Their means and standard deviations are displayed in Table 3.

Demographic variables

- gender,
- race,
- Hispanic ethnicity,
- age in years,
- urbanicity,

The racial categories were white, African American, Native American, Asian, and other. A separate question was asked about Hispanic ethnicity. Many Hispanic persons considered themselves to be "other" race, but there were Hispanics in almost every race category. Age in years was defined as age in months divided by 12 and rounded down. Urbanicity categories were rural, suburban, or urban based on definitions by the National Center for Education Statistics.[4]

Daily activities (sports and non-sports)

- how often in a week work was done around the house,
- how often in a week hobbies were pursued,
- the number of times per week they participated in sports,
- how often in a week they "hung out" with friends
- whether or not they belonged to any clubs at school (not including teams or band)
- the number of times they exercised in a week
- the number of hours of sedentary pursuits in a week,
- their score on the Adolescent Health Picture Vocabulary Test
- whether they used a neighborhood fitness or recreation facility,
- whether they felt safe in their neighborhood,

A second group of variables reflects the daily activities of the students. The variables that represent work around the house, hobbies, sports participation, and hanging out with friends each had four categories: none, one or two times a week, three or four times a

[4] Urban is defined as the central city of a CMSA or MSA. Suburban is located in a CMSA or MSA, but not in the central city. Rural is not located in a CMSA or MSA.

week, and five or more times a week. The club variable was defined as 0 if they belonged to no clubs at school and 1 if they belonged to at least one (not including sports or band).

The number of times of exercise in a week was defined as the sum of the variables for physical education classes, exercise such as jogging, dancing, etc., and roller-blading, rollerskating, skateboarding, or bicycling. The possible answers for PE classes ranged from 0 to 5. For the other parts of this variable the possible answers were none (group=0), 1 or 2 (group=1), 3 or 4 (group=2), and 5 or more (group=3). Thus the total times exercised could range from 0 to 11 and was treated as if it were a continuous variable.

The number of hours of sedentary behaviors was defined as the sum of three variables: hours per week watching television, hours per week watching videos, hours per week playing video or computer games. Each of these variables could have a value between 0 and 99. If the sum exceeded the total number of hours in a week (168), the variable was set equal to 168. Hours listening to the radio were not included because many people do other things while listening to the radio including physically active things like jogging.

Each student's standardized score on the Adolescent Health Picture Vocabulary Test (AHPVT) was included. This test was a subset of the Peabody Picture Vocabulary Test (PPVT) and included half of the questions on the PPVT. This is a proxy for intelligence with a higher score being associated with higher intelligence.

The students answered yes or no to questions about their use of a neighborhood fitness or recreation center and whether they felt safe in their neighborhood.

<u>Family characteristics</u>

- whether the biological mother has a weight problem,
- whether the biological father has a weight problem,
- how close their relationship with their mother was,
- how close their relationship with their father was,
- parent's education,
- household income,

Family characteristics can have an impact on obesity in childhood and adolescence. Parents reported whether the student, the biological mother, and the biological father suffer from obesity. There were originally ten categories of parental education. Because the categories were not significant either individually or as a group, they were regrouped into fewer categories: less than high school (group=1), high school grad or GED or trade school instead of high school (group=2), trade school after high school or some college (group=3), college graduate, (group=4), training beyond college (group=5), or never went to school (group=6). (There were no observations in the no school group, so it dropped out of the model for the Southern sample.) Total household pretax income was reported between 0 and 999 thousand dollars; it was treated as a continuous variable. Students rated the closeness of their relationships with their parents (not at all, very little, somewhat, quite a bit, or very much).

Health and diet

- general level of health,
- whether or not they generally ate breakfast,
- whether they had learned in school what foods to eat or not eat, the importance of exercise, and the dangers of obesity,
- how long they were breastfed,
- birth weight,
- self efficacy (whether they felt they were more or less intelligent than their peers),
- how often they had felt depressed during the previous week,
- whether or not they regularly smoke cigarettes,
- whether or not they frequently drink alcoholic beverages,
- whether they have a disability (self-assessed),
- whether or not they had a routine physical exam in the previous year
- how physically mature they were compared to their peers.

General health level was self-assessed and could be excellent, very good, good, fair, or poor. If they ate anything for breakfast, they were classified as usually eating breakfast. Only if they marked that they usually had nothing for breakfast on a weekday morning, were they classified as usually not eating breakfast. The parental respondent was asked about the duration of breastfeeding (less than 3 months, 3 to less than 6 months, 6 to less than 9 months, 9 to less than 12 months, 12 to less than 24 months, 24 or more months, or not breastfed at all) and birth weight. The students reported whether or not they had been taught in school about what foods to eat or not eat, the dangers of obesity, and the importance of exercise. These three variables were summed. The resulting variable (fooded) could range from 0 to 3. In the Self Efficacy section they reported how intelligent they thought they were compared to their peers. In the feelings scale section, they were asked how often in the last week they had felt depressed.

They answered whether they had ever smoked cigarettes regularly (at least one cigarette a day for 30 days). They responded to questions about how often during the past 12 months did they drink alcohol. The categories for drinking alcohol were every day or almost every day, 3-5 days a week, 1 or 2 days a week, 2 or 3 days a month, once a month or less, 1 or 2 days in the past 12 months, and never. Those students who were "legitimate skips" because they had never had a drink of beer, wine or liquor, were assigned the value of "never" for the current project.

The students self-evaluated whether or not they had a disability (no=0, yes=1). They reported whether or not they had had a routine physical exam in the previous year (no=0, yes=1).

Physical maturity was determined by the self-assessed question of how they compared to their peers: I look younger than most, I look younger than some, I look about average, I look older than some, or I look older than most. This question was the same for males and females, but was asked as part of separate sections for males and females. The interviewers were also asked to rate the physical maturity of the adolescents. Since the correlation between the self-assessed and interviewer-assessed maturity levels was only

.1456, the two variables were combined into one. This was done by taking integer value of the average of the two scores. Other questions in the sections were about more specific signs of sexual development, and they were not included in the analysis because they would be highly correlated with overall physical maturity.[5]

Table 3. Means, Standard Deviations, Minimum, and Maximums for the Endogenous and Exogenous Variables, Wave I Southern Adolescents

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
bmipct1	BMI percentile	7359	60.5992	28.95888	4.95E-15	99.95008
gender		7632	0.502096	0.500028	0	1
race		7620	4.46063	1.84997	2	6
ethn	Hispanic	7632	0.16575	0.37188	0	1
ageyrs	Age in years	7628	15.64289	1.769208	11	21
metro	Urban, suburban, or rural	7632	1.858753	0.721983	1	3
chores	Times per week	7625	2.046164	0.903514	0	3
hobby	Times per week	7625	1.410492	1.071497	0	3
sports	Times per week	7623	1.318772	1.143438	0	3
hangout	Times per week	7624	1.910677	1.029932	0	3
club	Belong to any clubs	7632	0.60587	0.488695	0	1
ttex	Total times of exercise	7623	4.190214	2.960117	0	14
hsed	Hours of Sedentary Behaviors	7573	25.36181	23.79925	0	168
testscore	Score on AHPVT	7197	97.29929	15.09816	13	146
reccenter	Use recreation center	7575	0.169769	0.375455	0	1
feelsafe	Feel safe in neighborhood	7573	0.871517	0.334649	0	1
momobese	Biological mother obese	6199	0.19116	0.393246	0	1
dadobese	Biological father obese	5921	0.101672	0.302242	0	1
momclose	Close relationship with mother	7624	4.347587	1.279045	0	5
dadclose	Close relationship with father	7623	2.858848	2.184729	0	5
parented	Parent's education	6333	2.580925	1.202478	1	6
income	Household income	5520	39.2038	45.7703	0	999
ghealth	General health	7620	2.096982	0.915897	1	5
breakfast	Eat breakfast	7621	0.197349	0.398024	0	1
fooded	Learned about food and exercise in school	7610	2.365966	0.829679	0	3
brstfed	How long breastfed	6183	5.390911	2.355159	1	7
birthw	Birthweight in ounces	5573	116.0904	20.26774	64	191
selfeff	Self Efficacy	7595	3.849375	1.114801	1	6
depressed	Felt depressed lately	7610	0.521551	0.754969	0	3
smoke	Smoker	7623	0.17093	0.376473	0	1
drink	Drink Alcohol	7524	5.979798	1.494593	1	7
disability	Have disability	7630	0.004456	0.06661	0	1
physexam	Routine physical in last year	7610	0.608804	0.48805	0	1
avmature	Physical (sexual) maturity	7504	3.04411	0.803365	1	5

[5] Using time since menarche for the girls instead of the physical maturity variable yielded similar results.

Econometric Models

The SAS Generalized Linear Model procedure was used. First an ordinary least squares linear model was estimated.

$$BMIPCT1 = \alpha + \beta D + \delta A + \gamma F + \tau H \text{ where}$$

BMIPCT is the BMI percentile in Wave I,
D is a vector of demographic variables,
A is a vector of daily activity variables,
F is a vector of family characteristics,
H is a vector of health and diet variables, and
β, δ, γ, and τ are vectors of parameters to be estimated.

Most independent variables were specified as dummy (or class) variables. Continuous explanatory variables included age in years, hours of sedentary activities, birth weight, total household income, and times per week of exercise. The dependent variable, BMI percentile, is also a continuous variable.

Because of concerns with predicted values at the ends of the distribution[6], a logit transformation was performed on the dependent variable so that

$$BMIlogit = \ln((bmipct1/100)/(1-(bmipct1/100))).$$

This was then used as the dependent variable in a second model:

$$BMIlogit = \alpha + \beta D + \delta A + \gamma F + \tau H$$

Based on F tests from the linear and logit models with all variables, some variables were eliminated from the model. If the probability of a type I error was greater than .10 in both models, the variable was eliminated unless there was some other reason for keeping it. This was done for each group of dummy variables representing a variable. For example, to test for the importance of general level of health, the null hypothesis

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$

where β_1, β_2, β_3, and β_4 are the coefficients for Excellent, Very Good, Good, and Fair general health levels respectively, uses the partial F test. If the probability value of a Type I error was greater than .10, the null hypothesis was rejected.

Thus hobby and sports were kept because they were involved in the principal hypothesis. The full model F values and estimates are reported in the Appendix (Table A1.)

---

[6] For example, in the linear model the effect of gender is estimated to be 4.54 percentiles. At the 95th percentile, this increases BMI past the 99th percentile. Using the logit model, the effect at the 50th percentile is larger (8.63), but the effect at the 95th percentile is only a 1.64 percentile shift. See the last three columns of Table 4 to see how the effects are different at different percentiles.

In almost all cases, variables that are significant in the linear model are also significant in the logit model. The variables that were eliminated were urbanicity, work around the house, club membership, test score on the AHPVT, feeling of safety in the neighborhood, closeness of relationship with mother, parent's education, self efficacy, feeling depressed, and frequency of drinking alcohol. The results of the model after the elimination of the non-significant variables are reported in Table 4.

Table 4. Parameter Estimates for Linear and Logit Regressions after Eliminating Non-Significant Variables.

		Linear bmipct1 R2=.149362 N=4237 Root MSE=26.52908				Logit bmilgit1 R2=.148146 N=4237 Root MSE=1.817883				Logit Effects on BMI Percentile At Selected Percentiles		
Parameter		Estimate	Standard Error	t Value	Pr > |t|	Estimate	Standard Error	t Value	Pr > |t|	50	75/25	90/10
Intercept		124.1119	11.73581	10.58	<.0001	5.222062	0.804186	6.49	<.0001			
gender	Male	4.539009	0.896709	5.06	<.0001	0.345158	0.061446	5.62	<.0001	8.63	6.47	3.11
gender	Female	0	.	.	.	0	.	.	.	0.00	0.00	0.00
race	African Am	4.936903	1.050974	4.7	<.0001	0.335494	0.072017	4.66	<.0001	8.39	6.29	3.02
race	Native Am	5.038346	2.85431	1.77	0.0776	0.214862	0.195589	1.1	0.272	5.37	4.03	1.93
race	Asian Am	-4.47495	3.909661	-1.14	0.2524	-0.27836	0.267906	-1.04	0.2989	-6.96	-5.22	-2.51
race	Other Race	2.099	1.987705	1.06	0.291	0.183189	0.136206	1.34	0.1787	4.58	3.43	1.65
race	White	0	.	.	.	0	.	.	.	0.00	0.00	0.00
ethn	Non-Hispanic	-4.83453	1.415667	-3.42	0.0006	-0.32413	0.097007	-3.34	0.0008	-8.10	-6.08	-2.92
ethn	Hispanic	0	.	.	.	0	.	.	.	0.00	0.00	0.00
ageyrs		-1.24612	0.262014	-4.76	<.0001	-0.08009	0.017954	-4.46	<.0001	-2.00	-1.50	-0.72
hobby	0 times	0.06429	1.266488	0.05	0.9595	0.003635	0.086785	0.04	0.9666	0.09	0.07	0.03
hobby	1-2 times	0.738028	1.132532	0.65	0.5147	0.042781	0.077606	0.55	0.5815	1.07	0.80	0.39
hobby	3-4 times	1.704224	1.235506	1.38	0.1679	0.124857	0.084662	1.47	0.1404	3.12	2.34	1.12
hobby	5 or more times	0	.	.	.	0	.	.	.	0.00	0.00	0.00
sports	0 times	1.44155	1.519248	0.95	0.3427	0.064177	0.104105	0.62	0.5376	1.60	1.20	0.58
sports	1-2 times	1.186629	1.361448	0.87	0.3835	0.107892	0.093292	1.16	0.2475	2.70	2.02	0.97
sports	3-4 times	0.429051	1.323304	0.32	0.7458	0.044622	0.090678	0.49	0.6227	1.12	0.84	0.40
sports	5 or more times	0	.	.	.	0	.	.	.	0.00	0.00	0.00
hangout	0 times	3.816495	1.534857	2.49	0.0129	0.241869	0.105175	2.3	0.0215	6.05	4.54	2.18
hangout	1-2 times	3.339137	1.076456	3.1	0.0019	0.178367	0.073763	2.42	0.0156	4.46	3.34	1.61
hangout	3-4 times	-0.07887	1.040561	-0.08	0.9396	-0.06297	0.071304	-0.88	0.3772	-1.57	-1.18	-0.57
hangout	5 or more times	0	.	.	.	0	.	.	.	0.00	0.00	0.00
Ttex		0.690178	0.189804	3.64	0.0003	0.036193	0.013006	2.78	0.0054	0.90	0.68	0.33
Hsed		0.06765	0.018521	3.65	0.0003	0.004596	0.001269	3.62	0.0003	0.11	0.09	0.04
reccenter	Don't use	-2.54379	1.130611	-2.25	0.0245	-0.17867	0.077474	-2.31	0.0211	-4.47	-3.35	-1.61
reccenter	Use	0	.	.	.	0	.	.	.	0.00	0.00	0.00
momobese	No	-10.9781	1.095584	-10.02	<.0001	-0.8376	0.075074	-11.16	<.0001	-20.94	-15.70	-7.54
momobese	Yes	0	.	.	.	0	.	.	.	0.00	0.00	0.00
dadobese	No	-3.45084	1.391832	-2.48	0.0132	-0.31203	0.095374	-3.27	0.0011	-7.80	-5.85	-2.81
dadobese	Yes	0	.	.	.	0	.	.	.	0.00	0.00	0.00
dadclose	0=least	-0.83115	1.053546	-0.79	0.4302	-0.04657	0.072193	-0.65	0.5189	-1.16	-0.87	-0.42
dadclose	1	0.038708	3.741307	0.01	0.9917	-0.07821	0.25637	-0.31	0.7603	-1.96	-1.47	-0.70

dadclose	2	-3.2556	2.629193	-1.24	0.2157	-0.19902	0.180163	-1.1	0.2694	-4.98	-3.73	-1.79
dadclose	3	-1.68011	1.572074	-1.07	0.2853	-0.07046	0.107725	-0.65	0.5131	-1.76	-1.32	-0.63
dadclose	4	-4.1584	1.166819	-3.56	0.0004	-0.26578	0.079955	-3.32	0.0009	-6.64	-4.98	-2.39
dadclose	5=closest	0	.	.	.	0	.	.	.	0.00	0.00	0.00
income		-0.02654	0.010157	-2.61	0.009	-0.00147	0.000696	-2.11	0.0345	-0.04	-0.03	-0.01
ghealth	Excellent	-15.4257	6.965798	-2.21	0.0268	-1.20093	0.477325	-2.52	0.0119	-30.02	-22.52	-10.81
ghealth	Very Good	-10.8158	6.946285	-1.56	0.1195	-0.92012	0.475988	-1.93	0.0533	-23.00	-17.25	-8.28
ghealth	Good	-6.60191	6.953193	-0.95	0.3424	-0.58673	0.476462	-1.23	0.2182	-14.67	-11.00	-5.28
ghealth	Fair	-2.25068	7.107449	-0.32	0.7515	-0.24235	0.487032	-0.5	0.6188	-6.06	-4.54	-2.18
ghealth	Poor	0	.	.	.	0	.	.	.	0.00	0.00	0.00
breakfast	Yes	-6.28759	1.080539	-5.82	<.0001	-0.38195	0.074043	-5.16	<.0001	-9.55	-7.16	-3.44
breakfast	No	0	.	.	.	0	.	.	.	0.00	0.00	0.00
fooded	0 Topics	2.228541	2.032611	1.1	0.273	0.068544	0.139283	0.49	0.6227	1.71	1.29	0.62
fooded	1 Topic	-1.86549	1.518603	-1.23	0.2194	-0.1693	0.104061	-1.63	0.1038	-4.23	-3.17	-1.52
fooded	2 Topics	-1.61007	0.917043	-1.76	0.0792	-0.14248	0.06284	-2.27	0.0234	-3.56	-2.67	-1.28
fooded	3 Topics	0	.	.	.	0	.	.	.	0.00	0.00	0.00
brstfed	1=Shortest	-2.19914	1.239036	-1.77	0.076	-0.12529	0.084904	-1.48	0.1401	-3.13	-2.35	-1.13
brstfed	2	-4.34531	1.488407	-2.92	0.0035	-0.24714	0.101992	-2.42	0.0154	-6.18	-4.63	-2.22
brstfed	3	-3.42422	1.811984	-1.89	0.0589	-0.22434	0.124165	-1.81	0.0709	-5.61	-4.21	-2.02
brstfed	4	-5.58002	2.071851	-2.69	0.0071	-0.37256	0.141972	-2.62	0.0087	-9.31	-6.99	-3.35
brstfed	5	-1.42352	2.196824	-0.65	0.517	-0.02475	0.150535	-0.16	0.8694	-0.62	-0.46	-0.22
brstfed	6=Longest	-4.56824	4.675991	-0.98	0.3286	-0.63753	0.320418	-1.99	0.0467	-15.94	-11.95	-5.74
brstfed	Not breastfed	0	.	.	.	0	.	.	.	0.00	0.00	0.00
birthw	In Ounces	0.082546	0.020841	3.96	<.0001	0.005405	0.001428	3.79	0.0002	0.14	0.10	0.05
smoke	No	2.536058	1.157114	2.19	0.0285	0.139932	0.07929	1.76	0.0777	3.50	2.62	1.26
smoke	Yes	0	.	.	.	0	.	.	.	0.00	0.00	0.00
disability	No	-14.8206	6.683586	-2.22	0.0266	-0.96233	0.457987	-2.1	0.0357	-24.06	-18.04	-8.66
disability	Yes	0	.	.	.	0	.	.	.	0.00	0.00	0.00
physexam	No	-1.63991	0.869299	-1.89	0.0593	-0.09417	0.059568	-1.58	0.114	-2.35	-1.77	-0.85
physexam	Yes	0	.	.	.	0	.	.	.	0.00	0.00	0.00
avmature	1=least	-27.4662	4.120497	-6.67	<.0001	-1.91124	0.282354	-6.77	<.0001	-47.78	-35.84	-17.20
avmature	2	-21.3076	2.987316	-7.13	<.0001	-1.41039	0.204703	-6.89	<.0001	-35.26	-26.44	-12.69
avmature	3	-14.7952	2.890697	-5.12	<.0001	-1.01239	0.198083	-5.11	<.0001	-25.31	-18.98	-9.11
avmature	4	-6.16665	2.934228	-2.1	0.0356	-0.50284	0.201065	-2.5	0.0124	-12.57	-9.43	-4.53
avmature	5=most	0	.	.	.	0	.	.	.	0.00	0.00	0.00

Relationship Between Percentiles and Weight

What do all these percentiles mean in terms of weight? This is not a simple question. The easiest way to explain is through an example. Consider the case of a 15 year-old boy. The median weight for a 15 ½ year-old boy is 130 pounds and the median height is 68 inches. These yield a BMI of 19.87 which is the 45th percentile for 15 year-old boys.[7] The following table increases weight in one pound increments while holding height at the median value.

An increase of one pound to 131 pounds moves the boy to the 47.3th percentile or by 2.3 percentiles. Therefore, from rough interpolation, a one percentile increase in BMI corresponds to a .43 pound increase in weight, holding height constant. Because BMIs do not have a uniform distribution (all values of BMI are not equally likely), the size of the percentile shift caused by a one pound increase becomes smaller as weight moves away from the median. Thus, the number of pounds needed to cause a given percentile shift becomes larger toward the tails of the distribution. For example in Table 5, increasing weight from 143 to 144 shifts BMI percentile by 1.5, or conversely, a one percentile increase in BMI corresponds approximately to a .67 pound gain in weight. The size of the weight impact of the parameters from the linear model increases as the BMI increases beyond the mean.

Table 5. The relationship between weight and BMI percentile for a 15 ½ year-old boy.[8]

Height in inches	Weight in pounds	BMI	BMIPCT	Change in percentile on the BMI distribution	Weight change in pounds corresponding to one percentile change in BMI
68	130	19.87	44.99		
68	131	20.03	47.31	2.32	0.43
68	132	20.18	49.59	2.28	0.44
68	133	20.33	51.81	2.23	0.45
68	134	20.49	53.98	2.17	0.46
68	135	20.64	56.09	2.11	0.47
68	136	20.79	58.13	2.04	0.49
68	137	20.95	60.11	1.98	0.51
68	138	21.10	62.02	1.91	0.52
68	139	21.25	63.86	1.84	0.54
68	140	21.40	65.63	1.77	0.57
68	141	21.56	67.32	1.70	0.59
68	142	21.71	68.95	1.63	0.62
68	143	21.86	70.50	1.56	0.64
68	144	22.02	71.99	1.49	0.67

The specific relationship between weight and BMI percentile will be similar but different for each combination of age, height, and sex.

[7] At first thought it seems that the median height and weight ought to yield the median BMI. However, while height is distributed normally, the distributions for weight and BMI are skewed to the right. September 16, 2003 conversation with Zugo May of the CDC.

[8] http://www.cdc.gov/nchs/data/nhanes/growthcharts/bmiage.txt

Using the logit model necessitates an additional layer to the interpretation, but allows for the differences at the tails of the distribution. To make a logit parameter estimate roughly equivalent to the linear parameter estimate, multiply the parameter by p*(1-p) where p is the percentile at which the effect is to be evaluated. For example, to evaluate the effect of a variable at the 90th percentile of the distribution, multiply the parameter estimate by .09 (=.9*.1). At the 50th percentile the parameter would be multiplied by .25 (=.5*.5).

Significant Variables

Demographic Variables

Gender is significant with boys (gender=0) being significantly heavier relative to the norm than are girls (gender=1). This means that even after adjusting for differences in age and gender, the boys have higher BMI percentiles. The linear estimate is that boys are about four and a half percentiles heavier than girls. The logit estimates are consistent with this, ranging from 3.13 at the 10th or 90th percentiles to 8.7 at the 50th percentile. For the 15 ½ year-old boy, this translates to a difference of about 4 pounds at the 50th percentile or about 8 pounds at the 90th percentile.

In almost all cases the linear and logit parameter estimates are in agreement in the sense that the linear estimates fall in the range of the corresponding logit estimates evaluated at the 50th and 90th percentiles. The logit estimates when multiplied by p*(1-p) are actually easier to link with a specific pound difference. Therefore, only the logit estimates will be discussed for the rest of the variables. In some cases statistical significance may have been rejected because of limited sample size for a category, so non-significant impacts will be discussed, too. In all of the following discussion, the weight changes are for a 15 ½ year-old boy who is about 5'8'' tall. The 50th percentile BMI for this boy is 20.2, corresponding to a weight of 132 pounds. The 90th percentile BMI is 25.1 corresponding to a weight of 164 pounds.

African Americans (race=2) are significantly heavier than **Whites** (race=6). At the 50th percentile the difference is about 4 pounds, at the 90th percentile about 8 pounds. Although **American Indians** (race=3) were not significantly different from whites, the logit parameter implies a difference of about 3 pounds at the 50th percentile and 4 to 5 pounds at the 90th percentile. **Asians** (race=4) weigh less although the difference from whites was not significant. At the 50th percentile, the difference is about 3 pounds and at the 90th percentile 4 to 5 pounds. **Other races** (race=5) are not significantly different from Whites, with the implied difference in weight being 2 pounds at the 50th percentile and 3 to 4 pounds at the 90th percentile.

Non-Hispanics are significantly lighter than **Hispanics**. At the 50th percentile the difference is about 4 pounds, at the 90th percentile about 5 pounds.

Age is significantly and negatively related to BMI percentile. The logit parameter is -0.07945 and the linear parameter is -1.2382. The example is not useful in interpreting this because it assumes a constant age. Since this is an analysis of Wave I only at this point, the data are cross-sectional. This could be interpreted to mean that successive age

cohorts are becoming heavier. Remember that relative physical (sexual) maturity has been accounted for.

Daily Activity Variables

Contrary to the hypothesis, the number of times that a student participates in **hobbies** does not appear to have a significant influence on BMI percentile. The estimated effects are small and although those who participate in hobbies 5 or more times per week weigh less than all the other hobby categories, there is not a consistent relationship with fewer times per week always implying a higher BMI percentile. The effect at the 50th percentile ranges from less than one pound to about 1.5 pounds. The effect at the 90th percentile ranges from practically nothing to less than 2 pounds.

The number of times that **sports** are participated in is not significant either, but for the linear model more sports implies lower BMI percentile consistently. For the logit model, the group that has the highest BMI percentile is the one that participates 1 or 2 times a week (higher than the one with no sports participation). This largest difference from those who participate in sports 5 or more times a week is about 1 ½ pounds at the 50th percentile and 2 pounds at the 90th percentile.

Students who didn't **hang out with friends** or who did so only once or twice a week were significantly heavier than those who hung out 5 or more times. Those who never hung out with friends were about 3 pounds heavier at the 50th percentile and 5 pounds heavier at the 90th percentile.[9]

The number of times per week that a student **exercised** (not in active sports) had a significant, but positive impact on BMI percentile. This could mean that exercise burns calories, but also builds muscle. A gain in muscle can be a weight gain resulting in a higher BMI. This points up the limitation of BMI as a measure of obesity since it cannot differentiate between weight from fat and weight from muscle(Prentice and Jebb, 2001). Although the variable is significant, the effect in our example of the 15 ½ year-old male is only about a pound at either the 50th or the 90th percentile.

Hours spent in sedentary pursuits is significant, but the impact is small. The estimated impact from the logit parameters is well less than a pound at either the 50th or 90th percentile. The use of a **neighborhood recreation or fitness center** was significant, but the sign was negative, the opposite of that expected—children who did not use a center had a lower BMI percentile than those who did. The effect was about 2 pounds at the 50th percentile and 3-4 pounds at the 90th percentile. It is possible that snacks were served at recreation centers.

Family Characteristic Variables

The existence of obesity in the parents, especially the mother, had a significant impact on the heaviness of the students. At the 50th percentile, the effect of **maternal obesity** was 9-10 pounds while at the 90th percentile it was about 15 pounds. The effect of **paternal obesity** was about one-third the size of the impact of maternal obesity. This was one of

[9] See Appendix (Table A2) for Sums of Squares.

the largest impacts in the model. **Birth weight** of the student was positively and significantly related to their BMI percentile, but the effect was small.

The **closeness of the student to his or her father** was significant as a whole, but there was no consistent pattern of progression from closest to least close relationship.

Household income is a continuous variable and was significantly negative. This is consistent with the findings of many studies. However the effect was small, with an income difference of $30,000 having an impact of less than a pound at the 50th percentile and 2-3 pounds at the 90th percentile of BMI.

Health and Diet Variables

Students in excellent or very good **health** had significantly lower BMI percentiles than those with poor health. The impact is one of the largest in the model. At the 50th percentile the difference between a student in poor health and one in excellent health would be as much as 14 pounds. At the 90th percentile the impact would be as much as 22 pounds. The impact of being in very good health is about 80% as large.

Those who eat **breakfast** have significantly lower BMI percentiles than those who do not usually eat breakfast and the impact is considerable, 4-5 pounds at the 50th percentile and 5-6 at the 90th percentile. The effect of being **taught in school about what foods to eat or not eat** was not significant. However, those who had no education about food, exercise, or obesity were heavier than those who had been educated about all three. The effect was only about a pound at either the 50th or the 90th percentile.

Some categories of length of **breastfeeding** were significantly different from the control group (not breastfed). All categories had lower BMIs compared to the group who were not breastfed at all. Taken as a whole, students who had been breastfed as infants had significantly lower BMI percentiles than those who had not. In the logit model the largest impact was for the group who had been breastfed for the longest period (24 or more months). The impact at the 50th percentile was about 4 pounds and at the 90th percentile, 12 pounds.

Non-smokers had significantly higher BMIs in the linear model. The variable was almost significant in the logit model. The impact was less than 2 pounds at the 50th percentile and 2-3 pounds at the 90th percentile.

Students with self-assessed **disabilities** had significantly higher BMIs than those without a disability and the size of the effect is large. At the 50th percentile the difference was about 11 pounds. The difference at the 90th percentile was about 18 pounds.

Contrary to expectations, students who had had a **routine physical exam** during the previous year were heavier than those who had not. The variable was not quite significant at the 5 percent level. The difference at the 50th percentile was about a pound and at the 90th percentile it was about 2 pounds. Perhaps children who are overweight are more likely to be taken for a physical.

The level of **physical (sexual) maturity** was highly significant. This variable was defined as the integer value of the average of self-assessed physical maturity and interviewer-assessed physical maturity. (The correlation between the two was only .15) The values ranged from 1 to 5 and all groups were significantly different from the most mature (=5). The more physically mature the student, the higher the BMI percentile. In preliminary regressions the boys and girls were analyzed separately, but the differences in parameters were small so they were combined here. The logit effect at the 50th percentile works out to a change of 48 percentiles for the least mature group compared to the most mature group. The second percentile weight for this height and age is about 106 pounds compared to the 50th percentile of 132 pounds. This yields a difference of 26 pounds. However, if the change is so large, it doesn't make sense to say that you are evaluating at the 50th percentile when clearly, a lot of the change is taking place at lower or higher percentiles. A more conservative approach is to look at the difference in weights at the 26th and 74th percentiles—a difference of 23 pounds. This is still a very large difference. At the 90th percentile the estimated difference is 17 percentiles. The conservative estimate of the difference in weights was 47 pounds. Caution should be taken when interpreting the effects of variables at the extremes of the distribution like this because the last few percentiles in the tail of the distribution cover such a large range of weights. The effects of the other categories of physical maturity declined approximately linearly with the effect of being category 2 being about ¾ of the effect of category 1, category 3 about ½ of the effect of category 1, and category 4 about ¼ the effect of category 1.

Differences for the overweight and obese children only

Because so few of the significant variables are susceptible to policy changes and because maternal and paternal obesity are such strong variables, the effect of parental acknowledgement of a child's weight problem seemed like a possible covariant that would be susceptible to policy changes. Therefore, a new variable, **recfail**, was defined to indicate failure by parents to recognize that their child is overweight. For those children who fell into either the overweight or the obese category, **recfail** was defined as equal to 1 if the parents answered no to the question about their child's suffering from obesity or equal to 0 if the parents answered yes. For this subsample of students (1108 observations), regressions were run with and without **recfail**.[10]

Because by definition, these regressions were performed toward the tail of the distribution, only the logit model is useful. There were some noticeable changes in the coefficients and their significance between the regressions with **recfail** and without **recfail**. This seems to mean that at least some of the differences between demographic groups are not genetic but social. These groups may have social systems that find heavier weights appealing or they do not recognize the problems of overweight. This is a hopeful finding in that educating parents is possible, while we cannot change characteristics such

[10] See the Appendix for the complete results.

as race or ethnicity. There are also differences between the subsample of overweight and obese children and the larger sample that includes all BMI categories.

There were some interesting changes in the effects of the demographic variables. The impact of being male is slightly greater for the overweight children, but adding the **recfail** variable reduces it by about 40%. This implies that we are less likely to recognize overweight in boys. The impact of being **African American** is about one-third less for the overweight children than for the group as a whole. Introducing the **recfail** variable further reduces the impact to about a third of that for the whole group. **American Indian** children who are overweight are less overweight than their white counterparts rather than more for the whole group. **Asian Americans** are less overweight than corresponding white children. The effect of **Hispanic ethnicity** disappears when considering the overweight children alone. The effect of **age** is still negative, but only one-eighth the size.

In the daily activities category of variables, there were some changes. The number of times a student participated in **hobbies** was still not significant. An interesting change is that while **sports participation** did not significantly impact the BMI percentile of the entire group, it did impact BMI percentile for the kids who are overweight or obese. Children who participated in sports 5 or more times a week had significantly lower BMIs than those in the other categories of sports participation. It appears that sports are particularly important for overweight children but they need to participate almost every day. Among the overweight children whose parents didn't recognize their weight problem, those who never **hung out with friends** were significantly heavier than those who hung out with friends 5 or more times a week. Those who hung out (1 or 2) or (3 or 4) were not significantly different. The number of times that overweight children **exercised (other than sports)** was not significant and the estimated effect was tiny. The **hours of sedentary activity** changed sign to negative for the overweight children, but was no longer significant. Using the neighborhood recreation center was no longer significant.

Some characteristics of the parents continued to be significant. **Obesity in the mother** and **in the father** were still significant contributors to the student's obesity. The size of the impact of the **mother's obesity** was cut in half; the size of the impact of the **father's obesity** remained about the same for the overweight children whether or not **recfail** was included. None of the categories of **closeness to the father** were significant for the overweight children. Household income was not significant and the impact was small for the overweight children.

Better **general health** is still consistently related to lower BMIs, but the sizes of the effects are reduced. Overweight children who eat **breakfast** are slightly heavier than those who don't, but the difference is not significant. The **food education** variable was still not significant in any consistent way. Length of **breastfeeding** was not significant and the signs varied for the overweight children. **Smoking** did not have a significant impact on the BMIs of the overweight children. The effect of having a **disability** changed sign and lost its significance; having a disability was associated with slightly lower BMIs for the overweight children. **Physical maturity** was not significant for the overweight

students. This could mean that the children and the interviewers were confusing weight with physical maturity.

The impact of the **parent's failure to recognize the child's weight problem** was large and highly significant. The size of the impact was twice the size of any other variable in the regression. Educating the parents to recognize a weight problem could have a large impact on reducing the weight of those children who are overweight.

Table 6. Parameter Estimates on Weight Categories 3 (Overweight) and 4 (Obese) Only. Southern Region, Wave I.

		Logit with recfail R2=.353593, N=1108 Root MSE=.795570		Logit without recfail R2=.168807 N=1108 Root MSE=4.021937	
Parameter		Estimate	Pr > |t|	Estimate	Pr > |t|
Intercept		4.579079	<.0001	4.117507	<.0001
gender	Male	0.206765	0.0003	0.371689	<.0001
gender	Female	0	.	0	.
race	Afr. Am.	0.112935	0.0765	0.217246	0.0026
race	Am. Indian	-0.41926	0.0079	-0.44254	0.0134
race	Asian Am	-0.2073	0.5401	-0.41006	0.2848
race	Other	0.061982	0.5887	0.1045	0.4211
race	White	0	.	0	.
ethn	Non-Hispanic	0.009541	0.9073	-0.05607	0.5455
ethn	Hispanic	0	.	0	.
ageyrs		-0.01312	0.3797	-0.03051	0.0709
hobby	None	0.028978	0.6994	-0.00415	0.9611
hobby	1 to 2	-0.05154	0.4474	-0.07873	0.3058
hobby	3 to 4	0.013305	0.8549	-0.0341	0.6791
hobby	5+	0	.	0	.
sports	None	0.181956	0.0423	0.179864	0.0765
sports	1 to 2	0.212655	0.0082	0.199653	0.0285
sports	3 to 4	0.161549	0.0353	0.144035	0.0977
sports	5+	0	.	0	.
hangout	None	0.164322	0.0588	0.160934	0.1024
hangout	1 to 2	-0.02128	0.7398	0.001084	0.9881
hangout	3 to 4	-0.02233	0.7238	-0.03684	0.6069
hangout	5+	0	.	0	.
ttex		0.000747	0.9452	-0.00734	0.5504
hsed		-0.00083	0.4093	-0.00097	0.3897
reccenter	Use	-0.00607	0.9257	0.029232	0.6915
reccenter	Don't use	0	.	0	.
momobese	No	-0.442	<.0001	-0.31153	<.0001
momobese	Yes	0	.	0	.
dadobese	No	-0.35232	<.0001	-0.27718	0.0005
dadobese	Yes	0	.	0	.
dadclose	0 = Least	-0.03813	0.5423	-0.08462	0.2325
dadclose	1	-0.18298	0.3912	-0.22824	0.3454
dadclose	2	-0.1977	0.239	-0.30222	0.1122
dadclose	3	-0.06667	0.4936	-0.07752	0.4825
dadclose	4	-0.10499	0.1435	-0.11702	0.1502
dadclose	5 = closest	0	.	0	.
income		-0.00092	0.3049	-0.00077	0.4451
ghealth	Excellent	-0.5473	0.08	-0.77314	0.029
ghealth	Very Good	-0.45117	0.1455	-0.63139	0.0722
ghealth	Good	-0.17673	0.5682	-0.3003	0.3921
ghealth	Fair	-0.0059	0.9851	-0.03744	0.9169

ghealth	Poor	0	.	0	.
breakfast	Yes	0.050556	0.4125	0.051409	0.4622
breakfast	No	0	.	0	.
fooded	0 topics	0.052575	0.6531	0.120527	0.3631
fooded	1 topics	-0.17241	0.0643	-0.23596	0.0254
fooded	2 topics	-0.0695	0.2156	-0.09581	0.132
fooded	3 topics	0	.	0	.
brstfed	1 shortest	0.033879	0.6494	0.071728	0.3956
brstfed	2	-0.05701	0.5522	0.012167	0.9108
brstfed	3	-0.06956	0.5489	-0.11519	0.3811
brstfed	4	0.047003	0.742	-0.02253	0.8893
brstfed	5	0.100025	0.4333	0.083606	0.5634
brstfed	6 longest	0.026332	0.9188	0.08197	0.7795
brstfed	7 none	0	.	0	.
birthw	In ounces	-5.7E-06	0.9962	0.000673	0.6212
smoke	No	0.032989	0.6347	-0.01388	0.8599
smoke	Yes	0	.	0	.
disability	No	0.223919	0.4361	0.26286	0.4199
disability	Yes	0	.	0	.
physexam	No	0.007894	0.8799	-0.00325	0.9562
physexam	Yes	0	.	0	.
avmature	1 least	0.366959	0.3397	-0.07995	0.854
avmature	2	-0.05585	0.6948	-0.21511	0.1818
avmature	3	-0.13335	0.3172	-0.266	0.078
avmature	4	-0.19438	0.1488	-0.27014	0.0766
avmature	5 most	0	.	0	.
recfail	No	-1.01229	<.0001		
recfail	Yes	0	.		

Let's put these numbers into the context of the example of the 15 ½ year-old boy who is 5'8" tall. This time all of the students are at or above the 85th percentile, so it makes no sense to look at effects at the 50th percentile. Consider the 90th percentile example.

Table 7. Predicted Logit Effects at the 90th Percentile (in Percentiles and Pounds) of Some Key Variables: Example of a 15 ½ year-old boy who is 5'8" tall.

Parameter		Entire sample (N=4237)		Overweight or Obese (N=1108) Model without Recfail		Overweight or Obese (N=1108) Model with Recfail	
		Percentiles	Pounds	Percentiles	Pounds	Percentiles	Pounds
gender	Male	3.1	6	3.3	6	1.9	4
race	Afr. Am.	3.0	6	2.0	4	1.0	2
race	Am. Indian	1.9	4	-4.0	-8	-3.8	-8
race	Asian Am	-2.5	-5	-3.7	-7	-1.9	-4
ethn	Hispanic	2.9	6	0.5	1	0.1	0
sports	None	0.6	1	1.6	3	1.6	3
sports	1 to 2	1.0	2	1.8	4	1.9	4
sports	3 to 4	0.4	1	1.3	2	1.5	3
sports	5+	0.0		0.0		0.0	
hangout	None	2.2	4	1.4	3	1.5	3
hangout	1 to 2	1.6	3	0.0	0	-0.2	0
hangout	3 to 4	-0.6	-1	-0.3	0	-0.2	0
hangout	5+	0.0		0.0		0.0	
momobese	Yes	7.5	13	2.8	5	4.0	8
dadobese	Yes	2.8	5	2.5	5	3.2	6
ghealth	Excellent	-10.8	-22	-7.0	-12	-4.9	-10
ghealth	Very Good	-8.3	-17	-5.7	-11	-4.1	-8
ghealth	Good	-5.3	-11	-2.7	-5	-1.6	-3
ghealth	Fair	-2.2	-4	-0.3	-1	-0.1	0
ghealth	Poor	0.0		0.0		0.0	
breakfast	No	3.4	7	-0.5	-1	-0.5	-1
disability	Yes	8.7	18	-2.40	-5	-2.0	-4
avmature	1 least	-17.2	-35	-0.7	-1	3.3	7
avmature	2	-12.7	-29	-1.9	-4	-0.5	-1
avmature	3	-9.1	-17	-2.4	-5	-1.2	-2
avmature	4	-4.5	-9	-2.4	-5	-1.7	-2
avmature	5 most	0.0		0.0		0.0	
recfail	Yes					9.1	20

When we look at the overweight children and include the variable **recfail** which represents the parent's failure to recognize that their child has a weight problem, the impact of being male is only 4 pounds instead of 6. The effect of being **African American** is only 2 pounds instead of 6. **American Indian** children who are overweight are actually less overweight than their white counterparts. The extra 6 pounds for being **Hispanic** disappear. Participating in **sports** five or more times a week is associated with 3 to 4 fewer pounds than any lesser amount of sports participation. For these overweight children, **hanging out with friends** was important even if they only did it once a week. Children who never hung out with friends were about 3 pounds heavier in this example.

The impact of **maternal obesity** is less when the failure to recognize a weight problem is included but it is still 8 pounds (compared to 13 for the entire sample). The impact of **paternal obesity** increased slightly when **recfail** was included from 5 to 6 pounds. The impact of **general health** level was reduced with excellent health being associated with

about 10 pounds less weight. Our example boy would be about 1 pound heavier if he eats breakfast rather than 7 pounds lighter.

An overweight child with a **disability** is predicted to weigh 4 to 5 pounds less than an overweight child without a disability. This may indicate an effort to overcome the disability. The impact of the level of **physical maturity** is practically eliminated when only the overweight students are considered. The **failure to recognize** a child's weight problem is associated with 20 additional pounds for our 15 ½ year-old boy. Examples for girls or for different aged boys would be similar, but with different means and spreads.

Conclusions from Wave I

When the entire southern sample is analyzed, the variables with the largest impacts (whether or not they are significant) are **gender**, **African American race**, **Native American race**, **Asian race** (negative), **Hispanic ethnicity**, **mother's obesity**, **general health**, **eating breakfast** (negative), and **physical (sexual) maturity**. Most of these are not susceptible to intervention--only **mother's obesity**, eating **breakfast**, and perhaps **general health**. **Father's obesity** and length of **breastfeeding** have somewhat smaller impacts and might also be influenced.

When only the overweight and obese individuals are analyzed, **failure by the parents to recognize** that the student has a weight problem has the biggest impact. The impact of the **mother's obesity** is reduced, though that of the **father's obesity** is unchanged. General **health** is still important, but the size of the impact is reduced. The effects of **physical maturity** and **Hispanic ethnicity** have virtually disappeared. Those for **gender** and **race** are reduced with Native Americans actually having lower BMI percentiles than other overweight or obese children.

The areas where interventions might work largely concern the parents. Parents need to reduce their own levels of obesity. They need to recognize when their children have a weight problem so they can take steps to reduce it. They should encourage physical activity, especially among children who do have a weight problem. Education of parents, especially Hispanic and African Americans, could have a significant impact on the level of adolescent obesity in this country.

The effect of non-sports afterschool activities on BMI percentile was not statistically significant. Neither was the effect of participating in sports. The effect of participating in physical education and non-sport exercise was statistically significant, but those who exercised more often had slightly higher BMI percentiles, perhaps a reflection of higher muscle mass.

Analysis of Wave III

The average time between the Wave I and Wave II interviews was only 11 months. Therefore, the changes in BMI percentile were small and hard to analyze. Thus, to look at changes in BMI percentiles, the differences between Wave I and Wave III were used. There are several reasons for using differences: in this case they represent increases in BMI relative to the norm, the data is not a true panel because the same questions were not asked at each wave (and questions on the same topic had different possible answers), using first differences is a simple way of dealing with individual characteristics that are not explicitly modeled (unobservables) (Wooldridge, 2002), and using the lagged BMI percentile logit allows for examination of regression to the mean. Table 8 displays the percentages of the students in each weight category at the time of Wave III.[11] Females who were in their fourth or later month of pregnancy were deleted.

The differences between the South and Non-South were small at the time of Wave I, but by Wave III the differences had grown considerably.[12] Southern males had approximately the same distribution across weight categories as non-Southern males. Forty-two percent of Southern females were in the overweight and obese categories versus 35% for non-Southern females. White Southerners were slightly heavier than were non-Southerner whites, but African American Southerners, especially the females, were heavier than non-Southern African Americans. Fifty-three percent of female, Southern, African Americans were overweight (23%) or obese (30%). In the non-Southern regions, 23% of female African Americans were overweight and 16% were obese. Twenty-three percent of male, Southern, African Americans were obese versus 17% of male, non-Southern, African Americans.

Table 9 displays the changes in the percentage in categories between Wave I and Wave III. The percentage of students who were underweight or normal weight fell for every race and both genders except for underweight, Southern, white males where it was unchanged and normal weight Southern males of "other" race and normal weight non-Southern females of "other" race, both of which increased slightly.[13] The percentages of overweight or obese students were either constant or grew for all races and both genders, except for overweight, non-Southern females of "other" race which decreased slightly (by the same number of percentage points as the obese category increased.) In the US sample, an additional 4% of the males and 6% of the females were overweight by Wave III; an additional 7% of the males and 10% of the females were categorized as obese. For the Southern sample, 3% more males were overweight and 6% more males were obese. The

[11] The categories here actually understate the rates of obesity and overweight because they are based on the assumption that all those who are more than 240 months old are 240 months old. The 85th percentile BMI for males is 27.05 and for females 26.48 compared to the usual 25.0 for adults. The 95th percentile BMI is 30.59 for 240 month-old males and 31.76 for females compared to the usual 30.0 for adults of either sex The underweight males are slightly overstated and the underweight females are slightly understated.

[12] The students are still classified as being in their Wave I regions even though they may have moved.

[13] Comparison Table (Wave I) with Table (Wave III) seems to indicate a small increase in the percentage of underweight white, Southern males, but this is due to rounding.

percentage of Southern females who were overweight increased by 6%, and the percentage who were obese increased by 13%.

The increase in the incidence of obesity for Southern, African American women (15%) was three times the increase for non-Southern, African American women (5%). The rate of obesity for these young women doubled from 15% to 30% during the time between Wave I and Wave III. More than half (52%) of the Southern, African American women surveyed were overweight or obese by Wave III. Thirty-eight percent of the non-Southern, African American women were overweight or obese with the difference occurring almost entirely in the obese category.

Table 8. Percentages by Weight Category, Gender, and Race. Wave III (2001-2002).

	US Sample		Non-South		South	
All Races						
	Male	Female	Male	Female	Male	Female
Underweight	4%	2%	4%	2%	4%	3%
Normal weight	60%	60%	60%	63%	59%	55%
Overweight	18%	19%	18%	19%	17%	20%
Obese	19%	18%	18%	16%	20%	23%
White						
	Male	Female	Male	Female	Male	Female
Underweight	4%	2%	4%	2%	4%	3%
Normal weight	60%	63%	61%	64%	59%	61%
Overweight	19%	18%	19%	18%	19%	18%
Obese	17%	16%	16%	15%	19%	19%
African American						
	Male	Female	Male	Female	Male	Female
Underweight	4%	2%	1%	2%	4%	2%
Normal weight	61%	51%	63%	60%	59%	45%
Overweight	15%	23%	16%	23%	13%	23%
Obese	20%	23%	20%	15%	23%	29%
Native American						
	Male	Female	Male	Female	Male	Female
Underweight	2%	1%	3%	1%	0%	0%
Normal weight	56%	52%	56%	50%	52%	55%
Overweight	22%	22%	23%	25%	24%	15%
Obese	20%	25%	19%	24%	24%	30%
Asian American						
	Male	Female	Male	Female	Male	Female
Underweight	4%	4%	4%	4%	12%	9%
Normal weight	61%	70%	61%	70%	60%	70%
Overweight	17%	14%	16%	15%	24%	14%
Obese	19%	11%	20%	11%	5%	7%
Other race						
	Male	Female	Male	Female	Male	Female
Underweight	2%	1%	4%	4%	1%	2%
Normal weight	52%	57%	61%	70%	59%	57%
Overweight	21%	20%	16%	15%	19%	20%
Obese	25%	21%	20%	11%	20%	21%

The incidence of obesity more than tripled for Southern, Native American females from 9% to 31%. However, the number of subjects in this category was small, so the influence of individuals is greater. Asian Americans in the South continued to have lower rates of

obesity than in the rest of the nation, but again, there were few individuals in this category.

All in all, the picture of overweight and obesity in American is horrendous. The subjects were only 18 to 25 years old at Wave III. The future is not bright if these trends continue.

Table 9. Change in Percentages in Weight Categories, by Gender and Race. (Wave III-Wave I.)

	US Sample		Non-South		South	
All Races						
	Male	Female	Male	Female	Male	Female
Underweight	-2%	-5%	-2%	-4%	-2%	-5%
Normal weight	-9%	-11%	-10%	-9%	-7%	-14%
Overweight	4%	6%	5%	6%	3%	6%
Obese	7%	10%	7%	8%	6%	13%
White						
	Male	Female	Male	Female	Male	Female
Underweight	-1%	-4%	-1%	-4%	0%	-5%
Normal weight	-9%	-12%	-11%	-11%	-8%	-13%
Overweight	5%	6%	6%	6%	3%	6%
Obese	6%	10%	6%	9%	5%	11%
African American						
	Male	Female	Male	Female	Male	Female
Underweight	-2%	-5%	-4%	-5%	-2%	-5%
Normal weight	-7%	-12%	-7%	-6%	-8%	-16%
Overweight	1%	7%	1%	6%	0%	7%
Obese	8%	11%	9%	5%	10%	15%
Native American						
	Male	Female	Male	Female	Male	Female
Underweight	-4%	-5%	-3%	-5%	-8%	-7%
Normal weight	-5%	-16%	-6%	-17%	-6%	-15%
Overweight	7%	9%	8%	12%	6%	1%
Obese	2%	12%	1%	9%	7%	20%
Asian American						
	Male	Female	Male	Female	Male	Female
Underweight	-2%	-2%	-2%	-2%	-2%	-3%
Normal weight	-10%	-10%	-10%	-10%	-11%	-10%
Overweight	4%	7%	4%	7%	12%	8%
Obese	7%	6%	8%	5%	0%	6%
Other race						
	Male	Female	Male	Female	Male	Female
Underweight	-5%	-6%	-2%	-3%	-9%	-7%
Normal weight	-10%	-11%	-3%	2%	1%	-13%
Overweight	5%	5%	0%	-2%	4%	7%
Obese	10%	12%	5%	2%	4%	12%

Table 10 shows the relationship between BMI percentile and weight in pounds for a 20 year-old male of average height (69.6 inches). The interpretation of Table 10 is the same as for Table 5.

The median height for a 20 year-old male is 69.6257 inches; the median weight is155.6 pounds. This works out to a BMI of 22.5 which corresponds to a BMI percentile of 42.8. (For a 15 ½ year-old male, the median height was 68 inches, the median weight was 130 pounds, and the median BMI was 20.2.) Near the mean, a small increase in weight implies a large increase in percentile. Approaching the tails of the distribution, a large increase in weight is needed to accomplish a small increase in percentile.

Table 10. The Relationship Between Weight and BMI percentile for a 20 year-old Male of Median Height.

Height in Inches	Weight in Pounds	BMI	BMIPCT	Change in Percentile on the BMI Distribution	Weight Change in Pound Corresponding to a One Percentile Change in BMI
69.6257	155	22.48	42.84		
69.6257	157	22.77	46.73	3.89	0.51
69.6257	161	23.35	54.15	7.43	0.27
69.6257	165	23.93	60.95	6.80	0.29
69.6257	169	24.51	67.01	6.06	0.33
69.6257	173	25.09	72.30	5.29	0.38
69.6257	177	25.67	76.85	4.54	0.44
69.6257	181	26.25	80.70	3.85	0.52
69.6257	185	26.83	83.94	3.24	0.62
69.6257	189	27.41	86.64	2.70	0.74
69.6257	193	27.99	88.88	2.24	0.89
69.6257	197	28.57	90.73	1.85	1.08
69.6257	201	29.15	92.26	1.53	1.31
69.6257	205	29.73	93.53	1.26	1.58
69.6257	209	30.31	94.57	1.04	1.92
69.6257	213	30.89	95.43	0.86	2.33
69.6257	217	31.47	96.14	0.71	2.82
69.6257	221	32.05	96.72	0.59	3.40
69.6257	225	32.63	97.21	0.49	4.10
69.6257	229	33.21	97.62	0.41	4.92
69.6257	233	33.79	97.96	0.34	5.89
69.6257	237	34.37	98.24	0.28	7.04
69.6257	241	34.95	98.48	0.24	8.38
69.6257	245	35.53	98.68	0.20	9.95
69.6257	249	36.11	98.85	0.17	11.75
69.6257	253	36.69	99.00	0.14	13.86
69.6257	257	37.27	99.12	0.12	16.27
69.6257	261	37.85	99.23	0.11	19.03
69.6257	337	48.88	99.88		

Econometric Analysis of Changes between Wave I and Wave III

The simplest model regressed the change in the BMI percentile logit between Wave I and Wave III (**chlogit**) against the BMI percentile logit at the time of Wave I. BMI logit1 was highly significant and the sign was negative indicating a regression toward the mean. In other words, people with higher BMIs gained relatively less (in percentiles) than did lighter individuals from Wave I. Because the logit-transformed variables were used, this is not simply a reflection of the larger number of pounds associated with a given percentile change near the tails of the distribution.

Table 11. Regression of Change in BMI Percentile Logit on BMI Percentile Logit at Wave I.

Dependent Variable: chlogit			Mean=.512304	
N=5824	R2=.143377		Root MSE=.1585903	
Parameter	Estimate	St. Error	t Value	Pr > |t|
Intercept	0.725153	0.021871	33.16	<.0001
bmilgit1	-0.31805	0.010189	-31.22	<.0001

Next **chlogit** was regressed against the variables used in the Wave I analysis plus the initial **BMI logit** and the **age at Wave III** (but not the age at Wave I.) Then these variables plus whether or not the person had **dieted to lose weight** and whether or not the person had **exercised to lose weight** at the time of Wave I were used as the regressors. These results are reported in Table 12.

Based on the Type III sums of squares, several of the variables from Wave I had a significant impact on the change in BMI percentile between Wave I and Wave III. While the total times per week the student participated in **(non-sports) exercise** in Wave I was associated with a slightly higher BMI percentile at Wave I, it reduced the change in BMI percentile between the waves. **Mother's obesity** had a significant, positive effect on change in BMI percentile just as it had a significant, positive effect on BMI percentile in Wave I. The impact of **father's obesity** on the change in BMI percentile was significant when the diet and exercise at Wave I variables were omitted. The size of the impact of **father's obesity** was only 1/5 to ½ the size of the effect of **mother's obesity**. The **closeness of the student's relationship with the father** had a significant impact, but the direction of the effect was ambiguous for the individual categories of closeness. **Eating breakfast** at Wave I was associated with significantly smaller gains in BMI percentile by Wave III. **Breastfeeding** of any duration was associated with smaller gains in BMI percentile and the difference was significant or nearly significant for all of the breastfeeding categories except the shortest (less than 3 months). Birthweight had no significant impact on weight change between Wave I and Wave III even though it had a significant, positive impact on weight at Wave I.

Smoking was connected to lower gain in BMI percentile, but the health risks of smoking rule out encouraging smoking as a weight reduction or weight maintenance plan. Taken

as a whole, the average **physical maturity** at Wave I had a significant impact on the change in BMI percentile, but the direction of causality was ambiguous with respect to the individual levels of maturity. The person's **age at Wave III** was positively related to BMI percentile unlike the effect of **age in Wave I** which was negative.

Variables from Wave I that had no significant impact on the change in BMI percentile were **hobbies, sports, hanging out with friends, hours of sedentary behaviors, times of (non-sports) exercise, using a recreation center, income[14], general health, education about food and exercise, birth weight, disability**, and whether they had a **regular physical exam** in the 12 months prior to the Wave I interview. It is interesting that **participation in organized sports** did not reduce weight gain, but **non-sports exercise** did. But **exercise for the purpose of losing weight** at Wave I was associated with a significantly greater increase in BMI percentile as was **dieting to lose weight**.

Table 12. Results from Regressing the Changes in BMI percentile logit on Variables from Wave I.

		Mean=0.494173, N=2414 R2=.177954, Root MSE=1.383310				Mean=0.476751, N=3427 R2=.158080, Root MSE=1.442739			
Parameter		Estimate	St.Error	t Value	Pr > |t|	Estimate	St. Error	t Value	Pr > |t|
Intercept		-1.943	0.865	-2.25	0.025	-1.802	0.740	-2.43	0.015
bmilgit1	Logit at Wave I	-0.294	0.017	-17.22	<.0001	-0.268	0.014	-19.44	<.0001
hobby	0 times	-0.030	0.088	-0.34	0.732	-0.055	0.076	-0.72	0.472
hobby	1-2 times	0.033	0.080	0.41	0.681	0.002	0.069	0.03	0.974
hobby	3-4 times	0.039	0.086	0.45	0.649	0.008	0.075	0.1	0.919
hobby	5 or more times	0.000	.	.	.	0.000	.	.	.
sports	0 times	-0.165	0.106	-1.56	0.120	0.016	0.092	0.18	0.860
sports	1-2 times	-0.059	0.095	-0.62	0.532	0.109	0.083	1.31	0.190
sports	3-4 times	-0.069	0.097	-0.72	0.474	0.021	0.083	0.25	0.804
sports	5 or more times	0.000	.	.	.	0.000	.	.	.
hangout	0 times	0.100	0.109	0.92	0.357	0.137	0.095	1.45	0.147
hangout	1-2 times	0.001	0.075	0.02	0.985	-0.022	0.065	-0.33	0.741
hangout	3-4 times	0.060	0.072	0.82	0.410	0.064	0.063	1.01	0.312
hangout	5 or more times	0.000	.	.	.	0.000	.	.	.
ttex	Times of Exercise	-0.016	0.013	-1.19	0.233	-0.007	0.012	-0.63	0.531
hsed	Sedentary Hours	-0.001	0.001	-1	0.316	-0.001	0.001	-0.65	0.516
reccenter	Don't Use	0.065	0.079	0.82	0.412	0.013	0.068	0.19	0.848
reccenter	Use	0.000	.	.	.	0.000	.	.	.
momobese	No	-0.326	0.076	-4.31	<.0001	-0.279	0.068	-4.13	<.0001
momobese	Yes	0.000	.	.	.	0.000	.	.	.
dadobese	No	-0.062	0.094	-0.66	0.512	-0.188	0.085	-2.21	0.027
dadobese	Yes	0.000	.	.	.	0.000	.	.	.
dadclose	0=least	-0.093	0.072	-1.29	0.198	-0.125	0.063	-1.99	0.047
dadclose	1	0.236	0.256	0.92	0.357	0.160	0.214	0.75	0.456

[14] Income was almost significant in one specification, but the size of the impact was very small.

dadclose	2	0.046	0.167	0.28	0.783	0.110	0.148	0.74	0.459
dadclose	3	-0.345	0.106	-3.24	0.001	-0.295	0.092	-3.19	0.001
dadclose	4	-0.211	0.084	-2.51	0.012	-0.176	0.072	-2.44	0.015
dadclose	5=closest	0.000	.	.	.	0.000	.	.	.
income	$1,000	-0.002	0.001	-1.88	0.060	-0.001	0.001	-1.32	0.185
ghealth	Excellent	-0.810	0.535	-1.52	0.130	-0.653	0.407	-1.6	0.109
ghealth	Very Good	-0.888	0.533	-1.67	0.096	-0.670	0.406	-1.65	0.099
ghealth	Good	-0.760	0.534	-1.42	0.155	-0.639	0.407	-1.57	0.116
ghealth	Fair	-0.534	0.544	-0.98	0.326	-0.418	0.416	-1	0.316
ghealth	Poor	0.000	.	.	.	0.000	.	.	.
breakfast	Yes	-0.213	0.074	-2.88	0.004	-0.297	0.066	-4.5	<.0001
breakfast	No	0.000	.	.	.	0.000	.	.	.
fooded	0 topics	0.008	0.137	0.06	0.952	0.008	0.123	0.07	0.947
fooded	1 topic	-0.198	0.110	-1.81	0.071	-0.234	0.093	-2.53	0.012
fooded	2 topics	0.050	0.064	0.78	0.434	0.043	0.055	0.79	0.432
fooded	3 topics	0.000	.	.	.	0.000	.	.	.
brstfed	1=Shortest	-0.048	0.084	-0.57	0.569	-0.088	0.075	-1.17	0.241
brstfed	2	-0.388	0.107	-3.62	0.000	-0.219	0.092	-2.38	0.017
brstfed	3	-0.401	0.127	-3.15	0.002	-0.294	0.111	-2.66	0.008
brstfed	4	-0.282	0.137	-2.05	0.040	-0.235	0.124	-1.9	0.058
brstfed	5	-0.471	0.163	-2.88	0.004	-0.358	0.141	-2.53	0.011
brstfed	6=Longest	-0.418	0.340	-1.23	0.219	-0.574	0.252	-2.27	0.023
brstfed	Not breastfed	0.000	.	.	.	0.000	.	.	.
birthw	Ounces	0.002	0.001	1.11	0.269	0.000	0.001	0.37	0.713
smoke	No	0.190	0.078	2.44	0.015	0.268	0.067	3.99	<.0001
smoke	Yes	0.000	.	.	.	0.000	.	.	.
disability	No	0.503	0.423	1.19	0.235	0.175	0.404	0.43	0.665
disability	Yes	0.000	.	.	.	0.000	.	.	.
physexam	No	-0.001	0.061	-0.02	0.984	-0.045	0.053	-0.84	0.402
physexam	Yes	0.000	.	.	.	0.000	.	.	.
avmature	1=least	0.014	0.317	0.04	0.965	-0.217	0.256	-0.85	0.395
avmature	2	0.100	0.200	0.5	0.618	-0.104	0.177	-0.59	0.556
avmature	3	0.237	0.191	1.24	0.215	0.125	0.171	0.73	0.465
avmature	4	0.497	0.195	2.55	0.011	0.297	0.173	1.71	0.087
avmature	5=most	0.000	.	.	.	0.000	.	.	.
diet1	Didn't diet	-0.147	0.075	-1.97	0.050				
diet1	Dieted	0.000	.	.	.				
extolose1	Didn't exercise	-0.093	0.062	-1.48	0.139				
extolose1	Exercised	0.000	.	.	.				
age3	Age at Wave III	0.157	0.018	8.93	<.0001	0.154	0.015	10.05	<.0001

Next, **chlogit** was regressed against demographic variables and variables from Wave III. The means, standard deviations, minimums and maximums for these variables are displayed in Table 13. The regressors can be categorized as demographic, health and diet, daily activities, and lagged variables.

<u>Demographic variables</u>

- Gender

- Race
- Hispanic Ethnicity
- Education
- Income
- Age

Gender, **race** and **Hispanic ethnicity** were used from Wave I even though the question was repeated at each wave. **Educational categories** were GED, high school diploma, associate or junior college degree, bachelor's degree, master's degree, Ph.D. (of which there were none), professional degree, and no degree or diploma.

Income was a continuous variable in thousands of dollars. **Age** was calculated as the time in months between birth and the date of the interview.

Health and Diet

- Exercise Center Use
- Vegetarianism
- Days of Fast Food
- Days of Breakfast
- Cigarette Smoking

Exercise Center Use ranged from 0 to 15 times per week. They were either **vegetarians** or they weren't. They ate at **fast food** restaurants between 0 and 7 days per week. They weren't asked the total times per week that they ate there, so it was not distinguished between eating one or more meals per day. Days per week that they ate **breakfast** ranged from 0 to 7. **Cigarette smoking** was categorized as don't smoke, 10 or fewer cigarettes per day, 11-20 cigarettes per day, 21-30 cigarettes per day, or 31 or more cigarettes per day.

Daily Activities

- Times of Housework
- Times of Hobbies
- Times of Sports
- Times of Walking for Exercise
- Walk to Work or School
- Total Times of Exercise (not sports or walking)
- Hard, Moderate, or Light Labor at Work
- Hours of Sedentary Behaviors

Times in the last week of **housework** and **hobbies** ranged from 0 to 7 for each, as did walking for exercise. Times of **sports** was the sum of team sports and individual sports each of which could range from 0 to 14. Team sports specifically mentioned were football, soccer, basketball, lacrosse, rugby, field hockey, and ice hockey. Individual sports specifically mentioned were running, wrestling, swimming, cross-country skiing, cycle racing, and martial arts. **Walk to work or school** was defined as equal to 1 if they did one or the other or both.

Total times of exercise (not walking or sports as defined above) was the sum of four variables (each of which ranged from 0 to 7) and ranged from 0 to 28. The activities included are bicycle, skateboard, hike, hunt, yardwork, roller blade, roller skate, downhill skiing, snow boarding, racquet sports, aerobics, gymnastics, weight lifting, strength training, golf, fishing, bowling, softball, and baseball.

The **hard**, **moderate**, or **light labor** variables indicate the number of hours per week spent at hard, moderate, or light work on the job. **Hard labor** ranged from 0 to 84 hours; **moderate labor** from 0 to 72; and **light labor** from 0 to 80. **Hours of sedentary activities** were the sum of hours spent watching videos, hours spent playing video or computer games or using the computer not for school, and hours spent watching TV. It was restricted not to exceed the number of hours in a week (168).

Lagged Variables

- Dieted at Wave I
- Exercised to Lose Weight at Wave I
- BMI Logit at Wave I

The **dieted** variable indicated whether or not they had dieted to lose weight at the time of Wave I. Similarly the **exercised to lose weight** indicated if they had done so at Wave I. **BMI logit at Wave I** was the logit transformation of the Wave I BMI percentile used in the earlier analysis of Wave I data.

Table 13. Means, Standard Deviations, Minimums, and Maximums of Variables from Wave III South.

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
bmipct3	BMI percentile	5045	67.35	29.41	1.8E-05	99.86694
gender		5045	0.52	0.50	0	1
race		5040	4.50	1.84	2	6
ethn	Hispanic	5045	0.16	0.37	0	1
edcat	Education	5043	2.79	1.90	1	8
ExCent3	Exercise Center	5044	1.10	1.86	0	15
veggie3	Vegetarian	5042	0.02	0.14	0	1
FastF3	Fast Food days per week	5041	2.77	2.12	0	7
Break3	Breakfast days per week	5045	3.00	2.74	0	7
Cigs3	Amount of Cigarettes	5018	0.46	0.83	0	4
HouseW3	Housework days per week	5034	4.47	2.32	0	7
Hobby3	Hobbies days per week	5035	2.49	2.26	0	7
sports3	Sports times per week	5036	1.21	2.27	0	14
walkex	Walk for exercise days per week	5037	1.61	2.18	0	7
walkwors	Walk to work or school	5045	0.08	0.28	0	1
ttex3	Total times (non-sport) exercise	5035	3.04	3.81	0	28
hardlabor	Hard labor at work	3633	8.18	14.87	0	84
modlabor	Moderate labor at work	3631	7.18	12.42	0	72
lgtlabor	Light labor at work	3631	8.74	13.16	0	80
Income3	$1,000	5027	83.21	33.48	1	99
HSED3	Hours per week of sedentary	4997	23.21	20.68	0	168
diet1	Diet at Wave I	3539	0.20	0.40	0	1
extolose1	Exercise to lose weight at Wave I	3539	0.63	0.48	0	1
agemos3	Age at Wave III in months	5045	268.39	21.45	219	336

Gender was significant at Wave I, and had an almost significant effect on the increase in BMI percentile. While **race** taken as a whole did have a significant impact on the increase, only Asian Americans were significantly different from whites. They gained significantly less. **Hispanic ethnicity** had no significant impact on weight gain. At Wave I **age** was negatively related to BMI percentile, but age was positively related to the change between Wave I and Wave III.

The **educational category** attained by the subjects was not significant overall. The only groups that were significantly different form those with no degree or diploma was the Bachelor's degree group and the GED group, both which gained less. This could be partly a reflection of some subjects still being in school. **Income** (in this case the subject's income, not the parent's) was not significant.

Dietary variables from Wave III were included. Being a **vegetarian** had a large, negative impact on weight gain, but it was not statistically significant. The number of days per week that they usually ate at a **fast food restaurant** was not significant. The signs were not consistent from group to group for the number of days per week that they usually ate **breakfast**.

Cigarette **smoking** was significant as a whole and the category estimates were consistent in that more smoking led to smaller weight gains.

Daily activity variables from Wave III included the number of days per week they did **housework, hobbies,** and **walked for exercise**. Again **hobbies** had no significant effect, nor did **housework**. **Walking for exercise** was not significant and the signs were inconsistent from group to group. Hours spent in **sedentary activities** had a very small, but significant impact. The number of times **sports** were played in a week had a significant and negative impact on **chlogit. Total times of exercise (not sports or walking)** was not significant and the estimated impact was very small.

The strenuousness of work did not have a significant impact on the amount of weight gain. Hours of **hard, moderate, or light labor** were not significant and the estimated effects were small. **Walking to work or school** had a large and significant negative effect on weight gain between Wave I and Wave III.

The effects of three lagged variables were again estimated. **Dieting** at Wave I was associated with larger weight gains as was **exercising to lose weight** then. These effects were significant. **BMIlogit** at Wave I was significantly and negatively related to weight gain indicating a regression to the mean. This result was found in every specification of the model.

The results of this regression are displayed in Table 14 along with estimated effects at some selected percentiles. The Type III sums of square are shown in the Appendix (Table A3.)

Table 14. Parameter Estimates for Logit Regression with Wave III Variables.

Dependent Variable: chlogit

Mean=.519004 N=2819
R2=.222995, Root MSE=1.438839

Parameter		Estimate	St. Error	t Value	Pr > |t|	Effects on BMI Percentile at Selected Percentiles 50/50	25/75	10/90
Intercept		-3.937	0.588	-6.69	<.0001			
bmilgit1	Logit at Wave I	-0.333	0.015	-21.6	<.0001	-8.32	-6.24	-3.00
gender	Male	0.121	0.071	1.72	0.086	3.03	2.27	1.09
gender	Female	0.000	.	.	.	0.00	0.00	0.00
race	African American	0.115	0.069	1.68	0.093	2.89	2.17	1.04
race	Native American	0.226	0.179	1.26	0.208	5.64	4.23	2.03
race	Asian American	-0.485	0.210	-2.31	0.021	-12.12	-9.09	-4.36
race	Other	0.190	0.120	1.57	0.116	4.74	3.56	1.71
race	White	0.000	.	.	.	0.00	0.00	0.00
ethn	Non-Hispanic	0.113	0.094	1.21	0.228	2.83	2.12	1.02
ethn	Hispanic	0.000	.	.	.	0.00	0.00	0.00
edcat	GED	-0.345	0.143	-2.41	0.016	-8.63	-6.47	-3.11
edcat	High School Diploma	-0.137	0.104	-1.32	0.186	-3.43	-2.57	-1.23
edcat	Associate or Junior College	-0.190	0.144	-1.32	0.187	-4.76	-3.57	-1.71
edcat	Bachelor's	-0.363	0.142	-2.55	0.011	-9.07	-6.80	-3.26
edcat	Master's	-0.658	0.403	-1.63	0.103	-16.46	-12.34	-5.93
edcat	Professional	-0.010	0.470	-0.02	0.982	-0.26	-0.20	-0.09
edcat	No Degree or Diploma	0.000	.	.	.	0.00	0.00	0.00
ExCent3	Times per week at exercise center	-0.010	0.018	-0.58	0.559	-0.26	-0.20	-0.09
veggie3	Not vegetarian	0.257	0.207	1.24	0.215	6.43	4.82	2.32
veggie3	Vegetarian	0.000	.	.	.	0.00	0.00	0.00
FastF3	No Fast Food	0.013	0.116	0.11	0.913	0.32	0.24	0.11
FastF3	One day a week	-0.035	0.110	-0.31	0.753	-0.86	-0.65	-0.31
FastF3	Two days a week	0.041	0.104	0.39	0.695	1.02	0.76	0.37
FastF3	Three days a week	0.249	0.108	2.3	0.022	6.23	4.67	2.24
FastF3	Four days a week	0.012	0.122	0.1	0.922	0.30	0.22	0.11
FastF3	Five days a week	-0.024	0.126	-0.19	0.848	-0.60	-0.45	-0.22
FastF3	Six days a week	-0.031	0.213	-0.14	0.885	-0.77	-0.58	-0.28
FastF3	Seven days a week	0.000	.	.	.	0.00	0.00	0.00
Break3	No Breakfast	0.144	0.079	1.82	0.069	3.60	2.70	1.30
Break3	One day a week	0.065	0.105	0.62	0.536	1.63	1.22	0.59
Break3	Two days a week	-0.127	0.099	-1.28	0.202	-3.17	-2.38	-1.14
Break3	Three days a week	0.057	0.113	0.5	0.616	1.41	1.06	0.51
Break3	Four days a week	0.364	0.120	3.03	0.002	9.11	6.83	3.28
Break3	Five days a week	-0.165	0.123	-1.34	0.180	-4.12	-3.09	-1.48
Break3	Six days a week	0.097	0.196	0.49	0.621	2.42	1.81	0.87
Break3	Seven days a week	0.000	.	.	.	0.00	0.00	0.00
Cigs3	Don't smoke	1.670	0.363	4.6	<.0001	41.75	31.31	15.03
Cigs3	Ten or fewer a day	1.556	0.366	4.25	<.0001	38.91	29.18	14.01
Cigs3	11-20 a day	1.293	0.367	3.53	0.000	32.33	24.25	11.64
Cigs3	21-30 a day	0.858	0.391	2.2	0.028	21.45	16.08	7.72
Cigs3	31 or more a day	0.000	.	.	.	0.00	0.00	0.00
HouseW3	No housework in last week	-0.335	0.129	-2.61	0.009	-8.39	-6.29	-3.02
HouseW3	Once	-0.169	0.137	-1.24	0.215	-4.23	-3.17	-1.52
HouseW3	Twice	-0.196	0.101	-1.94	0.053	-4.91	-3.68	-1.77

HouseW3	3 Times	-0.228	0.085	-2.7	0.007	-5.71	-4.28	-2.05
HouseW3	4 Times	-0.116	0.092	-1.26	0.207	-2.90	-2.18	-1.04
HouseW3	5 Times	-0.065	0.103	-0.63	0.531	-1.62	-1.21	-0.58
HouseW3	6 Times	-0.208	0.137	-1.52	0.129	-5.19	-3.89	-1.87
HouseW3	7 or more times	0.000	.	.	.	0.00	0.00	0.00
Hobby3	No hobbies	0.040	0.111	0.36	0.721	0.99	0.74	0.36
Hobby3	Once	0.090	0.123	0.73	0.465	2.26	1.69	0.81
Hobby3	Twice	-0.103	0.118	-0.87	0.384	-2.57	-1.93	-0.93
Hobby3	3 Times	-0.056	0.118	-0.47	0.639	-1.39	-1.04	-0.50
Hobby3	4 Times	0.012	0.128	0.09	0.928	0.29	0.22	0.11
Hobby3	5 Times	0.078	0.152	0.51	0.609	1.94	1.45	0.70
Hobby3	6 Times	-0.069	0.228	-0.3	0.761	-1.73	-1.30	-0.62
Hobby3	7 or more times	0.000	.	.	.	0.00	0.00	0.00
sports3	Times in last week	-0.042	0.017	-2.48	0.013	-1.05	-0.78	-0.38
walkex	No walking for exercise	-0.177	0.113	-1.57	0.118	-4.42	-3.31	-1.59
walkex	Once	-0.056	0.138	-0.41	0.685	-1.40	-1.05	-0.51
walkex	Twice	0.104	0.131	0.79	0.430	2.60	1.95	0.93
walkex	3 Times	0.058	0.133	0.44	0.664	1.45	1.09	0.52
walkex	4 Times	0.195	0.159	1.22	0.221	4.87	3.65	1.75
walkex	5 Times	0.111	0.179	0.62	0.535	2.78	2.08	1.00
walkex	6 Times	0.052	0.288	0.18	0.858	1.29	0.97	0.46
walkex	7 or more times	0.000	.	.	.	0.00	0.00	0.00
walkwors	No walking to work or school	0.246	0.117	2.1	0.036	6.16	4.62	2.22
walkwors	Walk to work or school	0.000	.	.	.	0.00	0.00	0.00
ttex3	Total times exercise in last week	-0.006	0.010	-0.63	0.532	-0.16	-0.12	-0.06
hardlabor	Hours of hard labor at work	-0.003	0.002	-1.54	0.123	-0.08	-0.06	-0.03
modlabor	Hours of moderate labor at work	-0.004	0.002	-1.55	0.122	-0.09	-0.07	-0.03
lgtlabor	Hours of light labor at work	0.000	0.002	0.15	0.882	0.01	0.01	0.00
Income3	Total income before taxes	0.001	0.001	0.95	0.342	0.02	0.01	0.01
HSED3	Hours of sedentary	0.004	0.001	2.87	0.004	0.11	0.08	0.04
diet1	Didn't diet at Wave I	-0.340	0.072	-4.73	<.0001	-8.49	-6.37	-3.06
diet1	Dieted	0.000	.	.	.	0.00	0.00	0.00
extolose1	Didn't exercise to lose weight at Wave I	-0.192	0.059	-3.27	0.001	-4.80	-3.60	-1.73
extolose1	Exercised	0.000	.	.	.	0.00	0.00	0.00
age3	Age at Wave III in years	0.141	0.016	8.53	<.0001	3.52	2.64	1.27

Conclusions and Policy Implications

Obesity tends to be multigenerational with obese parents (especially the mother) having overweight or obese adolescents. Moreover, the adolescents gain more weight than their peers as they move into young adulthood. Policy needs to focus on the entire family. Surprisingly, parents do not always recognize when their child has a weight problem. These children weigh more than other overweight or obese children. This is obviously an area where education could help.

The effects of variables from Wave I persist and affect the amount of weight individuals gained between Wave I (1994-95, ages 11-21) and Wave III (2001-2002, ages 18-28). Breastfeeding has longlasting benefits in weight gain moderation as well as the better known short term benefits. Breastfeeding for less than 3 months did not have a large impact on weight gain between Wave I and Wave III. All categories of breastfeeding of 3 months or greater did have a large impact (as much as a 6-14 pound reduction in weight gain.)

Exercising or dieting to lose weight in adolescence did not reduce the amount of weight gained between the survey waves even when controlling for the BMI percentile at Wave I. Each added up to an estimated 6 pounds of weight gain between Wave I and Wave III. Although the correlations between dieting or exercising to lose weight at Wave I and BMI percentile at Wave I were large and positive, this endogeneity problem should have been solved by including the initial BMI percentile in the regressions models. An emphasis on healthy food (including breakfast) and an active lifestyle may work better.

Policy should encourage non-sports exercise in adolescence. In young adulthood team and individual sports have a bigger effect on moderating weight gain than other exercise though both tend to reduce weight gain. Although the effects of walking for exercise are not clear, it should be encouraged. It may be that walking is a threshold exercise that can be done by people with serious weight problems. As they lose weight and/or gain fitness, they may be able to move on to more vigorous activities. Or maybe more emphasis needs to be placed on the pace of walking as opposed to “strolling.” The impact on weight gain of hours spent at sedentary activities was small.

Walking to work or school does have a large, negative impact (4-6 pounds less gained) on weight gain and should be encouraged. Communities could help by including safe walking routes in their development plans. Two reasons come to mind why walking to work or school has an impact while walking for exercise does not: walking to work of school is less likely to be forgone for reasons of weather or “busyness” and people who walk to work or school probably walk a lot of other places, too.

Although lack of knowledge by parents was a key factor among overweight/obese children at Wave I, no one behavioral factor predominated as a preventative for obesity. While no impact from hobbies was found in this study, it may still bear looking at as a means of boosting self-esteem and thus mitigating the impacts of other variables. A multipronged, multigenerational approach is needed to stem the rising tide of obesity in the United States.

References

Beals, Katherine S., Rebecca A. Brey and Julianna B. Gonyou. “Understanding the Female Athlete Triad: Eating Disorders, Amenorrhea, and Osteoporosis.” *Journal of School Health*. Oct. 1999, v69 i8 p337.

Centers for Disease Control. http://www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm

Faith, Myles S., Mary Ann Leone, Tim S. Ayers, Moonseong Heo and Angelo Pietrobelli. “Weight Criticism During Physical Activity, Coping Skills, and Reported Physical Activity in Children,” *Pediatrics*, Vol. 110, No2, August 2002.

Gordon-Larsen, Penny, Robert G. McMurray, and Barry M. Popkin. “Determinants of Adolescent Physical Activity and Inactivity Patterns,” *Pediatrics*, Vol. 105, No. 6, June 2000.

Gortmaker, Steven L. , Aviva Must, Arthur M. Sobol, Laren Peterson, Graham A. Colditz, and William H. Dietz. “Television Viewing as a cause of Increasing Obesity Among Children in the United States, 1986-1990,” *Archives of Pediatrics and Adolescent Medicine*, April 1996, vol. 150, i4, p356.

Herman-Giddens, Marcia E., Eric J. Slora, Richard C. Wasserman, Carlos J. Bourdony, Manju V. Bhapkar, Gary G. Koch, and Cynthia M. Hasemeier. “Secondary Sexual Characteristics and Menses in Young Girls Seen in Office Practice: A Study from the Pediatric Research in Office Setting Network. *Pediatrics*, Vol. 99, p505, April 1997.

Kaplowitz, Paul B., MD, PhD, Eric J. Sora, PhD, Richard C. Wasserman, MD, MPH, Steven E. Pedlow, BS and Marcia E. Herman-Giddens, PA, DrPH. “Earlier Onset of Puberty in Girls: Relation to Increase Body Mass Index and Race,” *Pediatrics*, Vol. 108, No. 2, August 2001.

Kim, Sue Y.S.,MD, Bruce A. Barton, PhD, Eva Obarzanek, PhD, Robert P. McMahon, PhD, Zak I. Sabry, PhD, Myron A. Waclawiw, PhD, George B. Schreiber, PhD, John A. Morrison, PhD, Shari Similo, MS and Stephen R. Daniels, MD. “Racial Divergence in Adiposity During Adolescence; The NHLBI Growth and Health Study,” *Pediatrics*, Vol. 107, No. 3, March 2001.

Ludwig, David S., Karen E. Peterson, and Steven L. Gortmaker. “Relationship between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *The Lancet*, Feb 17, 2001, vol. 357, i9255, p 505.

Pellai, Alberto, Luca Brizzi, Rossella Curci, Ida Pazardjiklian, and Antonio Pagano. “Negative Body Self Image in Preadolescent Girls and Females’ Sport Abandonment During Adolescence: Is There a Relationship?” *Research Quarterly for Exercise and Sport*, March 2001 v72 i1 pA-94.

Prentice, A.M. and S.A. Jebb, "Beyond Body Mass Index," *Obesity Reviews*. Vol. 2, 2001. pp 141-147.

Stice, Eric, Rebecca P. Cameron, Joel. D. Killen, Chris Hayward; C. Barr Taylor. "Natural Weight-Reduction Efforts Prospectively Predict Growth in Relative Weight and Onset of Obesity Among Female Adolescents," *Journal of Consulting and Clinical Psychology*, Dec. 1999, V67 i6 pp967-968.

Stoutjesdyk, D. and R. Jevne. "Eating Disorders Among High Performance Athletes," *Journal of Youth and Adolescence*, 1993, v22 pp271-281.

Strauss, Richard S. "Childhood Obesity and Self-Esteem," *Pediatrics*, Vol. 105, No.1, January 2000.

Strauss, Richard S. and Judith Knight. "Influence of the Home Environment on the Development of Obesity in Children," *Pediatrics*, Vol. 103, No. 6, June 1999.

Strauss, Richard S. and Harold A. Pollack. "Epidemic Increase in Childhood Overweight, 1986-1998. *The Journal of the American Medical Association*, Dec.12, 2001, vol286, no22, p2845.

Strauss, Richard S. and Harold A. Pollack. "Epidemic Increase in Childhood Overweight, 1986-1998. *Journal of the American Academy of Child and Adolescent Psychiatry*, Oct. 2002, vol 41, no 10, p1181.

Troiano, Pichard P., Katherine M. Flegal, Robert J. Kuczmarski, Stephen M. Campbell, and Clifford L. Johnson. "Overweight Prevalence and Trends for Children and Adolescents: the National Health and Nutrition Examination Surveys, 1963 to 1991," *Archives of Pediatrics and Adolescent Medicine*, Oct 1995 v149 n10 p1085(7).

Viner, R. "Splitting Hairs: Is puberty getting earlier in girls?" *Archives of Disease in Childhood*, Jan 2002, Vol 86m no.1, p6.

Wang, Youfa, MD. "Is Obesity Associated with Early Sexual Maturation? A Comparison of the Association in American Boys Versus Girls." *Pediatrics*, Vol. 110, No. 5, November 2002.

White, Jane H. "The Prevention of Eating Disorders: A Review of the Research on Risk Factors with Implications for Practice," *Journal of Child and Adolescent Psychiatric Nursing*. April 2000 v13 i2 p76.

Wooldridge, Jeffrey M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

60 Minutes broadcast, July 1, 2001, repeated June 30, 2002. Burrell's Information Services, CBS News Transcripts. http://web.lexis-nexis.com/universe/document?_m=2dd348f5a6c744ac36460391cf065544&_docnum=1&wchp=dGLSlS-lSlAl&_md5=72e2c2ec13668dcc1587eaaa184bdf92

Appendix

Table A1. Results for Wave I Regressions with All Initial Variables

Logit Model
Dependent Variable: bmilgit1 N=3980

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	81	2411.061	29.76618	9.12	<.0001
Error	3898	12717.46	3.26256		
Corrected Total	3979	15128.52			

R-Square	Coeff Var	Root MSE	Mean
0.159372	277.328	1.806256	0.651307

Source	DF	Type I SS	Mean Square	F Value	Pr > F
gender	1	78.71718	78.71718	24.13	<.0001
race	4	140.1515	35.03788	10.74	<.0001
ethn	1	11.24913	11.24913	3.45	0.0634
ageyrs	1	93.0753	93.0753	28.53	<.0001
METRO	2	14.43822	7.219108	2.21	0.1095
chores	3	11.73516	3.911722	1.2	0.3086
hobby	3	14.17647	4.72549	1.45	0.2267
sports	3	2.357025	0.785675	0.24	0.8679
hangout	3	20.76332	6.921108	2.12	0.0954

Linear Model
Dependent Variable: bmipct1 N=3980

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	81	521139.9	6433.825	9.12	<.0001
Error	3898	2749188	705.282		
Corrected Total	3979	3270328			

R-Square	Coeff Var	Root MSE	Mean
0.159354	43.84665	26.55714	60.56823

Source	DF	Type I SS	Mean Square	F Value	Pr > F
gender	1	11613.71	11613.71	16.47	<.0001
race	4	34158.13	8539.532	12.11	<.0001
ethn	1	3350.871	3350.871	4.75	0.0293
ageyrs	1	23756.25	23756.25	33.68	<.0001
METRO	2	3162.869	1581.435	2.24	0.1064
chores	3	1151.951	383.9835	0.54	0.6519
hobby	3	2979.981	993.327	1.41	0.2383
sports	3	113.1017	37.7006	0.05	0.9837
hangout	3	5806.826	1935.609	2.74	0.0416

club	1	0.034636	0.034636	0.01	0.9179	866.4459	866.4459	1.23	0.2678
ttex	1	7.044526	7.044526	2.16	0.1418	3400.294	3400.294	4.82	0.0282
hsed	1	42.40681	42.40681	13	0.0003	9685.04	9685.04	13.73	0.0002
testscore	1	0.323766	0.323766	0.1	0.7528	706.8051	706.8051	1	0.3169
reccenter	1	9.25912	9.25912	2.84	0.0921	1971.404	1971.404	2.8	0.0946
feelsafe	1	4.363119	4.363119	1.34	0.2476	475.2116	475.2116	0.67	0.4118
momobese	1	693.6682	693.6682	212.61	<.0001	119678.9	119678.9	169.69	<.0001
dadobese	1	26.57524	26.57524	8.15	0.0043	2920.085	2920.085	4.14	0.0419
momclose	5	13.86616	2.773231	0.85	0.5141	2018.92	403.784	0.57	0.7212
dadclose	5	56.74887	11.34977	3.48	0.0039	13116.38	2623.277	3.72	0.0023
parented	5	39.08343	7.816687	2.4	0.0353	5858.024	1171.605	1.66	0.1404
income	1	10.71263	10.71263	3.28	0.0701	3480.79	3480.79	4.94	0.0264
ghealth	4	330.766	82.6915	25.35	<.0001	63560.05	15890.01	22.53	<.0001
breakfast	1	95.38016	95.38016	29.23	<.0001	25883.6	25883.6	36.7	<.0001
fooded	3	27.25368	9.084561	2.78	0.0394	6491.879	2163.96	3.07	0.0268
brstfed	6	48.70463	8.117438	2.49	0.021	9561.253	1593.542	2.26	0.0352
birthw	1	71.09884	71.09884	21.79	<.0001	16675.9	16675.9	23.64	<.0001
selfeff	5	13.12866	2.625731	0.8	0.546	3510.545	702.109	1	0.4188
depressed	3	1.626115	0.542038	0.17	0.9192	297.3476	99.1159	0.14	0.9357
smoke	1	3.610834	3.610834	1.11	0.2929	1409.577	1409.577	2	0.1575
drink	6	26.44063	4.406771	1.35	0.2309	5627.734	937.9557	1.33	0.2399
disability	1	19.00139	19.00139	5.82	0.0159	4511.293	4511.293	6.4	0.0115
physexam	1	18.39315	18.39315	5.64	0.0176	4747.07	4747.07	6.73	0.0095
avmature	4	464.9069	116.2267	35.62	<.0001	128591.6	32147.91	45.58	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F	Type III SS	Mean Square	F Value	Pr > F
gender	1	93.99456	93.99456	28.81	<.0001	14269.69	14269.69	20.23	<.0001
race	4	71.16896	17.79224	5.45	0.0002	15216.38	3804.095	5.39	0.0002
ethn	1	12.19755	12.19755	3.74	0.0532	2538.47	2538.47	3.6	0.0579
ageyrs	1	87.37589	87.37589	26.78	<.0001	20618.55	20618.55	29.23	<.0001
METRO	2	4.46101	2.230505	0.68	0.5048	973.741	486.8705	0.69	0.5015
chores	3	3.822168	1.274056	0.39	0.7598	103.634	34.5447	0.05	0.9857

hobby	3	10.8342	3.611399	1.11	0.3449	2501.938	833.9794	1.18	0.3148
sports	3	4.334992	1.444997	0.44	0.7223	1014.157	338.0522	0.48	0.6967
hangout	3	39.89768	13.29923	4.08	0.0067	10648.32	3549.441	5.03	0.0018
club	1	0.031657	0.031657	0.01	0.9215	472.1346	472.1346	0.67	0.4133
ttex	1	21.51686	21.51686	6.6	0.0103	7737.574	7737.574	10.97	0.0009
hsed	1	34.51726	34.51726	10.58	0.0012	7884.57	7884.57	11.18	0.0008
testscore	1	0.867912	0.867912	0.27	0.606	1087.487	1087.487	1.54	0.2144
reccenter	1	18.99031	18.99031	5.82	0.0159	3794.89	3794.89	5.38	0.0204
feelsafe	1	1.153454	1.153454	0.35	0.5521	42.0527	42.0527	0.06	0.8071
momobese	1	422.3852	422.3852	129.46	<.0001	72896.35	72896.35	103.36	<.0001
dadobese	1	26.92062	26.92062	8.25	0.0041	2907.798	2907.798	4.12	0.0424
momclose	5	28.13367	5.626735	1.72	0.1254	3898.029	779.6059	1.11	0.3552
dadclose	5	44.30702	8.861404	2.72	0.0186	9430.287	1886.057	2.67	0.0203
parented	5	28.79925	5.759851	1.77	0.1164	4048.986	809.7971	1.15	0.3325
income	1	7.161382	7.161382	2.2	0.1385	2440.163	2440.163	3.46	0.063
ghealth	4	311.0164	77.75409	23.83	<.0001	58368.53	14592.13	20.69	<.0001
breakfast	1	86.04028	86.04028	26.37	<.0001	23537.8	23537.8	33.37	<.0001
fooded	3	19.4074	6.469132	1.98	0.1143	4572.906	1524.302	2.16	0.0905
brstfed	6	44.24539	7.374232	2.26	0.0352	8484.49	1414.082	2	0.0616
birthw	1	43.39528	43.39528	13.3	0.0003	9680.1	9680.1	13.73	0.0002
selfeff	5	7.052178	1.410436	0.43	0.8263	2492.67	498.5339	0.71	0.6182
depressed	3	0.501772	0.167257	0.05	0.9847	61.8564	20.6188	0.03	0.9933
smoke	1	11.6276	11.6276	3.56	0.0591	3739.303	3739.303	5.3	0.0214
drink	6	17.62325	2.937209	0.9	0.4935	3454.377	575.7295	0.82	0.5571
disability	1	15.27913	15.27913	4.68	0.0305	3607.042	3607.042	5.11	0.0238
physexam	1	10.17022	10.17022	3.12	0.0775	2612.314	2612.314	3.7	0.0544
avmature	4	464.9069	116.2267	35.62	<.0001	128591.6	32147.91	45.58	<.0001

Parameter		Estimate	St. Error	t Value	Pr > |t|	Estimate	St. Error	t Value	Pr > |t|
Intercept		7.111327	1.550465	4.59	<.0001	160.2318	22.79628	7.03	<.0001
gender	Male	0.35368	0.065893	5.37	<.0001	4.35779	0.968814	4.5	<.0001
gender	Female	0	.	.	.	0	.	.	.
race	African American	0.306872	0.078218	3.92	<.0001	4.344071	1.150023	3.78	0.0002
race	Native American	0.250582	0.199058	1.26	0.2082	5.81044	2.926722	1.99	0.0472
race	Asian American	-0.37223	0.283645	-1.31	0.1895	-5.39326	4.170387	-1.29	0.196
race	Other	0.2728	0.140254	1.95	0.0518	3.496192	2.062131	1.7	0.0901
race	White	0	.	.	.	0	.	.	.
ethn	Non-Hispanic	-0.22105	0.114325	-1.93	0.0532	-3.18895	1.680906	-1.9	0.0579
ethn	Hispanic	0	.	.	.	0	.	.	.
ageyrs	Age in Years	-0.09896	0.019122	-5.18	<.0001	-1.52017	0.281154	-5.41	<.0001
METRO	Urban	-0.08034	0.090442	-0.89	0.3744	-1.02541	1.32975	-0.77	0.4407
METRO	Suburban	-0.088	0.077002	-1.14	0.2532	-1.32735	1.132151	-1.17	0.2411
METRO	Rural	0	.	.	.	0	.	.	.
chores	None	0.029937	0.162297	0.18	0.8537	0.518549	2.386231	0.22	0.828
chores	1-2 Times	-0.04063	0.075044	-0.54	0.5883	-0.13879	1.103362	-0.13	0.8999
chores	3-4 Times	-0.06956	0.070382	-0.99	0.323	-0.26698	1.034821	-0.26	0.7964
chores	5 or More	0	.	.	.	0	.	.	.
hobby	None	-0.00807	0.090952	-0.09	0.9293	-0.39977	1.337251	-0.3	0.765
hobby	1-2 Times	0.036467	0.080445	0.45	0.6503	0.530521	1.182777	0.45	0.6538
hobby	3-4 Times	0.135547	0.087534	1.55	0.1216	1.910573	1.286994	1.48	0.1378
hobby	5 or More	0	.	.	.	0	.	.	.
sports	None	0.10496	0.10745	0.98	0.3287	1.830183	1.579827	1.16	0.2467
sports	1-2 Times	0.10725	0.096546	1.11	0.2667	1.106887	1.419496	0.78	0.4356
sports	3-4 Times	0.051413	0.093623	0.55	0.5829	0.476438	1.376528	0.35	0.7293
sports	5 or More	0	.	.	.	0	.	.	.
hangout	None	0.217958	0.109166	2	0.0459	3.622764	1.605057	2.26	0.0241

hangout	1-2 Times	0.207292	0.076568	2.71	0.0068	3.769709	1.125765	3.35	0.0008
hangout	3-4 Times	-0.01804	0.073857	-0.24	0.8071	0.374225	1.085917	0.34	0.7304
hangout	5 or More	0	.	.	.	0	.	.	.
club	Number of Clubs	0.006053	0.061449	0.1	0.9215	-0.73921	0.903471	-0.82	0.4133
ttex	Times of Exercise	0.034961	0.013614	2.57	0.0103	0.662984	0.200162	3.31	0.0009
hsed	Hours of Sedentary	0.004272	0.001313	3.25	0.0012	0.064563	0.01931	3.34	0.0008
testscore	AHPVT	-0.00126	0.002446	-0.52	0.606	-0.04465	0.035961	-1.24	0.2144
reccenter	No	-0.19148	0.079365	-2.41	0.0159	-2.70676	1.166894	-2.32	0.0204
reccenter	Yes	0	.	.	.	0	.	.	.
feelsafe	No	0.056773	0.095482	0.59	0.5521	0.342798	1.403855	0.24	0.8071
feelsafe	Yes	0	.	.	.	0	.	.	.
momobese	No	-0.88333	0.077633	-11.38	<.0001	-11.6043	1.141429	-10.17	<.0001
momobese	Yes	0	.	.	.	0	.	.	.
dadobese	No	-0.28281	0.098455	-2.87	0.0041	-2.93927	1.447566	-2.03	0.0424
dadobese	Yes	0	.	.	.	0	.	.	.
momclose	Not at All	0.129694	0.17555	0.74	0.4601	1.820355	2.581086	0.71	0.4807
momclose	Very Little	-0.56147	0.417353	-1.35	0.1786	-6.51496	6.136284	-1.06	0.2884
momclose	Somewhat	-0.35769	0.213689	-1.67	0.0942	-4.156	3.141841	-1.32	0.186
momclose	Quite a Bit	-0.16353	0.129643	-1.26	0.2073	-1.71727	1.906124	-0.9	0.3677
momclose	Very Much	0.091869	0.082346	1.12	0.2646	1.157278	1.210716	0.96	0.3392
momclose	Refused	0	.	.	.	0	.	.	.
dadclose	Not at All	-0.05234	0.075982	-0.69	0.491	-0.65695	1.117147	-0.59	0.5565
dadclose	Very Little	-0.05806	0.266404	-0.22	0.8275	0.435347	3.916909	0.11	0.9115
dadclose	Somewhat	-0.17748	0.186556	-0.95	0.3415	-2.84498	2.742906	-1.04	0.2997
dadclose	Quite a Bit	-0.05641	0.11544	-0.49	0.6251	-1.24698	1.697292	-0.73	0.4626
dadclose	Very Much	-0.30744	0.086913	-3.54	0.0004	-4.44474	1.277873	-3.48	0.0005
dadclose	Refused	0	.	.	.	0	.	.	.
parented	Less than HS	-1.11035	1.304985	-0.85	0.3949	-22.0024	19.18701	-1.15	0.2516
parented	HS or GED	-1.22375	1.305228	-0.94	0.3485	-23.1122	19.19059	-1.2	0.2285
parented	Trade or	-1.361	1.30516	-1.04	0.2971	-24.5317	19.18959	-1.28	0.2012

parented	Some College	-1.33738	1.30703	-1.02	0.3063	-24.7309	19.21708	-1.29	0.1982
parented	College Grad	-1.26813	1.307895	-0.97	0.3323	-23.5911	19.22981	-1.23	0.22
parented	College Plus	0	.	.	.	0	.	.	.
parented	No School	-0.00109	0.000734	-1.48	0.1385	-0.02006	0.010787	-1.86	0.063
income	Thousands	-1.30347	0.484331	-2.69	0.0071	-16.5948	7.121052	-2.33	0.0198
ghealth	Excellent	-1.00029	0.48274	-2.07	0.0383	-11.5981	7.097659	-1.63	0.1023
ghealth	Very Good	-0.6536	0.482698	-1.35	0.1758	-7.44524	7.097037	-1.05	0.2942
ghealth	Good	-0.26772	0.492019	-0.54	0.5864	-2.56065	7.234091	-0.35	0.7234
ghealth	Fair	0	.	.	.	0	.	.	.
ghealth	Poor	-0.39121	0.07618	-5.14	<.0001	-6.47062	1.120067	-5.78	<.0001
breakfast	Yes	0	.	.	.	0	.	.	.
breakfast	No	0.107854	0.147144	0.73	0.4636	2.974402	2.163437	1.37	0.1693
fooded	None	-0.14152	0.107585	-1.32	0.1885	-1.6412	1.581809	-1.04	0.2995
fooded	One Topic	-0.12699	0.064673	-1.96	0.0497	-1.65187	0.950872	-1.74	0.0824
fooded	Two Topics	0	.	.	.	0	.	.	.
fooded	Three Topics	-0.03769	0.088535	-0.43	0.6703	-1.07999	1.301722	-0.83	0.4068
brstfed	< 3 Months	-0.21362	0.106504	-2.01	0.045	-3.95019	1.565909	-2.52	0.0117
brstfed	3-6 Months	-0.11188	0.129934	-0.86	0.3893	-2.17627	1.910409	-1.14	0.2547
brstfed	6-9 Months	-0.3593	0.147314	-2.44	0.0148	-5.26454	2.165936	-2.43	0.0151
brstfed	9-12 Months	0.046962	0.156106	0.3	0.7636	-0.38093	2.295208	-0.17	0.8682
brstfed	12-24 Months	-0.70919	0.330835	-2.14	0.0321	-5.09767	4.86422	-1.05	0.2947
brstfed	24 Months Plus	0	.	.	.	0	.	.	.
brstfed	None	0.005409	0.001483	3.65	0.0003	0.080787	0.021806	3.7	0.0002
birthw	Ounces	-0.21776	0.302662	-0.72	0.4719	-3.30549	4.450005	-0.74	0.4576
selfeff	Least Intelligent	-0.10078	0.178704	-0.56	0.5728	-1.44259	2.627462	-0.55	0.583
selfeff		-0.13048	0.122898	-1.06	0.2884	-1.55032	1.806958	-0.86	0.391

selfeff		-0.0914	0.127163	-0.72	0.4723	-0.76238	1.869659	-0.41	0.6835
selfeff		-0.1616	0.12343	-1.31	0.1905	-2.61146	1.814772	-1.44	0.1502
selfeff	Most Intelligent	0	.	.	.	0	.	.	.
depressed	Never	-0.01696	0.182144	-0.09	0.9258	-0.77261	2.678035	-0.29	0.773
depressed	Sometimes	-0.04145	0.18469	-0.22	0.8224	-0.70717	2.715476	-0.26	0.7946
depressed	A Lot	-0.02754	0.204812	-0.13	0.8931	-0.80688	3.011324	-0.27	0.7888
depressed	Most of Time	0	.	.	.	0	.	.	.
smoke	No	0.162124	0.085878	1.89	0.0591	2.907359	1.262655	2.3	0.0214
smoke	Yes	0	.	.	.	0	.	.	.
drink	Daily	0.082697	0.281187	0.29	0.7687	0.133618	4.134259	0.03	0.9742
drink	3-5 per Week	-0.31185	0.188669	-1.65	0.0984	-4.50953	2.773969	-1.63	0.1041
drink	1-2 per Week	0.142801	0.129297	1.1	0.2695	1.949878	1.901037	1.03	0.3051
drink	2-3 per Month	0.016438	0.122266	0.13	0.8931	0.405919	1.797654	0.23	0.8214
drink	Once a Month	0.087454	0.102602	0.85	0.3941	1.068737	1.508539	0.71	0.4787
drink	1-2 per Year	0.018624	0.083877	0.22	0.8243	-0.10296	1.233225	-0.08	0.9335
drink	Never	0	.	.	.	0	.	.	.
disability	No	-0.99163	0.458224	-2.16	0.0305	-15.2361	6.737203	-2.26	0.0238
disability	Yes	0	.	.	.	0	.	.	.
physexam	No	-0.1085	0.061453	-1.77	0.0775	-1.73891	0.903539	-1.92	0.0544
physexam	Yes	0	.	.	.	0	.	.	.
avmature	Least	-1.86703	0.288117	-6.48	<.0001	-27.4321	4.236151	-6.48	<.0001
avmature		-1.41883	0.208613	-6.8	<.0001	-22.2124	3.067211	-7.24	<.0001
avmature	Average	-1.04085	0.201007	-5.18	<.0001	-15.6789	2.955382	-5.31	<.0001
avmature		-0.52525	0.203565	-2.58	0.0099	-6.74159	2.992989	-2.25	0.0243
avmature	Most	0	.	.	.	0	.	.	.

Table A2. Type III Sums of Squares for Overweight and Obese Southern Adolescents Only, Wave I.

		Logit Model with **RECFAIL**			Logit Model without **RECFAIL**		
Source	DF	Type III SS	F Value	Pr > F	Type III SS	F Value	Pr > F
gender	1	9.0596473	14.29	0.0002	29.17148147	35.85	<.0001
race	4	7.3691247	2.91	0.0208	15.01385016	4.61	0.0011
ethn	1	0.003199	0.01	0.9434	0.31858929	0.39	0.5316
ageyrs	1	0.5065072	0.8	0.3716	2.64175798	3.25	0.0718
hobby	3	1.0644069	0.56	0.6417	1.12192043	0.46	0.7105
sports	3	4.9214975	2.59	0.0517	4.19297287	1.72	0.1616
hangout	3	3.4992442	1.84	0.1381	3.38357787	1.39	0.2455
ttex	1	0.0002874	0	0.983	0.38317086	0.47	0.4927
hsed	1	0.5369368	0.85	0.3576	0.70901357	0.87	0.3508
reccenter	1	0.0078353	0.01	0.9115	0.11094351	0.14	0.712
momobese	1	38.8949153	61.36	<.0001	19.75368012	24.28	<.0001
dadobese	1	15.1924835	23.97	<.0001	9.35076869	11.49	0.0007
dadclose	5	2.3832014	0.75	0.5847	3.93893725	0.97	0.4361
income	1	0.6669079	1.05	0.3053	0.45635929	0.56	0.4541
ghealth	4	33.5755499	13.24	<.0001	57.48775997	17.66	<.0001
breakfast	1	0.3685291	0.58	0.4459	0.35061928	0.43	0.5117
fooded	3	3.1073957	1.63	0.1798	6.45168852	2.64	0.048
brstfed	6	1.1029322	0.29	0.9419	1.88552939	0.39	0.8881
birthw	1	0.00068	0	0.9739	0.24016245	0.3	0.587
smoke	1	0.1004348	0.16	0.6907	0.0451675	0.06	0.8138
disability	1	0.3444401	0.54	0.4612	0.48097618	0.59	0.4421
physexam	1	0.0175915	0.03	0.8677	0.00168317	0	0.9637
avmature	1	1.259858	1.99	0.1589	0.03059891	0.04	0.8463
recfail	1	191.3302705	301.83	<.0001			

Table A3. Type III Sums of Squares for Change in BMI Percentile Logit Using Wave III Variables.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
gender	1	6.1163611	6.1163611	2.95	0.0858
race	4	25.6808501	6.4202125	3.1	0.0147
ethn	1	3.0155256	3.0155256	1.46	0.2276
edcat	6	24.9681592	4.1613599	2.01	0.061
ExCent3	1	0.7068016	0.7068016	0.34	0.5591
veggie3	1	3.1851997	3.1851997	1.54	0.2149
FastF3	7	24.8222683	3.5460383	1.71	0.1014
Break3	7	47.0420206	6.7202887	3.25	0.002
Cigs3	4	102.1747102	25.5436775	12.34	<.0001
HouseW3	7	26.4690484	3.7812926	1.83	0.078
Hobby3	7	11.3821931	1.6260276	0.79	0.5995
sports3	1	12.7667179	12.7667179	6.17	0.0131
walkex	7	38.9573769	5.5653396	2.69	0.0089
walkwors	1	9.111441	9.111441	4.4	0.036
ttex3	1	0.8091795	0.8091795	0.39	0.5319
hardlabor	1	4.9375072	4.9375072	2.38	0.1226
modlabor	1	4.9488131	4.9488131	2.39	0.1222
lgtlabor	1	0.0455474	0.0455474	0.02	0.8821
Income3	1	1.8733201	1.8733201	0.9	0.3416
HSED3	1	17.0439687	17.0439687	8.23	0.0041
diet1	1	46.2717961	46.2717961	22.35	<.0001
extolose1	1	22.1871459	22.1871459	10.72	0.0011
age3	1	150.7811871	150.7811871	72.83	<.0001
bmilgit1	1	966.1431602	966.1431602	466.68	<.0001