Childhood Influences on Youth Obesity

Abstract: We develop a model to estimate the influence of child and parental characteristics on the likelihood that a child will become an obese or overweight youth. We use this model to test whether it is possible to forecast obesity and overweight among youth. Comparing Receiver Operating Characteristic (ROC) scores from these forecasts, we find that a model using childhood covariates does as well in forecasting youth obesity and overweight as a model using the covariate values contemporaneous with the youth obesity and overweight outcomes.

The datasets used in this paper, the National Longitudinal Survey of Youth (NLSY79) and the NLSY79 Children and Young Adults, provide data from 1986 to 2002, allowing for the study of a child's transition to and from obesity or overweight over a long period. Explanatory variables that significantly influence the likelihood of youth obesity or overweight outcomes include the mother's obesity status and education, the youth's mental health, and certain demographic features including race, sex, and family size. These factors provide potential targets for policies that could be implemented early in life among children most likely to become obese or overweight.

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The rapid and large increases in the prevalence of child and adolescent obesity over the last two decades have been widely examined in both the academic and popular press. The book *Preventing Childhood Obesity: Health in the Balance* published by the Institute of Medicine, written in response to a request from Congress, is a recent addition to this line of research. The goal of this paper is to explore whether it is possible to identify influential factors during childhood that increase the likelihood that a child will become an obese or overweight youth. We generate forecasts of youth weight outcomes based on characteristics of the child or youth and their mother. Using Receiver Operating Characteristic (ROC) analysis to compare the relative quality of these forecasts, we find that childhood covariates do as well as covariates measured contemporaneously with youth weight outcomes.

Individuals who are obese by age 18 face significantly higher probabilities of developing certain morbidities later in life. Must and Strauss (1999) review results from a variety of studies and find evidence of a spectrum of long- and short-term risks of child and adolescent obesity. These include increased risk for Type-2 diabetes, cardiovascular disease, and an increased likelihood of being an obese adult. Given the wide range of potential maladies correlated with adolescent obesity and the burden that such health outcomes will likely place on the public health care system, identifying childhood characteristics that may lead to adolescent obesity could provide useful guidance for policy initiatives in this area.

Our starting point for studying this topic is the relationship between the likelihood of being an obese or overweight youth and the level of the Body Mass Index (BMI) of the youth's mother. Our interest in the role of mothers and their influence on child and youth obesity is partly motivated by our source of data. We use data from the NLSY79 Children and Young Adults, beginning in 1986, collected on the children of mothers who participated in the NLSY79 survey. Thus, the data on children are linked to the characteristics of their mothers and enable us to study this relationship over a long time.

We estimate that a mother's obesity status has a large and significant influence on the likelihood that her youth will be obese or overweight.[1] Across all specifications considered, we find an increasing relationship between the severity of a mother's obesity and the probability that her child will become an obese or overweight youth. In addition to mother's obesity status, we incorporate a variety of explanatory variables in an attempt to estimate the effect of family and individual characteristics during childhood that might play a role in the development of youth obesity.

Based on these estimated relationships, we forecast the likelihood of children becoming obese or overweight youth. We assess the relative diagnostic performance of these forecasts using ROC analysis. ROC scores provide a useful summary measure for comparing forecasted likelihoods. Our most interesting finding is that using childhood characteristics (while the child is age 8 or younger) to forecast youth obesity and overweight status (at age 9 or older) does at least as well as using the contemporaneous values of these characteristics (i.e., using family income status at age 6 to forecast obesity at age 14 does as well as using family income status at age 14). We also find justification for our full set of covariates relative to a basic model due to the improved predictive power of our full models.

Previous research into the causes of child and adolescent obesity as well as their recent trends are discussed in Section I. Section II outlines the probabilistic model used to explain the development of youth obesity and discusses the forecasting and ROC techniques used to judge

[1] We define children and youth as obese if their BMI is at or above the 95th percentile for their age and sex based on the 2000 CDC Growth Charts (see http://www.cdc.gov/nchs/data/nhanes/growthcharts/bmiage.txt for age and sex cutoffs). Children and youth are classified as overweight if their BMI is at or above the 85th percentile of this scale. Thus, all children who are obese are also classified as overweight. These categories are sometimes defined as overweight (BMI>95th percentile) and "at risk of overweight" (BMI>85th percentile) in other studies.

the quality of our models. Section III provides details of the NLSY data used in our analysis, and Section IV contains the results of our model estimation and forecast exercises. Section V discusses potential implications for public policies to prevent or treat adolescent obesity. Finally, Section VI summarizes the primary findings and implications of our research.

I. Previous Explanations for Child and Youth Obesity

Child and youth obesity rates in the United States have increased dramatically over the last two decades. According to the National Health and Nutrition Examination Surveys (NHANES I-IV), the prevalence of obesity among children and adolescents remained stable between the mid 1960's and 1980. From 1980 to 2002 the rate of obesity among children aged 6 to 11 more than doubled, from 7 percent to 16 percent; among adolescents aged 12 to 19 it tripled, from 5 to 16 percent (CDC, 2004). During this time, many medical and public health researchers have searched for explanations of this rapid growth.

The role of parental obesity in influencing the weight status of children has been examined by Maffeis et al., 1998; Mo-suwan et al., 2000; and Ramos de Marins et al., 2004. Furthermore, genetic factors seem to play a much larger role than environmental factors in explaining BMI differences in twins reared apart (Stunkard et al., 1990). Other links to child obesity include socioeconomic characteristics (Dietz, 1991; Wang, 2001; Storey et al., 2003), household size (Dietz, 1991; Ramos de Marins et al., 2004), and, to some degree, breastfeeding (Hediger et al., 2001).

A variety of other factors, familial, personal, and environmental, has been considered in connection with child obesity.

The relationship of child and youth obesity to maternal employment is explored in Anderson et al. (2003a). Using the NLSY79 data, they find that a child is more likely to be overweight if his or her mother works more hours per week, with a stronger effect among mothers of higher income status. Watching television is a popular explanation of child obesity (Dietz, 1991; Andersen et al., 1998; Maffeis et al., 1998; Storey et al., 2003). Gibson (2004), also using NLSY79 data, shows that long-term food stamp participation reduces the likelihood of obesity in young girls (age 5-11), but has the opposite effect on young boys. This effect disappears in older children (age 12-18).

The relationship between child obesity and mental health has also received attention. Strauss (2000) studies self-esteem and obesity among the children of the NLSY79. By the age of 13 or 14, obese boys, obese Hispanic girls, and obese white girls display lower self-esteem than their nonobese counterparts.

Research on the relationship between living in an urban area and child obesity has provided mixed results. Mamalakis et al. (2000) and Martorell et al. (1998), examining Greek and Latino children, respectively, find that children living in urban areas are more obese, whereas Wang (2001) and Strauss and Pollack (2001), in studies of American children, do not establish a significant connection between urban residence and child obesity.

II. Models of Youth Obesity and Forecast Techniques

Considering the previous factors identified as potentially influencing child and youth obesity, this section provides details on our methods to determine the role of a variety of explanatory variables in the development of youth weight problems. Our three main models are explained in the second subsection, while the final subsection discusses the procedures employed to compare the relative quality of our models' forecasts.

a. *Specification of Models of Youth Obesity and Overweight*

Economic theories explaining the growth in rates of obesity among adults have been developed in recent years (e.g., Cutler et al., 2003 and Lakdawalla and Philipson, 2002). These explanations may provide insights into the growth of child and youth obesity.[2] Technological changes have clearly influenced how children and adolescents use their time outside of school (the internet and video games being two potentially relevant developments) and insofar as children decide what to eat, declining food prices combined with declines in the relative prices of unhealthy foods may contribute to increased adolescent obesity. Although identification of the effects of changes in the vigor of work and ease of food production on obesity in adults does not necessarily contribute to the understanding of expanding child obesity, the food production decisions of parents obviously affect the available dietary choices of their children. Thus, if declining food prices and increased time costs induce higher and less healthy food production and consumption by parents (as discussed in Chou et al., 2004), the result will likely be increased consumption of less healthy food by their children.

Although it may be desirable to model such a process via a parental food production function which takes into account a parent's cost of time and specifying a child's utility from food consumption to determine an optimal level of caloric intake and expenditure, we work with a simplified model in which several factors combine to generate a child's weight status. Our measure of a child's weight status in this case is given by BMI.[3] Since measures of BMI levels have cutoffs for indications of obesity and overweight that vary by age and sex for children and youth, the dependent variables in our models consist of dichotomous indicators for obesity or

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[2] See Anderson et al. (2003b) for a discussion of other potential economic explanations for the growth in child and adolescent obesity.

[3] BMI is calculated with the formula 703*(weight/height^2) where weight is measured in pounds and height is measured in inches.

overweight based on these cutoffs. We estimate the likelihood of being an obese or overweight youth with a probit specification incorporating an array of characteristics of the children or youth and their mothers.

A variety of factors may influence the food production decisions in a child's household. While we recognize that choices such as the labor supply of a mother are likely determined jointly with other household production decisions, we formulate our models based on the assumed exogenous variation of several variables related to parental food production decisions.

1. We include a measure of the mother's overweight and obesity status. While this primarily reflects the genetic transmission of obesity, it may also serve as a proxy for the influence of parental food consumption decisions on their children's available dietary choices.

2. In order to account for the time costs related to parental food production decisions, we include measures of maternal labor supply with indicator variables for full-time and at-home mothers.

3. We include the marital status of mothers to control for its likely influence on food production choices.

4. The availability of food may be constrained by the number of other children in the family, so we include a variable for the total number of people in the household.

5. Income is likely to have an influence on food production (as well as several other inputs that may influence the health outcomes of children). Thus, indicator variables for quartiles of income per household member as well as a variable indicating the receipt of any forms of public assistance are included.[4]

[4] Due to top coding of the income variable in the NLSY (and the highest top-coded value changing over the period of our data), we classify income per household member by quartile.

Other potential influences include health insurance and education status. Health outcomes such as obesity are likely to be influenced by the presence or absence of routine health care for children, so we include a variable indicating the presence of private or employer-provided health insurance and a variable indicating whether the family received Medicaid benefits in the previous year.

The role of education in generating health outcomes has been the subject of much research. The important role of education in the production of good health is developed in the seminal health capital model of Grossman (1972). A mother's exposure to education may influence her own food choices and health literacy as well as that of her children, so we include a set of indicator variables for maternal education levels. Differences in exposure to health information or educational systems for children may be captured by their geographic location, so we include an indicator variable for whether the child is in an urban or rural location. Although the development of youth weight problems and depression may be endogenous, we control for the effect of depression on the food consumption decisions of youth and children by including a dichotomous variable if the child displayed any indication of depression.

A child's characteristics at birth may provide early indications of obesity, so we include variables indicating exceptionally high and low birthweights, the order of birth among the mother's children, and the mother's age at time of birth. Finally, we include a set of variables for race and sex and their interactions.

b. Techniques to Identify Factors in Development of Youth Obesity

In order to estimate the influence of childhood characteristics on youth obesity, we must define a cutoff age between childhood and youth. We use explanatory variables measured at ages under the cutoff to predict obesity and overweight outcomes at ages above the cutoff. Given the

NLSY79 data and age ranges we employ, the number of included observations is maximized when children's characteristics at ages 8 and younger are used to forecast youth obesity and overweight outcomes at ages 9 and older. Throughout the paper, we refer to observations under this age 8 cutoff as "childhood" and observations at ages over the age 8 cutoff as "youth."

There are several possible ways to align the data in order to use childhood variables to predict youth outcomes. We rank each individual's observations above and below our age cutoff and then pair observations of equal rank. As an example, a child who was surveyed at 3, 7, 9, 12, and 15 years of age would have three observations above the age cutoff and two below the age cutoff. Thus, the observation at 7 years of age is used to predict the obesity or overweight outcome at age 15 whereas the data for the child at 3 years of age is used to make forecasts of the outcome at age 12. With this technique, we do not attempt to forecast the outcome at 9 years of age since there is no corresponding observation below our age cutoff.

With this arrangement of the data, we estimate three probit models of obesity and overweight outcomes above the age cutoff using explanatory variables below or above the age cutoff. We estimate the likelihood of youth weight outcomes with a limited set of race, sex, neonatal, and maternal obesity status variables (measured at ages 8 and under). These estimates constitute our "Basic Child" model. We then estimate a model with the full set of childhood covariates considered; we refer to this model as "Full Child." For comparison, we also estimate models of youth obesity and overweight with explanatory variables measured at the contemporaneous age. These models are labeled "Full Youth."

The matching of observations above and below the age cutoff generates a distribution of differences in ages between the childhood characteristics used to explain the youth outcomes in our Full Child model. To control for these differing lengths of time between observed covariates and outcomes, we include a variable measuring (in months) this difference in ages.

c. Measurements of Youth Obesity and Overweight Forecast Quality

The forecast exercise we undertake in this paper uses estimates from the three probit models specified in the previous subsection. We apply the estimated coefficients back onto the characteristics used in the probit models to generate projected likelihoods of youth obesity and overweight. We then use Receiver Operating Characteristic (ROC) analysis to evaluate the quality of each forecast.[5] ROC methods are often employed in medical settings to determine the quality of diagnostic tests for the presence of a medical condition (Hanley and McNeil, 1982; Obuchowski, 2003). In our setting, predicted likelihoods from the three estimated probit models serve as our diagnostic tests for youth obesity and overweight.

For the diagnosis of a given condition, there are four possible outcomes: true and false positives (TP and FP) and true and false negatives (TN and FN). In ROC analysis, the two measures of interest are the sensitivity and specificity of the forecast. The sensitivity (or success rate) is the fraction of those with the given condition who are diagnosed as having the condition (TP/(FN+TP)) while the specificity is fraction of those without the condition who are diagnosed as not having the condition (TN/(FP+TN)). Sensitivity and specificity rates obviously depend on the cutoff value chosen to classify diagnoses as positive (above cutoff) or negative (below cutoff). As the cutoff value increases, sensitivity declines and specificity increases. A ROC curve is then generated from plotting values of sensitivity and 1-specificity for a range of cutoff values.[6]

[5] McTigue et al. (2002), using similar techniques, assess the forecastability of adult obesity using ROC analysis applied to data on adults of the NLSY79. Their parsimonious model of characteristics at age 20 to 22 (race, sex, and BMI) has good predictability of obesity at age 35 to 37.
[6] Table 3 and Figure 3 in Section IVb provide an example of sensitivity and specificity calculations and ROC curves for our youth obesity results.

The area under the ROC curve, called a ROC score,[7] represents the probability that, given two randomly chosen individuals (one with the condition and one without), the diagnostic test assigns a higher likelihood of having the condition to the diseased individual. A diagnostic test with no predictive power will have a ROC score of 0.5, while 0.7 is often considered to be a minimum acceptable standard. Since researchers are often interested in discriminating between the predictive power of competing diagnostic tests, a variety of statistical tests to compare ROC scores have been developed. The nonparametric technique for comparing forecast quality used in this paper is developed in DeLong et al. (1988).

III. Description of the Data

Section I discussed the significant increase in the rate of child and youth obesity and the trends of obese and overweight children and youth in the NLSY79 Children and Young Adults data are in accord with these previous results. Figure 1 displays trends in child and youth obesity in the NLSY data from 1986 to 2002 by sex, race, and the age division used in our forecasts, as discussed in Section IIb. Figure 2 shows trends in the proportion of overweight children and youth.

[INSERT FIGURE 1 NEAR HERE]

The rate of obesity increased from roughly 8 percent for each sex at the beginning of the children's survey in 1986 to 20 percent for males and 16 percent for females in 2002. The rate of obesity among black children and youth—near the overall mean of 8 percent in 1986—grew to 25 percent, by 2002.[8] The final graph in Figure 1 indicates that the prevalence of obesity among children was slightly higher than among youth during the period of our study.

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[7] This measure is sometimes referred to as the AUC (Area Under Curve) in other studies using ROC analysis.
[8] There is a potential concern that black and Hispanic mothers have children at younger ages than white mothers. We examined the average age over time of children and youth in our analysis sample. Looking at the average age

[INSERT FIGURE 2 NEAR HERE]

The trends for overweight children and youth displayed in Figure 2 are similar to those for obesity (our definition of overweight children includes those children who were also classified as obese). In 1986, roughly 19 percent of children and youth had a BMI above the 85th percentile for their age and sex; this fraction had doubled to 38 percent in 2002.[9] Again, blacks accounted for a disproportionately large share of this increase. They had an incidence of overweight near the sample mean in 1986, but over 44 percent were overweight in 2002. The growth in the rates of overweight differed across the two age ranges of children and youth used in this paper. The rate of overweight and obese children declined noticeably in 1994—a finding documented in other studies utilizing the NLSY79 data to analyze childhood obesity.[10]

Our sample for analysis in Section IV includes 15,086 observations for 4,980 children aged 2 to 18 born to 2,724 women in the NLSY79. Our sample includes roughly 44 percent of the children ever surveyed during the nine waves of the NLSY79 Children and Young Adults from 1986 to 2002, after making the exclusions noted in Appendix I. To focus on decisions made while children are in their parent's households, we limit our sample to children aged 18 and younger.

Summary statistics and definitions for the variables used in the analysis discussed in subsequent sections are provided in Table 1. In our analysis sample, approximately 14 percent of children are obese (which we define as BMI >95th percentile for age and sex from the 2000 CDC Growth Charts) at the time of the survey and 29.1 percent are overweight (BMI >85th

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by race shows very little difference. Initially, Hispanic children are slightly younger than their black and white counterparts, but by the end of the sample period the average age across groups is virtually the same.

[9] The 2000 CDC Growth Charts are based on historical data which may explain why more than 5% of the analysis sample have BMI levels above the 95th percentile for their sex and age.

[10] See, for example, Strauss and Pollack (2001).

percentile for age and sex).[11] Nearly 24 percent of mothers are obese (BMI>30) at the time of the survey, and 3.3 percent are "morbidly obese" (BMI >40). An additional 27.7 percent of mothers are overweight (BMI between 25 and 30). Hence, over half of the mothers in our sample are either overweight or obese, whereas only about 3 percent have low BMI levels (below 18.5). The NLSY oversamples minorities, and thus black and Hispanic children combine to make up just over half of our sample. We discuss certain results separately by race in Section IVa to examine the influence of this oversampling.[12]

[INSERT TABLE 1 NEAR HERE]

Definitions for the remainder of variables are provided in Table 1, but our measure of depression merits additional explanation. The parents of children in the NLSY answered a question from the Behavior Problems Index about how often the child seemed unhappy, sad or depressed during the last three months. There were three recorded outcomes for this question: often true, sometimes true, and not true. For adolescents aged 14 and older, the NLSY asked a separate question from the CES-D about how often the adolescent felt depressed in the past week. In this case, there are four possible responses: rarely (1 day), some (2 days), occasionally (3-4 days), and most of the time (5-7 days). In order to create a continuous series for this variable capturing depressive mood or state, we recoded the responses. Only those responses which indicated that signs of depression were absent or rare in children or adolescents were coded as zero and any indication of depression in the responses was coded as 1. While this may not be a

[11] Children's height and weight data in the NLSY are either measured by the interviewer or reported by the mother. In our analysis sample, 70 percent of the youth height or weight data are measured and 64 percent have both measured height and weight. Strauss (1999) finds that differences between self-reported and measured height and weight data do not lead to large differences in the classification of young adolescents into obese and overweight categories.

[12] The NLSY 79 Children and Young Adults data have sampling weights that can be used when analyzing data for a single year. Custom weights that allow weighting of our panel of data to account for non-responses over the nine Surveys analyzed are available. However, the significance and magnitude of our estimates did not change dramatically when using these custom weights and with the structure of our matched data procedure, the use of such weights seems inappropriate.

comprehensive measure of depression and likely overstates its prevalence, it can be interpreted as an indication of the child's mental health.

IV. Results of Model Estimation and Forecast Comparisons

Using the sample of the NLSY79 described above and the models developed in Section II, we now discuss results from probit estimates and subsequent forecasts of youth obesity and overweight. Table 2 displays the estimated marginal effects for probit models with dependent variables of youth obesity and overweight status. For each status, obesity or overweight, the table shows: (1) a simple model incorporating only mother's BMI status when her child is below our age cutoff of 8 years old and initial conditions for the child including race, sex, birthweight, birth order, and mother's age at birth (Basic Child model); (2) a model incorporating additional relevant demographic and socioeconomic variables measured during childhood to control for factors discussed in Section II (Full Child model); and (3) an analogous model using explanatory variables that are contemporaneous with the youth obesity or overweight outcome (Full Youth model). Results for these three models estimated separately for each race and sex combination in our data are provided in Appendix II.[13]

a. Results of Probit Model Estimations

The strongest and most consistent result from these estimates is the influence of a mother's obesity or overweight status on the likelihood of her child becoming an obese or overweight youth. The effect of maternal obesity or overweight on a youth's obesity or overweight status is large and, across all specifications, the likelihood of a youth being obese or overweight increases with the degree of the mother's obesity. When the other explanatory

[13] We also estimated the Full Child model without mother's obesity status. This model has a pseudo-R^2 less than half of the Basic Child model, so we do not report results here.

factors are taken into account, a mother with a BMI above 40 (“morbidly obese”) is at least 32 percent more likely to have an obese youth than is a mother in the acceptable BMI range (18.5–25). Similarly, obese mothers (BMI of 30–40) are at least 23 percent more likely to have an overweight youth than their peers with a BMI in the acceptable range. The magnitude of these effects are largest in the case of Hispanic children and youth. The models estimated separately by race and sex in Appendix II indicate that Hispanic children and youth with a morbidly obese mother have an increased likelihood of becoming an obese or overweight youth of at least 38 percent, with certain specifications indicating an increased risk of over 50 percent.

[INSERT TABLE 2 NEAR HERE]

The high levels of obesity among black youth shown in Figures 1 and 2 are reflected in Table 2 with the large and significant coefficients on the indicator variable for blacks. The inclusion of the interaction term for sex (Black*male) shows that the increased likelihood of obesity and overweight among blacks is driven mostly by results for females. The results indicate that Hispanics have a somewhat higher likelihood of obesity and overweight for both sexes, with a smaller difference between sexes than found for blacks and with less precision in the coefficient estimates.

The educational variables included in these models provide evidence that youth with college-educated mothers are at a significantly lower risk of being obese or overweight than children born to mothers with less than a high school education. Among the probits estimated separately by race and sex, the influence of a mother’s education on youth obesity or overweight is strongest among white youth. With the other controls included in the Full models, white females born to college-educated mothers are at least 10 percent less likely to become obese or overweight youth than their peers born to white mothers with less than a high school education.

Our categorical income variables and the two variables related to maternal employment status do not appear to influence strongly the likelihood of having obese or overweight youth to the extent expected (based on results in Anderson et al., 2003a and elsewhere). An intriguing result (shown in Tables A1 and A4 in Appendix II) from these variables is the large and strongly significant estimate that relative to their peers in the top income quartile, black males in the lower three income quartiles during childhood are significantly less likely to become overweight or obese youth. We also find some evidence that mothers who work more than 35 hours a week are more likely to have obese youth.

An interesting result from our estimates that has not been resolved in the previous literature is that certain children living in urban areas are less likely to be obese or overweight in adolescence than their rural counterparts. Table A1 reveals a significant reduction in the likelihood of youth obesity for black females living in urban areas, although the result in the Full Youth model of black male obesity indicates that the opposite may be true for black males.

Children born with a relatively high birthweight (150 ounces or more) appear significantly more likely to become obese youth. Although the coefficients on this variable for the overweight models are less precisely estimated than for the obesity specifications, it appears that those born with a birthweight above the 95th percentile of the NLSY79 distribution are roughly 5 percent more likely to become obese or overweight youth. The results for obesity among black males (Table A1) and overweight among white females (Table A6) indicate that a high birthweight increases the likelihood of a weight problem during youth by 16 to 20 percent. Conversely, white males born with a relatively low birthweight (less than 75 ounces) have a reduced likelihood of becoming an obese youth of 11 percent and a reduced likelihood of becoming an overweight youth of 26 percent.

A mother’s age at the time of the child’s birth and household size appear to affect significantly the obese and overweight outcomes studied. There exists some evidence in our Basic Child results that women giving birth at older ages may be more likely to have children who become obese or overweight youth. Children and youth raised in larger households have a reduced likelihood of being obese or overweight in our results. For black males, there appears to be a reduced likelihood of becoming an obese or overweight youth when born to a mother who has already had several children.

Finally, self-reported depression among youth appears to be positively correlated with the likelihood that the youth is obese or overweight in the Full Youth specifications. The influence of depression on youth overweight outcomes is most apparent in results for white females. Given the nature of such mental health conditions and their relation to physical health and obesity status, the exact process governing the two conditions seems more complex than allowed for in our specification.

b. Results of Forecast Comparisons

We use the estimated coefficients from our Full Child obesity and overweight probability models to generate predicted likelihoods of obesity and overweight for those age 9 and over, using their childhood characteristics. We also project the coefficient estimates from the Full Youth models onto the contemporaneous youth characteristics to provide a comparison forecast. As discussed in Section IIc, such forecasts can be used to generate ROC scores to compare the relative quality of forecasts.

A youth is classified in our “diagnosis” as obese or overweight based on their predicted probability relative to cutoff values ranging from zero to one. In our analysis, this cutoff takes on all values of the predicted probabilities assigned in our sample. Calculating the sensitivity and 1-specificity statistics at each of these cutoff values generates the ROC curve and allows for the computation of the ROC score (or area under the ROC curve). To illustrate this procedure, Table 3 shows sensitivity and false alarm (1-specificity) rates calculated at a cutoff value of 15.7% (the proportion of youth who are actually obese in our sample). For each model, these rates represent one point on the corresponding ROC curve. Figure 3 compares ROC curves for our three obesity models.

[INSERT TABLE 3 HERE]

[INSERT FIGURE 3 HERE]

A ROC score of .5 represents a "null" hypothesis for our forecast accuracy since such a score would indicate that our model has no forecast power greater than flipping a coin to predict whether a youth will be obese or overweight. In all cases, the lower bound of the 95% confidence intervals for our ROC scores lies above 0.6.

We compare the ROC scores from our Full Child model to that of our Full Youth model to determine whether childhood characteristics do as well as youth characteristics in predicting youth outcomes. Additionally, we compare ROC scores from our Full Child model to those generated from forecasts using the Basic Child model to add support for including the additional covariates in the Full Child model. Finally, we compare the predictive power of our Full Child model to a forecast that uses only the child's obesity or overweight status to predict these outcomes for the paired youth observations (labeled "Actual Child Obesity" or "Actual Child Overweight" in the following tables).

Tables 4 and 5 display ROC scores for a variety of comparable obesity and overweight forecasts, respectively. Nonparametric hypothesis tests for the equality of forecast performance (i.e., ROC scores) are provided in the last column of each panel. Similar results using forecasts generated from the probit models estimated separately by race and sex are provided in Tables 6 and 7.

[INSERT TABLES 4 and 5 HERE]

Panel A of each table compares the forecast quality when the Full model of youth obesity and overweight are estimated on childhood (Full Child) and contemporaneous (Full Youth) characteristics. Thus, the estimates from the models in Table 2 and the models estimated separately by race and sex are projected back onto the data that generated them. When we compare ROC scores for forecasts using the entire sample (Panel A of Tables 4 and 5), tests for significant differences in ROC scores indicate that the Full Youth forecasts do not predict youth obesity or overweight any better than the Full Child forecasts. Both forecasts have ROC scores of roughly 0.70 in the youth obesity models and 0.65 in the youth overweight models. Thus, the characteristics of children under 9 years of age do just as well in predicting obesity and overweight outcomes during youth as the values of these characteristics at the time their youth obesity or overweight is observed. This result also holds for the forecasts generated from probits estimated separately by race and sex (Panel A of Tables 6 and 7) with ROC scores increasing by roughly 0.03 in each case.

[INSERT TABLES 6 AND 7 NEAR HERE]

To test whether our Full Child model using all covariates provides additional forecast power over the Basic Child model of race, sex, neonatal characteristics, and mother's obesity status, Panel B in Tables 4 and 5 provides summaries of forecasts using the Full Child and Basic Child models. In these forecasts, data for children under age 9 are used to estimate the Full Child and Basic Child probit models of youth obesity in Table 2 and the coefficients of these models are then applied to the data for children under age 9 in the sample. From Panel B of

Tables 4 and 5, we find evidence that our model incorporating the full array of demographic and socioeconomic variables better predicts youth obesity than the basic model. Thus, the Full Child model shows superior forecast quality for youth obesity and overweight relative to the shorter Basic Child specification.

In Panel C of Tables 4 and 5, we show tests for differences in the ability of our Full Child model to forecast youth obesity and overweight relative to the forecast power of simply knowing a child's obesity or overweight status under the age of 9 (which we do not incorporate into the Full Child or Basic Child models). These results show that our Full Child model does no better in forecasting youth obesity than simply knowing the child's obesity status earlier in life. However, when using the forecasts of youth obesity generated from models estimated separately by race and sex, Panel C of Table 6 provides evidence that our Full Child model is able to outperform the forecast based on the observation of the child's obesity status.

For forecasts of youth overweight, the ROC comparison in Panel C of Table 5 indicates that using child overweight status does better than our Full Child model using all included explanatory variables. Panel C of Table 7 displays this comparison for the Full Child forecasts based on results estimated separately by race and sex. In this case, the magnitude of the difference in ROC scores is reduced but the test for differences indicates fairly strong evidence of the superior forecast quality of simply knowing the child's overweight status.

V. Policy Implications of Estimated Relationships

The results presented in Section IV provide evidence of childhood factors that potentially influence whether children become obese or overweight youth. The rapid increase of adolescent obesity over the previous 25 years, its likely consequences for future health outcomes, and the rise in its share of public health spending reveal the importance of identifying such factors early in life and developing policies for prevention. Our results of comparative forecast quality indicate that levels of variables during childhood have as much explanatory power for predicting youth obesity and overweight as the levels of these variables measured during youth. Thus, the childhood factors identified in the previous section may be efficient targets for policy interventions early in life.

The most consistent result to emerge from our research is the significantly greater prevalence of obesity among the children of overweight and obese women. While the role of genetics in this relationship is important, the potential exists for policies to slow the portion of this transmission that may be due to maternal choices. Potential interventions could occur very early, for example during prenatal care for women who were obese prior to becoming pregnant. Particular policies could include provision of weight-loss programs that target entire families, rather than only obese parents. Information on the long-term risks from adolescent obesity should be shared with all parents, but directed toward obese parents given the strength of the correlation in obesity between mothers and children found in this paper.

Our results also indicate that interventions to reduce youth obesity could focus on children born with relatively high birthweights. With our results, and previous evidence, of the increased likelihood of obesity among the youth of women working full-time, programs to inform working mothers of such risks may be beneficial. While we find that more highly educated mothers are less likely to have obese or overweight youth, there exists a need for improving health literacy and understanding of youth obesity determinants across all socioeconomic classes.

The results discussed in Section IV also provide evidence of the potential efficiency of targeting policies to reduce obesity in children and adolescents in black and Hispanic populations.

Whether racial disparities in the development of obesity result from neighborhood effects or other processes, the efficacy of emphasizing in minority communities the hazards of child and adolescent obesity seems apparent. The results for our models estimated separately by race and sex (in Appendix II) provide an indication of the most influential factors in the development of youth weight problems for each group.

Finally, although processes that lead to the development of obesity and depression among adolescents are likely symbiotic, continued development of approaches for the early recognition and treatment of mental health problems in children and adolescents would likely have spillover effects in the reduction of adolescent obesity.

VI. Conclusions and Summary

This paper has studied the development of obesity among youth in the context of a model incorporating certain potentially influential features of a child's upbringing, including a wide variety of maternal characteristics. We find strong evidence that a higher degree of obesity among mothers leads to a significantly increased likelihood that they will raise an obese youth. We find consistent support for the powerful influence of certain other childhood characteristics on the likelihood of becoming an obese youth. These include their mother's education as well as relatively high birthweights. The existence of potential signals of depression among youth is positively related to the likelihood of being overweight or obese. There are statistically significant racial and sex differences in the prevalence of obesity and overweight among children and youth. The role of mother's obesity in youth weight problems appears to be strongest for Hispanic children and youth. We also find that black males in the highest income quartile during childhood are at an increased risk of becoming obese or overweight during youth.

Using the results of the estimated relationships between these and other explanatory factors in the development of youth obesity, we forecast predicted likelihoods for youth obesity and overweight. We find that a model incorporating characteristics of children at ages 8 or younger does just as well in forecasting youth obesity and overweight as a model using youth characteristics contemporaneous with the obesity and overweight observations.

Increases in obesity among children and adolescents have attracted much attention in the popular press and many theories to explain these patterns have been proffered. While our models do not control for certain explanations that have been suggested to affect youth obesity and overweight such as television watching, diet, and exercise, we have identified other influences early in life that may increase the risk of developing weight problems during youth.

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Table 1: Summary Statistics for Analysis Sample

Variable	Mean	Std. Dev.
Children		
Age at time of survey, in months	114.43	37.36
% male	50.1%	0.50
% black	30.1%	0.46
% Hispanic	20.0%	0.40
black*male	14.7%	0.35
Hispanic*male	10.3%	0.30
Birthweight		
75 ounces or less	3.3%	0.18
150 ounces or more	5.0%	0.22
BMI		
>95th percentile (Obese)	14.1%	0.35
>85th percentile (Overweight)	29.1%	0.45
Any indication of depression	21.1%	0.41
No. people in household	4.35	1.41
Order among mother's births	1.85	0.99
Mothers		
Age at time of survey, in years	33.32	4.78
Age at time of child's birth, in years	23.73	4.01
BMI		
<18.5	2.8%	0.17
>25 and <30 (Overweight)	27.7%	0.45
>30 and <40 (Obese)	20.6%	0.40
>40 (Morbidly Obese)	3.3%	0.18
Married at time of survey	62.2%	0.48
Lives in urban area	74.3%	0.44
Education		
High school only	47.4%	0.50
Some college (>12 years and <16)	24.0%	0.43
Graduated college	12.2%	0.33
Income		
In lowest 25% of NLSY households	24.6%	0.43
In 25-50% of NLSY households	25.5%	0.44
In 50-75% of NLSY households	26.1%	0.44
In upper 25% of NLSY households	23.9%	0.43
Employment Status		
Does not work	24.2%	0.43
Works 35 hours/week or more	41.3%	0.49
Has private or employer health insurance	71.6%	0.45
Received welfare in year prior to survey	25.2%	0.43
Received Medicaid in year prior to survey	21.8%	0.41

Note: Mothers with education less than high school is the excluded category in probit estimates. Income variables are based on rankings of income per household member within the NLSY sample before excluding observations for missing data. The upper 25% of income distribution is the excluded category in the probit estimations in Section IVa.

Table 2: Marginal Effects Probit Estimates of Youth Obesity and Overweight

	Obesity Outcome			Overweight Outcome		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Child Variables						
Age at time of survey, in months		0.001	0.001		0.002	0.000
		(0.001)	(0.001)		(0.001)	(0.001)
Male	0.047	0.048	0.049	0.031	0.032	0.035
	(0.015)**	(0.015)**	(0.014)**	(0.019)	(0.019)	(0.019)
Black	0.098	0.091	0.094	0.107	0.107	0.116
	(0.019)**	(0.019)**	(0.019)**	(0.023)**	(0.024)**	(0.024)**
Hispanic	0.026	0.025	0.026	0.030	0.035	0.042
	(0.020)	(0.021)	(0.021)	(0.025)	(0.026)	(0.026)
Black*Male	-0.060	-0.058	-0.059	-0.099	-0.099	-0.099
	(0.017)**	(0.017)**	(0.017)**	(0.027)**	(0.027)**	(0.027)**
Hispanic*Male	-0.017	-0.017	-0.019	-0.008	-0.007	-0.013
	(0.024)	(0.024)	(0.024)	(0.034)	(0.034)	(0.034)
Low Birthweight	0.008	0.004	0.006	-0.017	-0.019	-0.018
	(0.028)	(0.027)	(0.027)	(0.037)	(0.037)	(0.036)
High Birthweight	0.054	0.054	0.057	0.051	0.051	0.052
	(0.025)*	(0.025)*	(0.025)*	(0.032)	(0.032)	(0.032)
Order among mother's births	-0.004	-0.004	-0.004	-0.016	-0.008	-0.012
	(0.005)	(0.006)	(0.006)	(0.007)*	(0.008)	(0.008)
Indication of depression		0.000	0.022		0.019	0.056
		(0.012)	(0.011)*		(0.016)	(0.014)**
No. of people in household		-0.009	-0.010		-0.015	-0.014
		(0.004)*	(0.004)*		(0.006)**	(0.005)**
Mother Variables						
Age at time of survey, in years		-0.041	-0.046		-0.070	-0.058
		(0.017)*	(0.021)*		(0.023)**	(0.029)*
Age Squared		0.001	0.001		0.001	0.001
		(0.0002)**	(0.0003)*		(0.0003)**	(0.0003)*
Age at time of child's birth, in years	0.004	0.013	0.018	0.005	0.021	0.005
	(0.001)**	(0.011)	(0.010)	(0.002)**	(0.015)	(0.014)
Mother BMI < 18.5	-0.051	-0.053	-0.057	-0.114	-0.117	-0.117
	(0.024)*	(0.023)*	(0.031)	(0.032)**	(0.031)**	(0.041)**
Overweight	0.069	0.069	0.061	0.101	0.103	0.088
	(0.013)**	(0.013)**	(0.013)**	(0.015)**	(0.015)**	(0.016)**
Obese	0.214	0.210	0.166	0.262	0.264	0.227
	(0.018)**	(0.018)**	(0.016)**	(0.019)**	(0.019)**	(0.017)**
Morbidly Obese	0.335	0.325	0.316	0.379	0.379	0.390
	(0.042)**	(0.042)**	(0.034)**	(0.038)**	(0.039)**	(0.031)**
Married at time of survey		0.005	0.009		0.008	0.014
		(0.012)	(0.012)		(0.017)	(0.017)
Lives in urban area		-0.019	-0.007		-0.025	-0.020
		(0.012)	(0.011)		(0.016)	(0.015)
High school only		-0.015	-0.025		-0.005	-0.023
		(0.014)	(0.014)		(0.020)	(0.021)
Some College		-0.033	-0.040		-0.029	-0.055
		(0.015)*	(0.015)**		(0.023)	(0.023)*
Graduated college		-0.065	-0.077		-0.061	-0.080
		(0.016)**	(0.015)**		(0.028)*	(0.027)**
Lowest Income Quartile		-0.003	0.011		-0.037	-0.007
		(0.019)	(0.017)		(0.025)	(0.023)
Second Income Quartile		0.004	-0.005		-0.016	-0.009
		(0.016)	(0.014)		(0.021)	(0.019)
Third Income Quartile		0.024	0.021		-0.017	0.002
		(0.015)	(0.013)		(0.020)	(0.017)
Does not work		0.009	0.005		0.005	-0.004
		(0.012)	(0.013)		(0.015)	(0.018)
Works 35 hrs/week or more		0.020	0.026		0.026	0.023
		(0.011)	(0.011)*		(0.015)	(0.014)
Has private or employer insurance		0.014	0.012		0.019	0.021
		(0.012)	(0.012)		(0.016)	(0.016)
Received welfare in year prior to survey		0.025	0.016		0.008	0.006
		(0.015)	(0.016)		(0.021)	(0.021)
Received Medicaid in year prior to survey		0.024	0.007		0.035	-0.010
		(0.016)	(0.015)		(0.022)	(0.021)
Observations	7,543	7,543	7,543	7,543	7,543	7,543
Pseudo-R^2	0.073	0.083	0.079	0.049	0.055	0.056

Note: The dependent variable is a binary variable equal to 1 if the youth's BMI is above the 85th percentile (overweight outcome) or 95th percentile (obese outcome) for his/her age and sex. Each coefficient represents the change in probability of the outcome due to a one unit change in a dichotomous independent variable or an infinitesimal change in a continuous independent variable. Standard errors (in parentheses below coefficient) correct for the longitudinal structure of the NLSY by accounting for repeated observations of youth over time. Standard errors do not account for clustering of families or geography present in NLSY survey sampling. A variable controlling for the length of time between observed covariates and outcomes in the Full Child model is omitted.
* represents significance at the 5% level; ** represents significance at the 1% level

Table 3: Calculating the Receiver Operating Characteristic Curve

		Full Child Prediction					
		Not Obese	Obese	Total	% Actually Obese	Success Rate (Sensitivity)	False Alarm Rate (1-Specificity)
Actual Status	Not Obese	TN=4,345	FP=2,014	6,359	15.7%	60.6%	31.7%
	Obese	FN=467	TP=717	1,184			
	Total	4,812	2,731	7,543			

		Full Youth Prediction					
		Not Obese	Obese	Total	% Actually Obese	Success Rate (Sensitivity)	False Alarm Rate (1-Specificity)
Actual Status	Not Obese	TN=4,171	FP=2,188	6,359	15.7%	62.9%	34.4%
	Obese	FN=439	TP=745	1,184			
	Total	4,610	2,933	7,543			

		Basic Child Prediction					
		Not Obese	Obese	Total	% Actually Obese	Success Rate (Sensitivity)	False Alarm Rate (1-Specificity)
Actual Status	Not Obese	TN=4,363	FP=1,996	6,359	15.7%	58.9%	31.4%
	Obese	FN=487	TP=697	1,184			
	Total	4,850	2,693	7,543			

Note: This table classifies individuals by actual obesity status and obesity status as predicted by our three models using the sample mean of 15.7% as a cutoff, so any predicted probability above this value is classified as obese. For our Full Child model, 4,345 individuals who are not obese are predicted to not be obese (True Negatives). The number of obese individuals who are predicted to be not obese (False Negatives) is 467. True and False Positive outcomes are defined analogously. For the Full Child model, the success rate (or sensitivity) at the population mean cutoff is 60.6% (717/1,184). The false alarm rate (1-specificity) is the fraction of nonobese youth who are predicted to be obese. Here the false alarm rate is 31.7% (2,014/6,359). Together these rates represent one point on the ROC curve for the Full Child model shown in Figure 3. The remaining panels show success and false alarm rates for the Full Youth and Basic Child models, again using the population mean as the diagnostic cutoff.

Table 4 - Comparison of ROC scores for Youth Obesity Forecasts

	Model	*Full Youth*	*Full Child*	Test for Difference	
A	ROC Score	0.697	0.699	Chi^2 Value	0.19
	95% Conf. Int.	(0.680 , 0.713)	(0.682 , 0.715)	p-value	0.66
	Model	*Full Child*	*Basic Child*	Test for Difference	
B	ROC Score	0.699	0.688	Chi^2 Value	**10.9**
	95% Conf. Int.	(0.682 , 0.715)	(0.671 , 0.705)	p-value	**0.001****
	Model	*Actual Child Obesity*	*Full Child*	Test for Difference	
C	ROC Score	0.697	0.699	Chi^2 Value	0.02
	95% Conf. Int.	(0.683 , 0.712)	(0.682 , 0.715)	p-value	0.89

Table 5 - Comparison of ROC scores for Youth Overweight Forecasts

	Model	*Full Youth*	*Full Child*	Test for Difference	
A	ROC Score	0.655	0.654	Chi^2 Value	0.10
	95% Conf. Int.	(0.642 , 0.668)	(0.640 , 0.667)	p-value	0.75
	Model	*Full Child*	*Basic Child*	Test for Difference	
B	ROC Score	0.654	0.645	Chi^2 Value	**9.75**
	95% Conf. Int.	(0.640 , 0.667)	(0.632 , 0.658)	p-value	**0.002****
	Model	*Actual Child Overweight*	*Full Child*	Test for Difference	
C	ROC Score	0.700	0.654	Chi^2 Value	**31.48**
	95% Conf. Int.	(0.689 , 0.710)	(0.640 , 0.667)	p-value	**0.00****

Note: ROC scores are generated from predictions of youth obesity and overweight using probit models estimated in Table 2. The final column displays a test for the significance of the difference of ROC scores in preceeding two columns.
* represents significance at the 5% level; ** represents significance at the 1% level

Table 6 - Comparison of ROC scores for Youth Obesity Forecasts based on Race & Sex Probit Models

A	Model	*Full Youth*	*Full Child*	Test for Difference	
	ROC Score	0.729	0.730	Chi^2 Value	0.07
	95% Conf. Int.	(0.713 , 0.744)	(0.714 , 0.746)	p-value	0.792
B	Model	*Full Child*	*Basic Child*	Test for Difference	
	ROC Score	0.730	0.700	Chi^2 Value	**39.99**
	95% Conf. Int.	(0.714 , 0.746)	(0.683 , 0.716)	p-value	**0.000****
C	Model	*Actual Child Obesity*	*Full Child*	Test for Difference	
	ROC Score	0.697	0.730	Chi^2 Value	**9.62**
	95% Conf. Int.	(0.683 , 0.712)	(0.714 , 0.746)	p-value	**0.002****

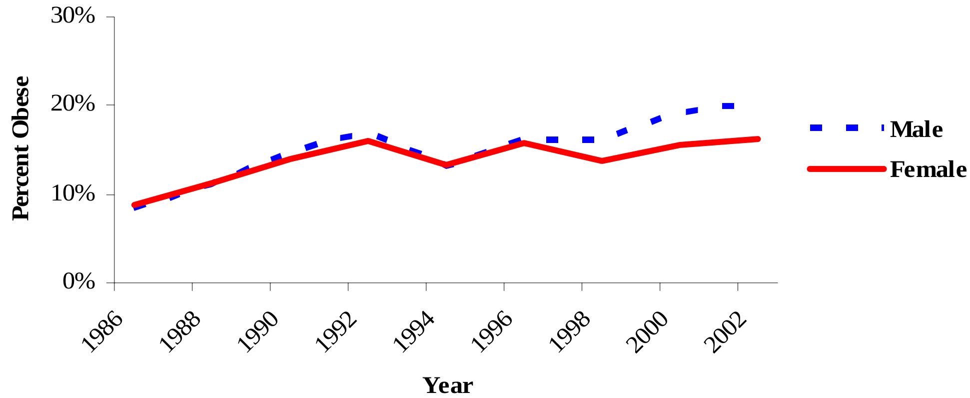
Table 7 - Comparison of ROC scores for Youth Overweight Forecasts based on Race & Sex Probit Models

A	Model	*Full Youth*	*Full Child*	Test for Difference	
	ROC Score	0.685	0.684	Chi^2 Value	0.05
	95% Conf. Int.	(0.672 , 0.697)	(0.671 , 0.696)	p-value	0.815
B	Model	*Full Child*	*Basic Child*	Test for Difference	
	ROC Score	0.684	0.657	Chi^2 Value	**46.07**
	95% Conf. Int.	(0.671 , 0.696)	(0.644 , 0.670)	p-value	**0.000****
C	Model	*Actual Child Overweight*	*Full Child*	Test for Difference	
	ROC Score	0.700	0.684	Chi^2 Value	3.81
	95% Conf. Int.	(0.689 , 0.710)	(0.671 , 0.696)	p-value	0.051

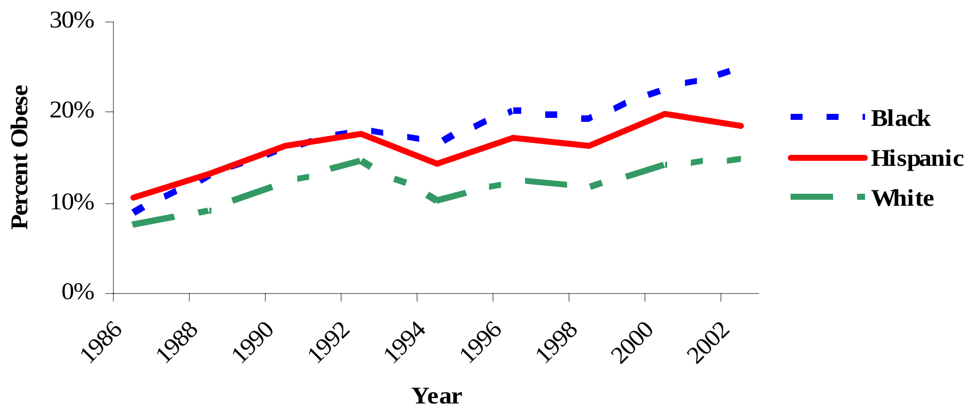
Note: ROC scores are generated from predictions of youth obesity and overweight using probit models estimated separately by race and sex. 7,543 observations are used in both tables. See note to Tables 4 and 5 for further details.
* represents significance at the 5% level; ** represents significance at the 1% level

Figure 1: Obesity Trends in NLSY Sample

Obesity Rates, by Sex



Obesity Rates, by Racial Category



Child and Youth Obesity Rates

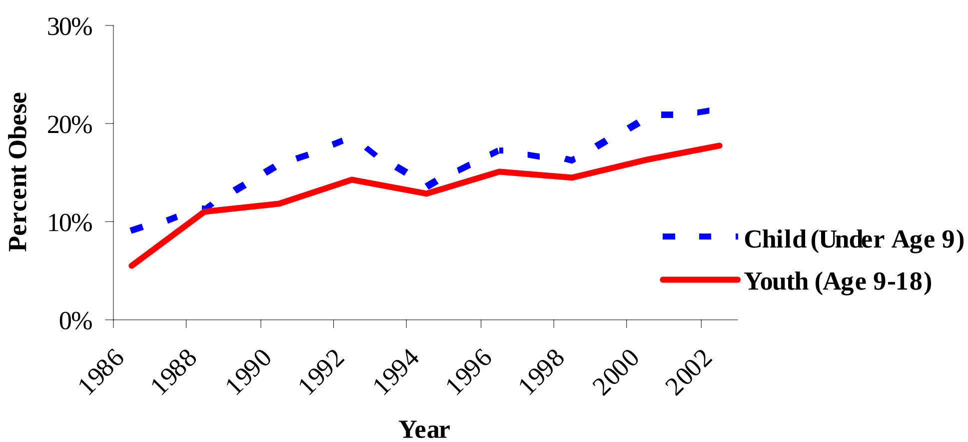
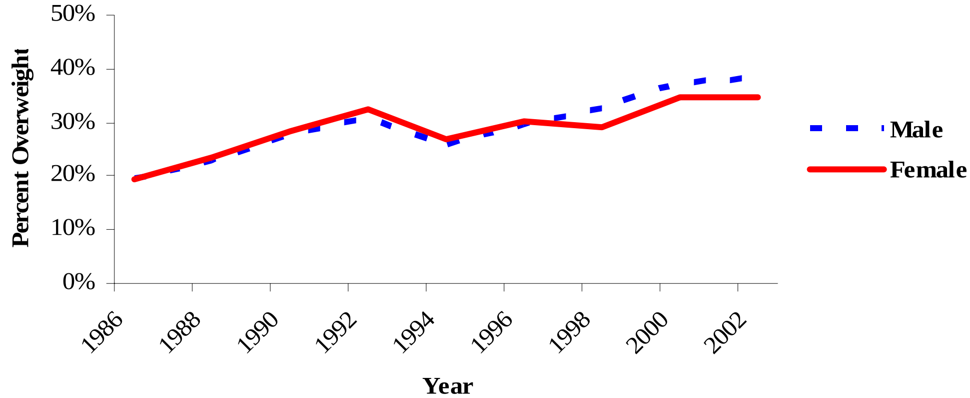
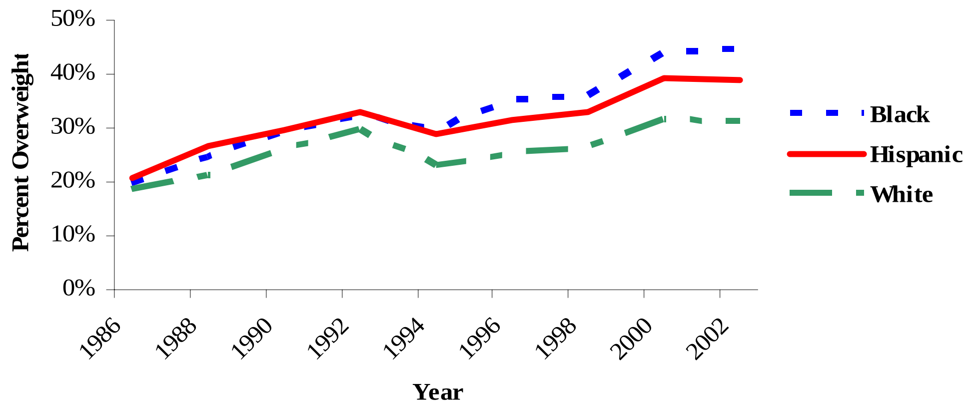


Figure 2:-Overweight Trends in NLSY Sample

Overweight Rates, by Sex



Overweight Rates, by Racial Category



Child and Youth Overweight Rates

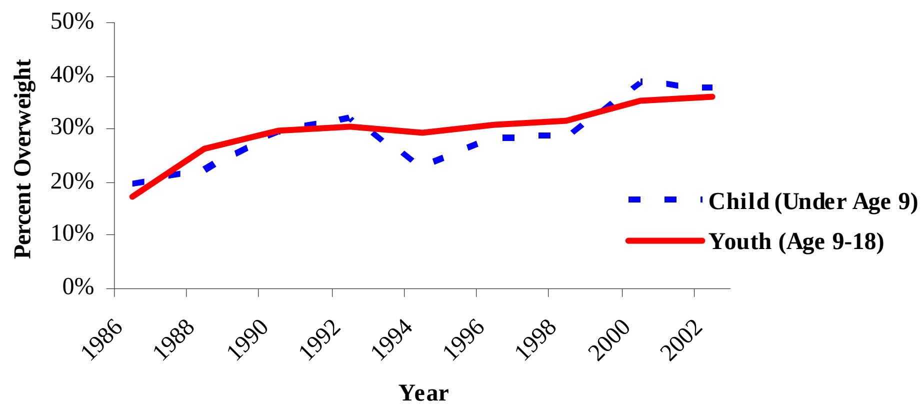
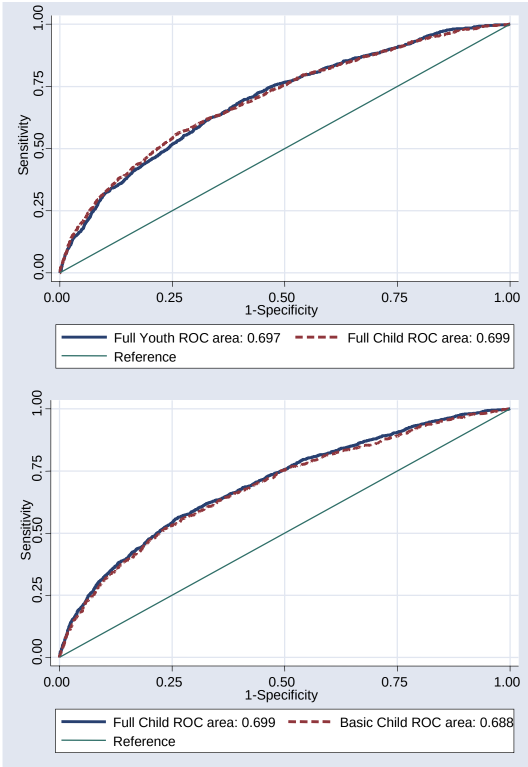


Figure 3: Comparison of ROC Curves for Youth Obesity Forecasts



Note: The top and bottom graphs display the ROC curves associated with Panels A and B of Table 4, respectively. The diagonal line represents a ROC curve with no forecast power.

Appendix I – Description of NLSY79 Analysis Sample

This paper utilizes data from the National Longitudinal Survey of Youth (NLSY79) and a supplement to the NLSY, the NLSY79 Children and Young Adults, which tracks the children of women in the original NLSY79 sample. We use data on mothers in the NSLY79 survey and their children for whom data was collected beginning in 1986. Data were collected biennially from 1986 to 2002, so the maximum number of observations for a single child is nine. Most exclusions occurred because of the poor quality of data regarding children's height. Data errors created difficulties in calculating sensible BMIs for certain children. The NLSY reports a child's height in two separate variables, one for feet and another for inches. These variables can show a child being 60 feet, 0 inches when he should be 60 inches tall or a child being 0 feet, 6 inches when he should be 6 feet, 0 inches. To address these difficulties, we (1) deleted any heights above 8 feet and used a child's height in inches if it appeared that this is the intended height; (2) calculated BMI, keeping BMIs between 6 and 80; (3) deleted any heights that show a child shrinking by more than 6 inches; and (4) deleted any heights that appeared unrealistic relative to previous heights and future heights. The last requirement prevents a pattern in heights such as 60, 48, 66; 30, 48, 42; and 50, 58, 48. In each of these examples, 48 seems unrealistic when compared to surrounding height measurements, so we deleted that child-year observation. We deleted any BMIs that seemed abnormal relative to each child's BMI average. We created a BMI ratio, defined as the child's BMI for a year relative to the child's average BMI across all years, and deleted any observation with a ratio below .5 or above 2. Finally, we excluded observations missing data on mother's income, health insurance status, and indications of child and youth depression.

Appendix II – Results by Race and Sex

Table A1 - Marginal Effects Probit Estimates of Youth Obesity Among Blacks

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		0.001	0.002		0.004	0.002
		(0.003)	(0.002)		(0.003)	(0.003)
Low Birthweight	-0.010	0.002	-0.022	0.038	0.042	0.024
	(0.060)	(0.063)	(0.056)	(0.081)	(0.080)	(0.078)
High Birthweight	0.175	0.196	0.184	0.069	0.038	0.040
	(0.095)	(0.098)*	(0.094)*	(0.101)	(0.091)	(0.098)
Order among mother's births	-0.049	-0.039	-0.036	-0.013	-0.012	-0.003
	(0.013)**	(0.015)**	(0.015)*	(0.015)	(0.017)	(0.017)
Indication of depression		-0.010	0.021		-0.019	0.023
		(0.032)	(0.032)		(0.033)	(0.030)
No. of people in household		-0.012	-0.018		-0.016	-0.020
		(0.010)	(0.010)		(0.010)	(0.010)
Age at time of survey, in years		-0.058	-0.050		-0.062	0.027
		(0.048)	(0.062)		(0.053)	(0.067)
Age Squared		0.001	0.000		0.000	-0.001
		(0.001)	(0.001)		(0.001)	(0.001)
Mother Variables						
Age at time of child's birth, in years	0.014	0.031	0.036	0.004	0.060	0.031
	(0.004)**	(0.028)	(0.027)	(0.004)	(0.032)	(0.031)
Overweight	0.067	0.074	0.041	0.080	0.090	0.069
	(0.033)*	(0.033)*	(0.038)	(0.037)*	(0.037)*	(0.039)
Obese	0.225	0.234	0.222	0.244	0.244	0.163
	(0.042)**	(0.043)**	(0.039)**	(0.042)**	(0.042)**	(0.040)**
Morbidly Obese	0.311	0.310	0.385	0.417	0.431	0.332
	(0.087)**	(0.090)**	(0.078)**	(0.087)**	(0.087)**	(0.071)**
Married at time of survey		0.046	0.062		-0.037	-0.036
		(0.035)	(0.035)		(0.033)	(0.032)
Lives in urban area		0.028	0.065		-0.112	-0.099
		(0.030)	(0.026)*		(0.042)**	(0.040)*
High school only		0.031	0.030		0.019	-0.003
		(0.039)	(0.041)		(0.042)	(0.044)
Some College		0.020	0.048		-0.023	-0.043
		(0.048)	(0.050)		(0.052)	(0.050)
Graduated college		-0.035	-0.032		-0.064	-0.087
		(0.054)	(0.053)		(0.069)	(0.059)
Lowest Income Quartile		-0.121	0.009		0.059	0.002
		(0.050)*	(0.042)		(0.061)	(0.048)
Second Income Quartile		-0.107	-0.024		0.047	-0.017
		(0.036)**	(0.037)		(0.058)	(0.042)
Third Income Quartile		-0.050	0.002		0.112	-0.011
		(0.041)	(0.037)		(0.066)	(0.041)
Does not work		-0.026	0.003		0.029	0.042
		(0.032)	(0.037)		(0.036)	(0.042)
Works 35 hrs/week or more		-0.011	0.013		0.003	0.068
		(0.032)	(0.031)		(0.034)	(0.034)*
Has private or employer insurance		0.010	0.011		0.022	-0.016
		(0.032)	(0.032)		(0.034)	(0.035)
Received welfare in year prior to survey		0.025	0.019		0.039	-0.058
		(0.034)	(0.039)		(0.040)	(0.037)
Received Medicaid in year prior to survey		0.079	0.030		-0.014	0.040
		(0.041)	(0.037)		(0.042)	(0.037)
Observations	1,108	1,108	1,108	1,165	1,165	1,165
Pseudo-R Sqr	0.091	0.115	0.128	0.060	0.094	0.073

Note: See note to Table 2 for description

Table A2 - Marginal Effects Probit Estimates of Youth Obesity Among Hispanics

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		-0.004	-0.001		0.001	0.000
		(0.003)	(0.003)		(0.003)	(0.003)
Low Birthweight	-0.014	-0.005	-0.001	-0.030	-0.045	-0.047
	(0.073)	(0.072)	(0.081)	(0.081)	(0.062)	(0.063)
High Birthweight	-0.037	-0.034	-0.037	0.000	0.005	0.001
	(0.054)	(0.052)	(0.052)	(0.065)	(0.070)	(0.066)
Order among mother's births	-0.005	0.008	-0.010	0.012	0.018	0.019
	(0.015)	(0.018)	(0.018)	(0.012)	(0.016)	(0.015)
Indication of depression		-0.021	0.002		-0.010	-0.008
		(0.036)	(0.032)		(0.034)	(0.029)
No. of people in household		-0.032	0.010		-0.012	-0.016
		(0.012)**	(0.012)		(0.012)	(0.012)
Age at time of survey, in years		-0.070	-0.138		-0.045	-0.034
		(0.056)	(0.068)*		(0.050)	(0.062)
Age Squared		0.002	0.002		0.000	0.000
		(0.001)**	(0.001)**		(0.001)	(0.001)
Mother Variables						
Age at time of child's birth, in years	0.006	-0.042	-0.010	0.002	0.033	0.008
	(0.005)	(0.036)	(0.033)	(0.004)	(0.034)	(0.033)
Overweight	0.037	0.036	0.037	0.037	0.050	0.034
	(0.037)	(0.036)	(0.040)	(0.034)	(0.034)	(0.034)
Obese	0.194	0.199	0.156	0.201	0.205	0.160
	(0.053)**	(0.056)**	(0.046)**	(0.052)**	(0.051)**	(0.045)**
Morbidly Obese	0.462	0.547	0.439	0.376	0.385	0.386
	(0.149)**	(0.141)**	(0.127)**	(0.152)*	(0.147)**	(0.116)**
Married at time of survey		0.046	-0.043		-0.036	-0.002
		(0.038)	(0.041)		(0.033)	(0.035)
Lives in urban area		-0.002	0.031		0.012	-0.010
		(0.059)	(0.046)		(0.048)	(0.041)
High school only		-0.013	-0.029		-0.046	-0.031
		(0.039)	(0.040)		(0.032)	(0.039)
Some College		-0.053	-0.065		-0.025	-0.010
		(0.041)	(0.040)		(0.035)	(0.040)
Graduated college		0.042	-0.049		-0.032	-0.014
		(0.095)	(0.059)		(0.046)	(0.051)
Lowest Income Quartile		0.027	-0.087		-0.035	0.002
		(0.076)	(0.040)*		(0.047)	(0.044)
Second Income Quartile		0.052	-0.060		-0.017	0.002
		(0.068)	(0.039)		(0.042)	(0.037)
Third Income Quartile		0.037	0.050		-0.022	-0.017
		(0.064)	(0.048)		(0.035)	(0.033)
Does not work		0.020	-0.008		0.016	0.048
		(0.036)	(0.039)		(0.036)	(0.038)
Works 35 hrs/week or more		0.001	-0.022		0.035	0.027
		(0.035)	(0.031)		(0.035)	(0.033)
Has private or employer insurance		0.013	-0.003		0.016	0.020
		(0.034)	(0.037)		(0.034)	(0.035)
Received welfare in year prior to survey		0.074	0.067		0.008	-0.007
		(0.052)	(0.049)		(0.042)	(0.039)
Received Medicaid in year prior to survey		-0.024	0.004		0.043	0.019
		(0.041)	(0.044)		(0.051)	(0.044)
Observations	779	779	779	730	730	730
Pseudo-R Sqr	0.052	0.094	0.082	0.066	0.094	0.075

Note: See note to Table 2 for description

Table A3 - Marginal Effects Probit Estimates of Youth Obesity Among Whites

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		0.001	0.003		-0.001	-0.001
		(0.002)	(0.002)		(0.002)	(0.001)
Low Birthweight	-0.109	-0.109	-0.110	0.120	0.114	0.109
	(0.030)**	(0.027)**	(0.025)**	(0.072)	(0.068)	(0.066)
High Birthweight	0.059	0.053	0.046	0.016	0.031	0.032
	(0.040)	(0.039)	(0.037)	(0.042)	(0.045)	(0.046)
Order among mother's births	-0.002	-0.014	-0.008	0.016	0.000	0.008
	(0.012)	(0.014)	(0.013)	(0.008)*	(0.009)	(0.009)
Indication of depression		0.007	0.020		0.025	0.040
		(0.023)	(0.020)		(0.019)	(0.018)*
No. of people in household		0.009	0.002		0.000	-0.010
		(0.010)	(0.009)		(0.008)	(0.008)
Age at time of survey, in years		-0.040	-0.131		0.010	0.005
		(0.033)	(0.038)**		(0.027)	(0.032)
Age Squared		0.001	0.001		0.000	0.000
		(0.000)	(0.0005)**		(0.000)	(0.000)
Mother Variables						
Age at time of child's birth, in years	0.005	0.011	0.042	0.000	-0.009	-0.005
	(0.003)	(0.019)	(0.019)*	(0.002)	(0.017)	(0.016)
Overweight	0.098	0.092	0.105	0.074	0.066	0.043
	(0.026)**	(0.025)**	(0.024)**	(0.023)**	(0.022)**	(0.022)*
Obese	0.237	0.226	0.167	0.181	0.144	0.114
	(0.039)**	(0.039)**	(0.033)**	(0.035)**	(0.034)**	(0.028)**
Morbidly Obese	0.308	0.301	0.233	0.232	0.180	0.198
	(0.109)**	(0.115)**	(0.096)*	(0.075)**	(0.071)*	(0.064)**
Married at time of survey		-0.022	-0.010		0.035	0.035
		(0.029)	(0.026)		(0.019)	(0.018)
Lives in urban area		-0.010	-0.022		-0.011	0.005
		(0.020)	(0.019)		(0.015)	(0.014)
High school only		-0.028	-0.037		-0.058	-0.080
		(0.030)	(0.031)		(0.024)*	(0.023)**
Some College		-0.057	-0.061		-0.055	-0.074
		(0.029)*	(0.029)*		(0.020)**	(0.018)**
Graduated college		-0.072	-0.082		-0.100	-0.107
		(0.029)*	(0.028)**		(0.015)**	(0.014)**
Lowest Income Quartile		-0.016	0.025		0.026	0.067
		(0.038)	(0.041)		(0.033)	(0.040)
Second Income Quartile		0.018	-0.036		0.022	0.040
		(0.029)	(0.024)		(0.026)	(0.025)
Third Income Quartile		0.045	0.029		0.020	0.027
		(0.027)	(0.021)		(0.022)	(0.020)
Does not work		-0.012	-0.026		0.014	-0.012
		(0.022)	(0.023)		(0.018)	(0.018)
Works 35 hrs/week or more		0.042	0.022		0.012	0.019
		(0.021)*	(0.020)		(0.017)	(0.016)
Has private or employer insurance		0.019	0.046		-0.006	0.011
		(0.025)	(0.021)*		(0.023)	(0.018)
Received welfare in year prior to survey		0.007	0.072		0.010	0.040
		(0.034)	(0.050)		(0.027)	(0.032)
Received Medicaid in year prior to survey		0.021	-0.057		0.040	-0.009
		(0.038)	(0.031)		(0.035)	(0.024)
Observations	1,891	1,891	1,891	1,870	1,870	1,870
Pseudo-R Sqr	0.069	0.087	0.088	0.065	0.101	0.105

Note: See note to Table 2 for description

Table A4 - Marginal Effects Probit Estimates of Youth Overweight Among Blacks

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		0.002	0.003		0.006	0.002
		(0.003)	(0.003)		(0.003)	(0.003)
Low Birthweight	-0.105	-0.088	-0.105	0.095	0.081	0.107
	(0.069)	(0.073)	(0.068)	(0.089)	(0.088)	(0.088)
High Birthweight	0.162	0.166	0.172	-0.111	-0.132	-0.140
	(0.102)	(0.101)	(0.101)	(0.107)	(0.105)	(0.105)
Order among mother's births	-0.063	-0.041	-0.041	-0.031	-0.014	-0.022
	(0.016)**	(0.018)*	(0.018)*	(0.018)	(0.022)	(0.021)
Indication of depression		-0.002	0.008		0.024	0.046
		(0.040)	(0.039)		(0.043)	(0.038)
No. of people in household		-0.013	-0.008		-0.023	-0.005
		(0.012)	(0.012)		(0.012)	(0.012)
Age at time of survey, in years		-0.017	-0.010		-0.183	-0.093
		(0.061)	(0.075)		(0.063)**	(0.079)
Age Squared		0.000	0.000		0.002	0.001
		(0.001)	(0.001)		(0.001)*	(0.001)
Mother Variables						
Age at time of child's birth, in years	0.018	0.030	0.034	0.014	0.081	0.026
	(0.004)**	(0.037)	(0.035)	(0.005)**	(0.039)*	(0.038)
Overweight	0.045	0.056	0.046	0.069	0.083	0.088
	(0.037)	(0.038)	(0.042)	(0.040)	(0.040)*	(0.045)
Obese	0.198	0.205	0.176	0.297	0.310	0.221
	(0.043)**	(0.045)**	(0.042)**	(0.042)**	(0.042)**	(0.044)**
Morbidly Obese	0.333	0.329	0.358	0.363	0.367	0.383
	(0.085)**	(0.085)**	(0.074)**	(0.072)**	(0.071)**	(0.055)**
Married at time of survey		0.054	0.042		-0.069	-0.071
		(0.042)	(0.042)		(0.042)	(0.042)
Lives in urban area		-0.012	0.049		-0.055	-0.047
		(0.040)	(0.039)		(0.047)	(0.045)
High school only		0.049	0.038		0.071	0.047
		(0.048)	(0.051)		(0.053)	(0.055)
Some College		0.104	0.103		0.007	-0.057
		(0.060)	(0.060)		(0.064)	(0.061)
Graduated college		0.117	0.121		-0.006	-0.053
		(0.083)	(0.085)		(0.098)	(0.087)
Lowest Income Quartile		-0.180	-0.074		0.067	-0.047
		(0.063)**	(0.052)		(0.074)	(0.057)
Second Income Quartile		-0.165	-0.055		0.055	0.017
		(0.050)**	(0.048)		(0.068)	(0.052)
Third Income Quartile		-0.123	-0.038		-0.002	-0.020
		(0.052)*	(0.048)		(0.070)	(0.053)
Does not work		-0.034	-0.044		0.036	0.071
		(0.041)	(0.044)		(0.043)	(0.049)
Works 35 hrs/week or more		-0.021	-0.013		0.053	0.055
		(0.042)	(0.041)		(0.044)	(0.040)
Has private or employer insurance		0.041	0.034		0.026	-0.020
		(0.040)	(0.041)		(0.044)	(0.042)
Received welfare in year prior to survey		0.002	0.035		0.006	-0.032
		(0.046)	(0.046)		(0.051)	(0.048)
Received Medicaid in year prior to survey		0.133	0.075		-0.004	-0.043
		(0.048)**	(0.048)		(0.054)	(0.044)
Observations	1,108	1,108	1,108	1,165	1,165	1,165
Pseudo-R Sqr	0.059	0.084	0.079	0.058	0.081	0.069

Note: See note to Table 2 for description

Table A5 - Marginal Effects Probit Estimates of Youth Overweight Among Hispanics

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		-0.001	-0.003		0.003	0.000
		(0.004)	(0.004)		(0.004)	(0.004)
Low Birthweight	-0.029	-0.028	0.001	0.032	0.053	0.014
	(0.109)	(0.108)	(0.117)	(0.116)	(0.124)	(0.117)
High Birthweight	-0.060	-0.066	-0.052	-0.012	0.006	-0.005
	(0.072)	(0.073)	(0.075)	(0.096)	(0.104)	(0.104)
Order among mother's births	-0.026	-0.009	-0.033	-0.018	-0.018	-0.008
	(0.020)	(0.025)	(0.024)	(0.019)	(0.024)	(0.023)
Indication of depression		0.026	0.032		-0.011	0.030
		(0.048)	(0.044)		(0.054)	(0.046)
No. of people in household		-0.033	0.001		0.002	-0.031
		(0.016)*	(0.017)		(0.017)	(0.016)
Age at time of survey, in years		-0.069	-0.134		-0.037	-0.039
		(0.076)	(0.101)		(0.070)	(0.090)
Age Squared		0.001	0.002		0.000	0.001
		(0.001)	(0.001)		(0.001)	(0.001)
Mother Variables						
Age at time of child's birth, in years	0.007	-0.003	-0.022	-0.004	0.035	-0.008
	(0.006)	(0.048)	(0.044)	(0.005)	(0.047)	(0.046)
Overweight	0.038	0.044	0.018	0.103	0.106	0.146
	(0.046)	(0.046)	(0.050)	(0.047)*	(0.048)*	(0.048)**
Obese	0.240	0.267	0.235	0.287	0.287	0.231
	(0.055)**	(0.056)**	(0.052)**	(0.057)**	(0.058)**	(0.055)**
Morbidly Obese	0.414	0.475	0.402	0.419	0.411	0.523
	(0.126)**	(0.109)**	(0.111)**	(0.139)**	(0.139)**	(0.090)**
Married at time of survey		0.043	-0.029		-0.027	0.117
		(0.051)	(0.054)		(0.049)	(0.048)*
Lives in urban area		-0.085	0.035		0.001	0.009
		(0.079)	(0.059)		(0.071)	(0.059)
High school only		-0.027	-0.065		-0.069	-0.061
		(0.053)	(0.055)		(0.053)	(0.056)
Some College		-0.091	-0.134		-0.047	-0.039
		(0.062)	(0.0592)*		(0.060)	(0.060)
Graduated college		0.043	-0.080		0.058	0.016
		(0.111)	(0.089)		(0.093)	(0.087)
Lowest Income Quartile		-0.057	0.005		-0.023	0.075
		(0.089)	(0.078)		(0.082)	(0.076)
Second Income Quartile		0.040	0.022		0.085	0.022
		(0.079)	(0.063)		(0.075)	(0.060)
Third Income Quartile		-0.071	-0.008		0.022	0.003
		(0.070)	(0.057)		(0.066)	(0.055)
Does not work		-0.003	0.019		0.024	0.045
		(0.047)	(0.056)		(0.049)	(0.057)
Works 35 hrs/week or more		0.013	0.018		0.062	0.082
		(0.049)	(0.044)		(0.048)	(0.049)
Has private or employer insurance		-0.010	0.059		0.028	-0.042
		(0.048)	(0.049)		(0.050)	(0.050)
Received welfare in year prior to survey		0.050	-0.032		0.057	0.027
		(0.060)	(0.058)		(0.065)	(0.058)
Received Medicaid in year prior to survey		-0.040	-0.021		0.020	-0.009
		(0.059)	(0.058)		(0.069)	(0.064)
Observations	779	779	779	730	730	730
Pseudo-R Sqr	0.033	0.057	0.052	0.0434	0.0592	0.0642

Note: See note to Table 2 for description

Table A6 - Marginal Effects Probit Estimates of Youth Overweight Among Whites

	Males			Females		
	Basic Child	*Full Child*	*Full Youth*	*Basic Child*	*Full Child*	*Full Youth*
Children Variables						
Age at time of survey, in months		0.004	0.004		-0.003	-0.004
		(0.003)	(0.003)		(0.002)	(0.002)
Low Birthweight	-0.259	-0.262	-0.265	0.159	0.173	0.173
	(0.040)**	(0.038)**	(0.037)**	(0.088)	(0.089)	(0.088)
High Birthweight	0.041	0.031	0.034	0.137	0.162	0.168
	(0.047)	(0.047)	(0.047)	(0.076)	(0.077)*	(0.074)*
Order among mother's births	-0.016	-0.022	-0.019	0.026	0.026	0.028
	(0.017)	(0.021)	(0.018)	(0.014)	(0.018)	(0.017)
Indication of depression		0.000	0.054		0.068	0.103
		(0.030)	(0.028)		(0.030)*	(0.027)**
No. of people in household		0.007	-0.012		-0.018	-0.030
		(0.015)	(0.013)		(0.013)	(0.012)*
Age at time of survey, in years		-0.110	-0.165		-0.010	0.037
		(0.049)*	(0.055)**		(0.046)	(0.056)
Age Squared		0.001	0.002		0.001	0.000
		(0.001)*	(0.001)*		(0.001)	(0.001)
Mother Variables						
Age at time of child's birth, in years	0.004	0.039	0.051	0.000	-0.041	-0.041
	(0.003)	(0.030)	(0.028)	(0.003)	(0.028)	(0.027)
Overweight	0.161	0.156	0.111	0.151	0.151	0.093
	(0.030)**	(0.031)**	(0.030)**	(0.032)**	(0.032)**	(0.032)**
Obese	0.279	0.273	0.256	0.269	0.253	0.246
	(0.042)**	(0.043)**	(0.038)**	(0.040)**	(0.042)**	(0.036)**
Morbidly Obese	0.307	0.311	0.266	0.430	0.419	0.405
	(0.110)**	(0.114)**	(0.092)**	(0.077)**	(0.079)**	(0.071)**
Married at time of survey		-0.003	0.020		0.055	0.014
		(0.040)	(0.037)		(0.036)	(0.037)
Lives in urban area		-0.024	-0.059		-0.030	-0.035
		(0.028)	(0.026)*		(0.026)	(0.025)
High school only		-0.069	-0.084		-0.033	-0.065
		(0.045)	(0.048)		(0.044)	(0.045)
Some College		-0.102	-0.125		-0.078	-0.109
		(0.047)*	(0.048)**		(0.047)	(0.045)*
Graduated college		-0.104	-0.128		-0.177	-0.180
		(0.052)*	(0.052)*		(0.042)**	(0.041)**
Lowest Income Quartile		-0.023	0.010		-0.052	0.043
		(0.054)	(0.053)		(0.045)	(0.050)
Second Income Quartile		-0.008	-0.047		-0.055	-0.027
		(0.040)	(0.037)		(0.037)	(0.035)
Third Income Quartile		0.057	0.014		-0.060	-0.005
		(0.037)	(0.031)		(0.031)	(0.030)
Does not work		-0.033	-0.054		0.027	-0.014
		(0.030)	(0.034)		(0.031)	(0.034)
Works 35 hrs/week or more		0.040	0.028		0.014	-0.026
		(0.029)	(0.028)		(0.028)	(0.027)
Has private or employer insurance		0.033	0.052		-0.002	0.035
		(0.035)	(0.035)		(0.034)	(0.033)
Received welfare in year prior to survey		-0.004	0.043		-0.002	0.001
		(0.050)	(0.056)		(0.045)	(0.048)
Received Medicaid in year prior to survey		0.037	-0.057		0.053	-0.028
		(0.056)	(0.053)		(0.053)	(0.048)
Observations	1,891	1,891	1,891	1,870	1,870	1,870
Pseudo-R^2	0.050	0.063	0.068	0.055	0.079	0.082

Note: See note to Table 2 for description