Childhood and Adolescent Obesity: Understanding the U.S. Epidemic

By

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[Signatures and dates for advisor and second reader]
Childhood obesity is the latest U.S. epidemic to come to the attention of the public health community. According to numerous recent studies, in the last 20 years, obesity rates have doubled for children and tripled for adolescents. In addition, for children aged 2 – 17, studies have reported an increase in the average weight. Statistics indicate that the risk of overweight or obesity in children and adolescents is directly related to minority status and poverty. The reasons for these increases are still under investigation.

Causes of obesity may include: genetics/family history, soft drink consumption, sedentary lifestyle, and fast food consumption. The detrimental effects on young people run the gamut from physiological effects (e.g. type 2 diabetes, cardiovascular disease, arthritic problems) to psychological effects (e.g. low self esteem, depression). Even more concerning is the potential for a decreased life span in this population at a time when technology and advanced health care techniques have the capacity to improve the quality of life and increase longevity.

Strategies for treatment and prevention are still being tested in an attempt to halt the epidemic. However, research on strategies for preventing and treating overweight in children has produced inconclusive results. In fact, the majority of treatment studies involving diet and exercise found no differences between treatment and control groups. Prevention research has focused on both primary and secondary prevention techniques which include promoting: breastfeeding, increased physical activity, reduced sedentary behaviors, increased fruit and
vegetable consumption, reduced consumption of sugar-sweetened drinks, and reduced portion sizes none of which have been shown to have unequivocal success.

For further progress to be made in stemming the tide of childhood and adolescent overweight and obesity, policies need to be implemented that address the need for scientific data to identify effective treatment and prevention strategies. However, it is unlikely that these policies will be enacted along with the funding necessary to address these research needs until childhood obesity is a high priority on the public agenda.

This paper reviews the current literature on the problem, causes, health outcomes, treatment, and prevention strategies associated with childhood overweight and obesity along with presenting a study of U.S. population data, and a summary of policy issues related to the epidemic.
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Introduction

Childhood obesity is the latest epidemic to come under scrutiny. Childhood obesity is a health concern that demands the immediate attention of both health care providers and the public health community. This paper will describe the background of the problem, discuss the causes of the problem, explore the health outcomes, assess the potential strategies for prevention and treatment, present a preliminary study of cross sectional data from NHANES III about the U.S. epidemic, and discuss policy options for dealing with the epidemic.

1. Background of the Problem

It is well know that children who are obese or overweight suffer from any number of serious medical conditions, including orthopedic dysfunctions, type 2 diabetes, metabolic syndrome, cardiovascular disease, diminished immune function, skin problems, impaired mobility, and hypertension. The majority of these are chronic conditions that are typically found in older adults (1). In addition, the physical appearance of obese children leads to additional psychosocial consequences. Low self esteem, social alienation, discrimination, and depression, particularly in girls are of particular note (1 – 4). More importantly, obesity that begins in childhood generally persists into adolescence and adulthood with the associated increased risks of morbidity and mortality from complications
of this disorder (5). One of the key factors in developing an understanding of this epidemic is that there is no universal mechanism for classifying children as overweight and obese. Obesity in adults is most often determined by calculating the ratio of weight in kilograms to the square of height in meters. This measure is called the body mass index (BMI). One important consideration in using this measure is that body habitus must be taken into account when classifying an individual as obese (6).

BMI is used differently as an indicator of obesity in children than in adults. BMI for children is age and gender specific and is plotted on gender specific growth charts. These charts are used to determine the BMI for children and teens aged 2-20 (7). When BMI is used as the indicator of overweight and obesity in children, a BMI between the 85th and 95th percentile for age and gender is considered overweight while a BMI greater that the 95th percentile for age and gender is considered obese (6).

However, there are some disadvantages of using BMI. These include:

- The inability to distinguish and increase in fat mass as opposed to lean mass
- Reference populations are largely non Hispanic whites and thus may not be completely applicable to non white population

Other measures of overweight and obesity that might be used include: skinfold thickness, bioelectrical impedance analysis and waist-hip circumference have some potential for assessing overweight in children but both the cost of performing these tests and issues with measurement validity, reliability and
comparability make them less desirable. Therefore, even with the disadvantages BMI is the best measure at this time (8).

Using BMI to classify children as overweight or obese, about 21-24% of children and adolescents in the U.S. are classified as overweight while on average 10-11% can be classified as obese. (9). According to the Institute of Medicine (IOM) report Preventing Childhood Obesity, Health in the Balance (10), obesity rates over the last 30 years for preschool children aged 2-9 have doubled while rates for school aged children (6-11) and adolescents (12-19) have tripled. Numerous investigations (11 – 16) have reported increased prevalence of overweight or obesity ranging from 12.3%-43% depending upon age and ethnic origin.

Mozlin (11) presented the breadth of the problem finding that 15% of children and adolescents aged 6 to 19 years are overweight or obese. She also reported that 30% of American children have a body mass index (BMI) higher than the 85th percentile for children of their same gender and age. More worrisome still, is the fact that from the last generation to the current one, the number of overweight children has increased by 50-60% and that obese children are even more obese (6, 12). According to data reported by Sherry (14) from the Centers for Disease Control and Prevention 2000 Growth Charts (17) developed from five of the national data sets including NEHS2, NEHS3, NHANES 1, 2 and 3), 2 to 5 year olds had an increased BMI of 10.3%, 6 to 11 year olds showed a 15.8 % BMI increase and 12 to 19 year olds a 16.1% increase.
Moreover, the data indicates that overweight prevalence rates are more acutely increased in minority groups. Strauss and Pollack (12) conducted a prospective cohort study of 8270 children aged 4-12 years of age from 1986-1998 using the National Longitudinal Survey of Youth to assess the prevalence of overweight in children. This study reported that the prevalence of overweight was 21.5% among African American children and 21.8% among Hispanics as compared to 12.3% among non Hispanic whites. In addition, they found that there was a 120% increase in prevalence of overweight for African Americans and Hispanics and only a 50% increase in prevalence for non Hispanic whites. Ogden et al (15) analyzed data from the 1990-2000 National Health and Nutrition Examination Survey (NHANES). This analysis included data from 4722 children (birth through 19 years of age) who had weight and height measurements obtained as a part of the survey. They assessed the prevalence of overweight in this population by age and race/ethnic group. They found that the prevalence of overweight had increased more sharply in minority groups. In fact, the prevalence of overweight among non-Hispanic blacks and Mexican-American adolescents increased more than 10 percentage points between the 1988-1994 and 1999-2000 studies, 13.4%-23.6% and 13.8%-23.4% respectively. Alarmingly, representative national data for prevalence of overweight in Asian children and adolescents is not available (18). Nevertheless, these results indicate continuing disparities between racial/ethnic groups as to the prevalence of overweight and obesity in children and adolescents.
Gordon-Larsen, Adair, Nelson, and Popkin (19) looked at the transition period between adolescence and adulthood to access the percent of overweight and obese adolescents who continue to have weight problems as they transition into adulthood using data from more than 20,000 adolescents in wave II (1996; ages 13-20) and wave III (2001; ages 19-26) of the National Longitudinal Study of Adolescent Health. They used the International Obesity Task Force Cutoffs, which link childhood BMI centiles to adult cutoffs, for wave II. For wave III, the investigators compared the age and sex specific cutoffs for obesity (≥95 percentile) from the 2000 CDC growth charts to the adult cutoffs. The study found that 9.4% of subjects were obese as both adolescents and adults. However, more disturbing is data that 12.7% of those individuals who were non obese at wave II became obese at wave III while only 1.6% moved from obese to non obese. In addition, certain minorities were more likely to be obese as adolescents and to remain obese into adult hood. For instance non Hispanic Black females were much more likely to be and remain obese than Asian females. In fact 90.8% of Asian females were non overweight in wave II and remained so into wave III, as compared to only 63.5% of Black females.

This disturbing upward trend of overweight and obesity in childhood and adolescents that continues in to adulthood has substantial public health implications. It foreshadows increases in morbidity and mortality from a number of chronic diseases as well as decreased quality of life years and life expectancy in this population. As stated by Carolyn Ashworth in her book *Defeating the Child Obesity Epidemic* (20), "Simply put, obesity may cause the current
generation of children in America to be the first to live shorter and less healthy lives than their parents.”

2. Causes of the Childhood Obesity Epidemic

The causes of the epidemic of childhood obesity are currently under investigation. Proposed causes of the epidemic now being studied include: genetic make-up, availability of calorie-dense foods, reduced physical activity, increased portion sizes, decreased fruit and vegetable consumption, and the built environment (21).

Studies show that overweight children come from households in which one or both parents are overweight or obese. This not only brings the genetic connection into play but the mirroring of parental dietary habits. Children are influenced at home by what the adults eat, how adults eat and what is made available. Parents who are not aware of nutritional quality eat and cook foods that easily fit their schedules and pocketbooks (22).

Second in influence is the school environment where school lunches have come under recent criticism. Most school lunches are heavy in the less nutritional, higher glycemic foods. The vending machines that populate many school systems are filled with high sugar and calorie-dense items with less nutritional value. No mandatory policies have been created nationally. However, some school systems have already evaluated and changed the quality of the menus provided to the students in their districts. Less than nutritional school lunches combined with the availability of numerous fast food facilities frequented by students with and without their parents create a less than healthy eating
environment. Many fast food facilities are frequently found in close proximity to school districts. This encourages quick and easy snacking or allows substitutions for home cooked meals. The ease and availability allow parents to use the drive through on the way home for a quick meal to take home or a convenient way to get food before shuttling sons and daughters off to after school functions (23).

Portion sizes (e.g. "super size") of the meals served at fast food and other out of home restaurants have greatly increased. In 2002, Young and Nestle (23) conducted a study of increasing portion sizes and their contribution to the obesity epidemic in the U.S. While their study did not specifically focus on children, they found that portion sizes which began to increase in the 1970’s and rose sharply in the 1980s have basically paralleled the trend toward increasing body weights. All of the commonly measured food portions that they measured, except for white bread, exceeded FDA and USDA standard portions. The most notable of these was cookies which exceeded the standard measure by 700%. Other excesses of note include cooked pasta (480%), muffins (333%), steaks (224%), and bagels (95%). Although no direct causal relationship has yet been proved, it is likely that these greatly increased portion sizes have led to greatly increased dietary intake of energy (calories) and have contributed to the increase in overweight and obesity in both children and adults in the U.S. population.

Experts have hypothesized that the steady decline in physical activity is one of the primary factors responsible for the increase in childhood obesity. In a study of Finnish monozygotic twins, Heitmann et al (24) found that the level of physical activity significantly influenced weight gain. In a review of the
prevalence of obesity, Dehghan, Akhtar-Danesh, and Merchant (25) identified a number of physical activity factors that may be fostering childhood obesity. The most prominent are sedentary behaviors such as watching television and playing computer games. In addition, the increased prevalence of obesity in children can be associated with the fact that children are driven to school and other activities as well as to the low participation in sports and physical education.

A diet low in fresh fruits and vegetables has also been posed as a contributor to childhood obesity. Children who eat fewer fresh fruits and vegetables tend to replace these nutrient rich foods with calorie dense foods that lead to weight gain. However, for some families it may not be economically feasible to provide a diet high in fresh fruits and vegetables. In 2004, a study by Drewnowski and Specter (26) confirmed that an unhealthy diet, high in saturated fat is significantly cheaper than one high in fresh fruits and vegetables. This is an especially important issue since children from low income families have a higher risk of obesity than their more affluent peers.

Research into the link between the childhood obesity epidemic and the built environment is still in early stages. Sallis and Glanz (27) recently attempted to shed some light on issues such as how the built environment influences lifestyle, would changing the infrastructure of the environment influence decisions about lifestyle and would those changes affect weight and overall health. Even though the built environment has changed over the past 40 years to promote a more sedentary lifestyle, it has not been clearly demonstrated that those changes have contributed to obesity in childhood. In addition, studies of the effect of the
built environment on weight have been less conclusive for children for the following reasons:

- Research on youth is limited
- All existing studies have the potential to be limited by self selection (e.g. people who live close to parks exercise more)
- Tracking major environmental changes is difficult because they are not under the investigators control

Nevertheless, a randomized controlled trial that would assign subjects to different neighborhoods is obviously not possible. However, it seems reasonable to assume that providing access to safe places in neighborhoods to be active may lead to healthier choices and help children to avoid obesity. A variety of studies of different age groups have been conducted. Overall these studies found that the amount of physical activity engaged in by the selected population was directly associated with the access to and attractiveness of the recreational facilities and programs. The following findings were of particular interest. The amount of physical activity adolescent girls engaged in was directly related to how close the recreational facility was to their neighborhood (27). Young children (preschool age) tend to be more active when there are facilities nearby that provide for rigorous physical activity (28). Finally, children and adolescents who have access to recreational facilities and programs near their homes are more likely to be physically active (29).

Frumkin (30) reviewed the public health impact of urban sprawl. He defined urban sprawl as the rapid geographic expansion of metropolitan areas
accompanied by low density areas, segregation of land uses (e.g. separate zoning for commercial versus residential areas), heavy dependence on automobile travel to access services, social homogeneity, and the movement of economic investment from the city center to the suburbs. All of these are the result of poor city and regional planning. One of the central phenomena associated with urban sprawl as defined by Frumkin (30) is the increase in driving along with the associated decrease in physical activity. Among the many health hazards (e.g. air pollution, automobile crashes, pedestrian injuries, decreased water quality) associated with the arrival of urban sprawl is the transformation to a more sedentary lifestyle resulting in increasing overweight and obesity in the population which affects both children and adults. Therefore, it is critical for city planners and public health officials alike to recognize the consequences of uncontrolled urban sprawl. Because of the recognized negative effect of urban sprawl increasingly, city planning boards have begun to include public health practitioners in the dialogue to help ensure that the effects of plans for development on health will be fully understood and potentially negative outcomes avoided (31).

3. Health Outcomes

The detrimental health effects of childhood obesity run the gamut from physiological (Type II diabetes, CVD, arthritic problems, etc.) to psychological (self-esteem, depression, etc.). Even more daunting is the potential for shortened life span at a time in our history when technology and healthcare have the capability to improve the quality of life and encourage longevity. The potential
impact related to providing treatment for these health effects on future
generations, society, the economy and health care in general are potentially
devastating. An overview of the adverse outcomes associated with childhood and
adolescent obesity are presented in Exhibit 1.

<table>
<thead>
<tr>
<th>Exhibit 1: Adverse Outcomes Associated with Childhood Obesity*</th>
<th>Related Disease States</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td><strong>Related Disease States</strong></td>
</tr>
<tr>
<td>Metabolic</td>
<td>• Type 2 Diabetes • Metabolic Syndrome</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>• Dyslipidemia • Hypertension • Left ventricular atrophy • Atherosclerosis</td>
</tr>
<tr>
<td>Hepatic</td>
<td>• Non alcoholic fatty liver disease • Non alcoholic steatohepatitis</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>• Obstructive sleep apnea • Asthma (exacerbation)</td>
</tr>
<tr>
<td>Renal</td>
<td>• Proteinuria</td>
</tr>
<tr>
<td>Neurological</td>
<td>• Pseudotumor cerebri</td>
</tr>
<tr>
<td>Orthopedic</td>
<td>• Slipped carpel femoral epiphysis • Blount’s disease</td>
</tr>
<tr>
<td>Psychological</td>
<td>• Depression • Poor quality of life</td>
</tr>
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*Adapted from Daniels et al (32)

Metabolic syndrome is a serious consequence of childhood obesity. The Adult Treatment Panel III of the National Cholesterol Education program (33) defined this syndrome to be a set of indicators that obesity, hyperglycemia, hypertension, hyperinsulinemia, and hyperlipidemia. This syndrome can be a predictor of more severe outcomes including Type 2 diabetes and coronary artery disease. In 1999, The Bogalusa Heart Study, an investigation of the risk of cardiovascular disease risk in 9167 children and adolescents aged 5-17 diagnosed the syndrome in 38.7% moderately obese and 49.7% of severely obese children and adolescents (34). Cook, Weitzman, Auinger, Nguyen, and Dietz, (35) using a modified definition of metabolic syndrome specifically for the study of
adolescents, conducted an analysis of the data from NHANES III (1988-1994) for 2430 male and female respondents aged 12-19. This involved primarily adjusting reference ranges for each measure to reflect those most applicable to an adolescent population. This investigation reported that the overall prevalence of metabolic syndrome in the overall population was 4.2% while the prevalence in overweight adolescents was 28.7%. Extrapolating to the population at large, these results suggest that there are about one million adolescents in the U.S. with metabolic syndrome. Obesity is a major risk factor for the development of metabolic syndrome which is a precursor to type 2 diabetes (36).

Therefore, it is likely that the childhood obesity epidemic will result in an increased risk of type 2 diabetes in children. Obese children are usually diagnosed with type 2 diabetes after the age of 10. Adolescents with type 2 diabetes are almost always obese. Logically, the combination of a larger number of obese children along with the increased severity of obesity in children and adolescents will lead to the diagnosis of type 2 diabetes in a greater number of children. In fact, since 1993, the incidence of type 2 diabetes in children and adolescents has increased paralleling the increased incidence and severity of obesity in adolescents and children (36). In addition to the morbidity and mortality associated with type 2 diabetes, there are a number of complications associated with this disease including cardiovascular disease, retinopathy, neuropathy, nephropathy, and foot complications. In 2002, Kordella (11), reported on a study of the rate of complications in type 2 diabetics aged 18-33 years old who were diagnosed as children. Of the 53 subjects, 3 were on dialysis,
23 had high blood pressure, 3 had retinopathy and 1 had undergone a toe amputation (11). Again there are disparities associated with minority in prevalence of this condition, most notably a 54% increase in the prevalence of type 2 diabetes in 15-19 year old adolescents reported by the Indian Health Service between 1988 and 1996 (37).

Cardiovascular disease is a third complication of childhood obesity. The Bogalusa Heart Study described above examined risk factors for cardiovascular disease in obese school age children. The results of that study revealed that overweight children and adolescents had a substantially greater risk of cardiovascular disease associated with increased odds ratios for unfavorable levels of several risk factors including lipids, blood pressure and insulin. To prevent cardiovascular disease in this population as they grow into adulthood, it is critical to treat the underlying cause which is this case is obesity (34).

Other adverse effects associated with childhood obesity (see Exhibit 1) are less well studied and more research is needed to define the consequences of their occurrence. Nevertheless, their importance as factors in the high levels of morbidity and mortality associated with childhood obesity must still be recognized.

4. Treatment of Obesity in Children and Adults

According to a recent United States Prevention Services Task Force (8), Screening and Interventions for Overweight in Children and Adolescents: Recommendation Statement there is fair evidence to support the following:
• BMI is a reasonable measure for identifying overweight children and adolescents or those who are at risk of becoming overweight.

• Children and adolescents aged 8 and older who are overweight are at higher risk of becoming obese adults.

However, the U.S. Preventive Services Task Force (USPSTF) also found that there was insufficient evidence:

• To support the effectiveness of behavioral interventions and other counseling with adolescents and children that can be delivered in a primary care setting

• To assess the magnitude of any potential harm that may be caused as a result of screening and prevention initiatives as well as treatment plans.

These conclusions were based upon the lack of high quality evidence of the effectiveness of screenings and interventions implemented in a clinical setting as well as scant evidence of effective individual or family based treatment programs for overweight children and adolescents that were used in a primary care setting.

In fact the USPSTF was able to find no direct evidence that implementing screening programs for overweight in children and adolescents would improve behavioral or psychosocial indicators or health outcomes. Based upon this lack of solid evidence, the USPSTF was unable to make a recommendation for or against screening for overweight in children and adolescents as a way of preventing adverse health outcomes. Details for selected studies upon which this determination was made are presented below.
Several longitudinal studies have been conducted to examine the negative health outcomes that may occur when childhood overweight persists into adulthood. However, because many of these studies fail to control for adult BMI, the predictive value of these studies may be limited (35, 38–43). In fact, in one study of cardiovascular risk factors, adjusting for adult BMI eliminated the association with childhood overweight (3).

Other studies of intervention and treatment programs have been conducted not in primary care clinics but in specialty clinics under the direction of obesity specialists (44, 45). Epstein, Myers, Raynor, and Saelens (46) reported on two such programs. They found that 12-24 months after treatment began, there was a 7-26% decrease in the mean percent of overweight in children and adolescents in the program that was maintained or improved in a subset of the patients for up to 10 years. In more rigorous randomized controlled trials, results varied depending upon the robustness of the study design. These trials evaluated the effectiveness of diet, lifestyle education, behavioral interventions, counseling, physical activity, and medication. However, the USPSTF found no acceptable evidence available for the evaluation of surgical interventions as a strategy for the prevention and treatment of overweight in children and adolescents.

None of the evidence for the effectiveness of these interventions is strong. In fact, no differences between the treatment and control groups were seen for educational and behavioral interventions. Moreover, only modest changes in BMI were observed in studies involving changes in diet and physical activity. However, significant changes in BMI loss were demonstrated in at least one trial.
of sibutramine (47), but adverse events resulted in discontinuation of treatment in a large number of patients.

One example of a dietary intervention in randomized controlled trial was the study conducted by Ebbeling, Leidig, Sinclair, Hangen, and Ludwig (48). Sixteen obese adolescents 14 of whom finished the study were divided into two treatment groups. One group consumed a reduced glycemic load diet (40-45% carbohydrates; 30-35% fat) while the other ate a conventional low fat diet (55-65% carbohydrates; 25-30% fat). After 12 months, BMI for obese adolescents consuming the low glycemic diet decreased significantly more than for those consuming the conventional low fat diet. Insulin resistance also increased less in the treatment group. Finally, this study showed that glycemic load was a better predictor of the response to treatment in both groups than was dietary fat.

Saelens et al (49) evaluated the efficacy of a behavioral intervention for weight control in adolescents. This program was initiated in a primary care clinic with follow-up conducted by telephone and mail. Forty four overweight adolescents were randomly assigned to treatment and control groups. The treatment group was given a complete program of behavioral interventions called Healthy Habits (HH) while the control group had a single session of weight counseling. The investigators measured weight, height, dietary intake, physical activity, sedentary behavior, and eating behaviors and beliefs at the beginning of treatment, four months into treatment and at a 3 month follow-up after treatment. In addition, they monitored participant satisfaction with the program and the results indicate that participants were satisfied with the program. At the end of
the follow-up period no significant difference between the treatment and control
groups could be found in BMI z scores, physical activity, sedentary behavior,
eating behaviors/beliefs, calorie intake, or percentage of calories from fat.
However, adolescents in the HH program did demonstrate higher behavioral skill
use and higher use led to better weight outcomes.

Finally, Berkowitz, Wadden, Tershakovec, and Cronquist (50)
investigated if adding sibutramine, a medication used to facilitate weight loss in
adults, to a family based intervention trial would lead to increased weight loss in
obese adolescents. They enrolled 82 obese (BMI =32-44) adolescents aged 13-17
into a double blind placebo controlled trial for 6 months. This was followed by
unblinded treatment for 7-12 months. For the first six months of the study
adolescents in the treatment group received sibutramine and a behavioral
intervention while the control group received placebo and a behavioral
intervention. Outcome measures included change in BMI, systolic and diastolic
blood pressure, pulse, and hunger. During the first 6 months of the study, the
group receiving both behavioral therapy and sibutramine had a significantly
greater reduction in BMI (8.5%) than the group receiving behavioral therapy
alone (6.8%). More than twice as many in the medication group reduced their
BMI by 10% or more as compared to those in the placebo group. During months
7-12, adolescents who continued use of the medication gained on average 0.8 kg
while those in the placebo group who started on medication at 7 months lost and
additional 1.3 kg. Participants in the sibutramine group reported significantly
greater reductions in hunger than those in the placebo group during the first 6
months of the study. By month 12 there was no difference in the reported hunger levels between the two groups. Nevertheless, the widespread usefulness of this approach to treatment of obesity in adolescents is limited by the fact that there was a high occurrence of adverse events related to sibutramine. As also noted in adult studies, increases in blood pressure and pulse rate were seen in adolescents as well. During the first 6 months of the study 19 of 43 patients (44%) receiving sibutramine had such significant increases in BP and pulse that their dose of sibutramine had to be reduced. This brings to light the fact that larger and longer studies in adolescents are required to evaluate the effect of sibutramine on BP and pulse. Additional studies involving the use of fenfluramine in combination with dietary intervention failed to demonstrate efficacy over dietary modifications alone (51 – 53). Therefore, treatment with these medications is not recommended for use in other than the research setting until more detailed data about their safety and efficacy are available.

In 1998, Epstein et al (46) reviewed the literature related to programs for the treatment of obesity. The studies they present involve dietary modifications and exercise either alone or in combination, along with a structured eating plan called the traffic light diet that was used in preschool and preadolescent populations. The most effective plans involved a combination of dietary modification and exercise.

Martul, Rica, Vela, and Aguayo (54) developed a protocol for clinical evaluation and treatment of obesity that has been in use in Spain for 30 years. Their evaluation begins with a complete medical history and medical examination.
to determine what circumstances may have caused obesity in the patient under their care. Measurements specifically for obesity, metabolic syndrome, cardiovascular disease and orthopedic conditions are conducted. Based upon the results of these tests, a consultation is conducted with each patient and the parents to explain the treatment plan. Patients are then referred to a dietician for a discussion of the dietary and physical activity requirements of the treatment. Dietary requirements include forbidden foods, recommended diet, and meal rules (e.g. no fixed amounts, five meals a day, vary food, nothing between meals, no high calorie foods, similar diet for the whole family, sit at the table, avoid stressful situations, serve food on small plates, etc). Physical activity is an integral part of the program. Taking the time to find a physical activity that is both appealing to the patient and fits their environment is critical. Monitoring of the treatment regimen is conducted on an outpatient basis. Weekly monitoring of weight and diet are conducted at home along with monthly outpatient visits which includes a physical examination. In severe cases, surgical treatment may be employed as a last resort. However, surgery is only recommended for adolescents with morbid obesity. In a retrospective study of 422 obese children who followed the rules of this program as stated above, the investigators found that 57% achieved and maintained weight loss while 37% attained and maintained a normal weight for their age.

Thus, there has been a great deal of research into the effectiveness of different plans for the treatment of obesity and overweight in children and adolescents including dietary modification, physical activity, medication, surgery,
and various combinations of these. However, the data about the effectiveness of these treatment plans is contradictory and inconsistent. Therefore, a focus on prevention may be a more effective strategy for reducing the prevalence of childhood obesity in the U.S.

5. Programs for Prevention of Obesity in Children

There is general agreement that prevention will be a key strategy to be employed in getting the current childhood obesity epidemic under control. Both primary and secondary prevention programs will be needed. Primary programs will focus on the prevention of overweight and obesity while secondary programs will focus on teaching techniques for preventing regaining of weight after weight loss as well as avoidance of additional weight gain in already obese individuals who are unable to lose weight. For these programs to be effective, Rosenbaum and Leibel (55) posit that it will be critical to understand and address what they call the “obesogenic” environment in which children live.

According to Noller and Paulk (6), the best approach for implementing a quality preventive intervention is to employ a team approach. The researchers stress that this team must include experts who can support both the medical and psychosocial aspects of the individual. They assert that, “The clinician must: empower the family to make long term behavior changes, support public policy changes, and provide resources.”

The CDC Community Preventive Services initiative (14) recommends six strategies for combating the childhood obesity problem. They include promoting:

- Breastfeeding
• Increased physical activity
• Reduced sedentary behaviors
• Increased fruit and vegetable consumption
• Reduced consumption of sugar-sweetened drinks
• Reduced portion sizes

There are ongoing studies for each of these strategies. Selected studies employing some of these strategies are discussed in Section 2 above.

To date prevention programs have focused on changing dietary and physical activity behaviors in individuals. Even though about 50% of adults in many countries around the world are overweight or obese, children not adults are the primary target for prevention. Because of the difficulty adults have in losing excess weight once it is established, it is logical to target programs to prevent obesity in children. In addition, there are more opportunities for structured interventions with children (e.g. schools, after care, preschool). Prevention programs should be targeted at a number of areas including built environment, physical activity and diet. Because of the increasing prevalence of obesity in children there is a sense of urgency for developing and implementing effective prevention and treatment programs.

Doak et al (5) in their 2006 review hypothesized that, for children, changes in the environment have had the most impact on bringing about the childhood obesity epidemic and so focusing on population based prevention programs that address environmental determinants of obesity, can be implemented on a large scale, and can be maintained over the long term will be most effective.
in the prevention of overweight and obesity in children. They reported on 25 programs that focused primarily on modifications in physical activity (e.g. reduced television viewing and physical education programs). The 25 programs reviewed by Doak et al (5) differed from the 22 that were included in the Cochrane Review (56) discussed below. They included programs and studies that focused on school aged children (aged 6-19); took anthropomorphic measurements of body weight and adiposity (e.g. BMI and skin-folds) at baseline and follow-up; included intervention of diet, physical activity or both, and were monitored and evaluated (e.g. peer reviewed publication). Studies focusing on treatment in a clinical setting, pilot studies or narrowly focused studies that were not generalizable were excluded. Programs were defined as effective if they showed a statistically significant improvement as compared to a control group. Of those programs studied, 17 were effective in attaining statistically significant reductions in BMI and skinfold thickness. In fact, one program not only reduced childhood overweight but also increased the prevalence of underweight. This was an unintended outcome that should be kept in mind when designing programs for preventing childhood obesity.

Another recent review of obesity prevention interventions by the Cochrane Collaboration (56) stressed the importance of the prevention of obesity in children as an international public health priority. While they acknowledge that prevention programs can change behavior, they also recognize that the efficacy of these programs in preventing obesity is still unproven. The objective of their review was to provide a better understanding of the available data about the effectiveness
behavioral interventions in preventing obesity in children. Twenty two studies were included in this review. Ten were long term interventions (12 months or greater) while twelve were short term (12 weeks to 12 months). Few of the studies showed any effect in preventing or reducing obesity in the populations' studied.

Of the six long term studies employing dietary education and physical activity interventions, only one resulted in any improvement in BMI and that improvement was for girls only. Two studies focused on physical activity alone. The one study involving a multimedia approach was the most effective. Two studies focused on nutrition interventions demonstrating no effect on BMI.

Of the short term studies, four included physical activity interventions. Two of those studies resulted in minor reductions in overweight. The remaining eight studies involved both dietary and physical activity components. None of these eight had any significant impact on overweight or obesity in children.

Therefore, the authors conclude that most of the interventions employed to date for prevention of overweight and obesity in children have had little or no effect on weight status. This is true despite significant changes in knowledge and behavior (57).

These results led to several recommendations. First, all stakeholders (e.g. families, schools, must be included in the process of developing strategies for ensuring supportive environments, behavior change in physical activity, and healthier food choices. The hypothesis is that this will lead to programs that will have a more positive impact than those previously employed. Sixteen
recommendations for design specifications for future research were made. Among these were recommendations for addressing social determinants of overweight and obesity, assessing the reliability of outcome measures (BMI), determining cost effectiveness of the interventions, sufficient power adequate numbers, and appropriate and adequate statistical analysis. The strongest recommendation from the group was that all interventions be designed with an in depth evaluation plan to determine what is working and what is not so that midcourse corrections can be made to improve program outcomes.

One of the few longitudinal studies of prevention of overweight in children is The Kiel Prevention Study (58). This study is being conducted to determine the determinants of childhood overweight as well as the effectiveness of prevention programs initiated in schools and families. Between 1996 and 2004, the investigators followed, 4997 German children aged 5-7 years old and 4487 children aged 0-11 years old. Interventions included a school based curriculum of nutrition and activity, a family based intervention and a structured sports program. Children in the intervention group were compared to a matched non intervention group and to a reference group of normal weight children with no intervention. Four follow-up data indicate that 77.4% of children who were overweight at age 5-7 were still overweight at age 10-11. However, the 4 year incidence of overweight in the intervention group was reduced (36.5% versus 41.7%). Risk factors for obesity that have identified in a variety of studies include parental overweight, low socioeconomic status (SES), high birth weight, early timing or rate of maturation, low physical activity, dietary intake, and
psychosocial factors (59–62). For the Kiel study, a cross sectional analysis of 2631 children aged 5-7 years indicated that parental overweight, low SES, and high birth weight were the primary risk factors for child overweight. Three reviews of the literature (60, 61, 63) have suggested that school based interventions are effective at improving behaviors except for nutritional behaviors. Consistent with this data, the Kiel study showed that a school intervention decreased the incidence of overweight in this population.

6. National Health And Nutrition Examination Survey Data

Because of the seriousness of the obesity epidemic in children in the U.S., there is a continuing need to examine the relationship between dietary quality and health. The objective of this section is to examine a number of parameters that may be associated with the current childhood obesity epidemic in a representative sample of children in the U.S. population who participated in the NHANES III.

Subjects: The Third NHANES is a nationally representative sample of the U.S. civilian population using a stratified, multistage, probability sample design. The details of the survey design are available elsewhere (64). Cross sectional data from 8394 children and adolescents were included in the study. Of those, 2783 were aged 5-10 and 2754 were aged 11-17.

The primary objective of the study was to determine if the Healthy Eating Index (HEI) could be used as an indicator of risk of overweight or obesity in children. The HEI is a measure of dietary status developed by the USDA Center for Nutrition Policy and Promotion. It consists of 10 components each of which represents a different facet of a healthy diet. Components 1-5 measure the degree
to which a person’s diet conforms to the recommendations of the Food Guide Pyramid. Components 6 and 7 assess compliance with total and saturated fat intake recommendations while components 8 and 9 determine conformance to recommended levels of cholesterol and sodium intake. Component 10 examines the extent of variety in the diet. The HEI has been used primarily for measuring dietary quality in adults. However, Feskanich, Rockett, and Colditz (65) recently adapted the measure to accommodate assessments of dietary quality in older children and adolescents. This new Youth Healthy Eating Index (YHEI) focuses on assessment of food quality, health and unhealthy foods and eating behavior. Each component is scored from 0 (lack of compliance) to 10 (full compliance). Details of the scoring criteria for each component in children have been presented elsewhere (65).

In addition to the healthy eating index, we examined the effects of genetic (e.g. gender, family history of obesity, ethnic group) and socioeconomic factors (e.g. geographic location, population, and family size) as well as insulin levels as contributors to the prevalence of obesity in this population. The prevalence of overweight in this population as defined by CDC was 11.6%. Characteristics of this population are presented in Exhibit 2 below.

<table>
<thead>
<tr>
<th>Exhibit 2: Characteristics of the Sample Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size N</td>
</tr>
<tr>
<td>Total Sample Age (2-17)</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Race-Ethnicity</td>
</tr>
<tr>
<td>Non Hispanic White</td>
</tr>
<tr>
<td>Non Hispanic Black</td>
</tr>
</tbody>
</table>
Exhibit 3 below presents the proportion of children in each HEI category according to body weight status. Not surprisingly, 88.36% of overweight children had an HEI that indicated that their diet was either poor or needed improvement. Similarly, 85.94% of normal weight children had HEI scores in these same categories. The Adjusted Odds Ratio and 95% CI for overweight are presented Exhibit 4.

<table>
<thead>
<tr>
<th>Geographical Region</th>
<th>Sample Size N</th>
<th>Normal Weight N (%)</th>
<th>Overweight N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexican-American</td>
<td>2805</td>
<td>2402 (85.10)</td>
<td>403 (14.90)</td>
</tr>
<tr>
<td>Other</td>
<td>396</td>
<td>345 (91.56)</td>
<td>51 (8.44)</td>
</tr>
<tr>
<td>Northeast</td>
<td>916</td>
<td>812 (90.53)</td>
<td>104 (9.47)</td>
</tr>
<tr>
<td>Midwest</td>
<td>1464</td>
<td>1296 (89.80)</td>
<td>168 (10.20)</td>
</tr>
<tr>
<td>South (including Texas)</td>
<td>3683</td>
<td>3256 (88.79)</td>
<td>427 (11.21)</td>
</tr>
<tr>
<td>West</td>
<td>2331</td>
<td>2056 (90.87)</td>
<td>275 (9.13)</td>
</tr>
<tr>
<td>Rural/Urban Areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 M Population</td>
<td>4146</td>
<td>3646 (90.19)</td>
<td>498 (9.81)</td>
</tr>
<tr>
<td>&gt; 1 M Population</td>
<td>4248</td>
<td>3772 (89.52)</td>
<td>476 (10.48)</td>
</tr>
<tr>
<td>Family Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 3</td>
<td>1686</td>
<td>1446 (86.06)</td>
<td>240 (13.94)</td>
</tr>
<tr>
<td>4–6</td>
<td>5418</td>
<td>4819 (90.76)</td>
<td>599 (9.24)</td>
</tr>
<tr>
<td>≥ 7</td>
<td>1290</td>
<td>1155 (91.16)</td>
<td>135 (8.84)</td>
</tr>
<tr>
<td>Family History of Diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parents with Diabetes</td>
<td>400</td>
<td>312 (78.15)</td>
<td>88 (21.85)</td>
</tr>
<tr>
<td>Parents no diabetes</td>
<td>7837</td>
<td>6966 (90.29)</td>
<td>871 (9.71)</td>
</tr>
<tr>
<td>Mother with diabetes</td>
<td>261</td>
<td>199 (78.62)</td>
<td>62 (23.89)</td>
</tr>
<tr>
<td>Mother no diabetes</td>
<td>7976</td>
<td>7079 (90.19)</td>
<td>897 (9.81)</td>
</tr>
<tr>
<td>Plasma Insulin Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1.85</td>
<td>5545</td>
<td>4794 (88.73)</td>
<td>651 (11.27)</td>
</tr>
<tr>
<td>1.85-3.5</td>
<td>2084</td>
<td>1831 (88.97)</td>
<td>253 (11.03)</td>
</tr>
<tr>
<td>≥ 3.5</td>
<td>865</td>
<td>795 (93.80)</td>
<td>70 (6.20)</td>
</tr>
</tbody>
</table>
So the data indicate that children and adolescents in this population who eat a poor diet are less likely to experience overweight than those who eat a diet that needs improvement or one that is good. This is counter intuitive to what would be expected. One hypothesis is that children who have been assessed as consuming a poor diet are taking in fewer calories even though they are consuming less healthy foods and therefore, have less obesity. Further study is needed to confirm this finding.

7. Policy Issues

Therefore, it can be seen that the threat of obesity in childhood is greater than it ever was before. While everyone seems to agree that urgent action is necessary no one is sure what that action should be. So even if a policy window were to open and the problem, policy and political streams were to converge, it is unlikely that strong policy related to strategies for overcoming childhood obesity could be put into place. It is more likely that the window would open and close
with no action because no efficient and effective alternatives exist for dealing with the problem of childhood obesity. Several investigators have examined policy issues related to the problem of obesity in general and childhood and adolescent obesity in particular both in this country and around the world.

In 2004, the British Medical Journal published an editorial presenting the findings of an obesity report from the United Kingdom (UK) House of Commons Health Committee (66). While this report dealt with the obesity problem in general, there were findings that are specifically pertinent to the problem of obesity in children and adolescents. The report was especially critical of the current UK initiatives indicating that they were mostly talk and little action. Consistent with other studies the committee found that the causes of obesity are environmental because modern living situations provide easy access to food with little need for exercise. In addition, they found that behavioral programs to prevent or treat obesity, focusing mostly on diet and exercise have been completely ineffective in stemming the increasing prevalence of obesity. Unlike policies in the U.S., which promote individual responsibility for the obesity problem, the UK is promoting a strategy of state responsibility for dealing with this issue and called for voluntary participation by food industry in anti-obesity initiatives. The report described a comprehensive approach emphasizing environmental factors contributing to obesity. Suggested strategies included implementing simpler food labeling practices (e.g. color code by healthfulness), banning vending machines from and school sponsorship by companies that produce unhealthful foods, and providing better access to programs that treat
obesity, all of which could be effective in reducing the prevalence of obesity in children. However, there is a dearth of scientific evidence to support the effectiveness of the proposed interventions. Nevertheless, Jain (2004) stresses that this should not be a reason for inaction calling attention to the fact that investigation of these policies must be conducted to create the evidence that will provide support for continuing effective programs.

In 2005, Nathan, Develin, Grove, and Zwi (67), examined how evidence was used to influence policy making at the NSW Childhood Obesity Summit held in New South Wales, Australia. They found that empirical evidence about the magnitude of the problem and the cost to the health system were critical in generating media coverage and agenda setting during the period leading up to and during the summit. On the other hand, empirical evidence for the effectiveness of various interventions in combating obesity was largely missing. However, for the most part, this did not hamper the passing of resolutions for programs to combat obesity in children. For instance, discussions of physical activity involved anecdotal evidence, expert opinion, and common sense solutions that were widely supported at the summit in part because there was no strong opposition to proposals in this area. On the other hand, policy development concerning regulation of food advertising was very contentious and resulted in the failure of the government to agree to proposed recommendations or to commit funds in this area. This was because of a lack of scientific evidence to support that controls on food advertising would be effective in reducing childhood obesity along with strong opposition by the food industry.
Anderson and Butcher (21) presented a comprehensive review of all aspects of the childhood obesity epidemic. They concluded that the childhood obesity epidemic appears to have begun sometime between 1980 and 1988 concurrent with multiple changes in children’s environment. In addition, during this period of time there was an increase in availability of calorie dense foods and soft drinks which became widely available to children in schools. Families also began to eat more pre-packaged and prepared food and consumed more food away from home. The investigators also highlight the host of environmental changes that have contributed to reducing children's activity levels during the period from 1980-1988 (e.g. traveling more in cars, changes in the built environment, more sedentary activities). In the end, their recommendation is not to focus on the causes of the childhood obesity epidemic, but to formulate policies to address children’s obesity focusing on effective ways to provide the child with a healthier overall environment. However, they offer not specific recommendations for policy development to accomplish this goal.

In 2006, Cawley (68) examined the problem of childhood obesity from an economic perspective. His study investigated both possible causes and policy solutions that may be influenced through markets. He included an analysis of how markets have influenced the rise of obesity. He proposed that the problem for researchers is not figuring out what has caused the rise in childhood obesity, but the fact that so many things may have caused it. He suggests three main things as having contributed to the increase in childhood obesity:
• The real price of food fell

• Rising wages have contributed to less time in preparing foods for college graduates, increasing the use of prepackaged and restaurant prepared foods

• Technological changes have encouraged the use of prepackaged food

He underscored that government intervention in markets could help childhood obesity, but that those interventions should be based upon economics. His recommendation was based upon three parameters of markets. First, markets are notorious for under providing information. In this case, government can step in to distribute this information so that consumers can make more informed decisions about food choices. Second, since the cost related to the morbidity and mortality associated with obesity is borne broadly across society (e.g. 50% of the costs for treating obesity are paid by Medicare), government can intervene with programs in an attempt to reduce those costs. Finally, children are minors and are not able to evaluate the future consequences of their decisions. In this case, government can step in to regulate the advertisement and sale of specific foods to minors in order to protect them from making bad choices that could ultimately affect their health. Other proposed government interventions in the market to deal with the childhood obesity epidemic pointed out by Cawley (68) include taxing unhealthy foods, subsiding industries that promote physical activity in children, and regulating food markets in schools. Still, he called attention to the fact that it is critical to assess the cost effectiveness of these programs before they are
implemented and that it is vitally important that those cost effectiveness studies be completed because even small changes in dietary habits can have a substantial impact in reducing childhood obesity.

In the U.S., the problem of childhood obesity was recognized at least as early as 1990 when Healthy People 2000 delineated policies that described national health objectives for health promotion including seven initiatives related to managing the problem of overweight in children. Those initiatives ranged from broad goals of reducing the prevalence of overweight in the U.S. to specific activities such as altering the types of foods served by school breakfast and lunch programs, increasing nutrition education in schools, and increasing to 75% those children engaging in vigorous physical activity three or more days a week. Unfortunately, these goals in large part were not attained (69). As a result, an increased focus on this problem was incorporated into Healthy People 2010. Obesity and overweight have been named as one of the topics of the leading health indicators (LHI) by which the health of the nation will be monitored. In fact, one of the objectives for the Nutrition and Overweight focus area is to track the proportion of children and adolescents who are overweight or obese as a measure of this LHI (70). In 2003, a review of the Nutrition and Overweight focus area was conducted. The findings of this review indicate that the trend in the prevalence of obesity in children and adolescence is still upward. The report presents the key challenges in dealing with the problem of overweight and obesity along with current and proposed strategies for attacking those challenges. However, no data is presented on the effectiveness of any of the programs in
decreasing obesity in children and adults. So it appears as if we are not farther ahead to day in terms of having empirical data about effective programs for prevention and treatment of overweight and obesity that we did in 1990. So like the policies in the UK, we have engaged in a lot of discussion but very little action.

In 2000, Congress undertook a major policy initiative to create a program that would provide scientific evidence about the health of the nation’s children. Over the past few years, hopeful progress was being made toward implementation of this policy through the National Children’s Study (NCS) (71). The purpose of this study was to conduct a national longitudinal study of environmental influences (including physical, chemical, biological, and psychosocial) on children’s health and development. The primary theme areas of study related to the childhood obesity epidemic were obesity, diabetes, and physical activity with obesity as a major focus area. However, recently Congress unexpectedly withdrew funding for this study (72). Speculation is that it is a matter of resources with funding for this program being diverted to support the war in Iraq and recovery efforts from a variety of natural disasters most notably hurricane Katrina. Although major efforts are underway by scientists and the public to get the funding restored, it appears after investing an estimated $100 M in preparation for the study over the last five years, the commitment to children’s health has taken a back seat to war. Actions such as these along with the relative amount of inaction surrounding the focus areas of Healthy People 2010 make it difficult to understand the U.S. policy connected to health of the nation’s children.
8. Future Directions and Research Priorities

So, where do we stand in 2006, relative to policies for dealing with childhood and adolescent obesity? It is instructive to examine past proposals in order to guide our thinking today. In 1998, Bar-Or et al (73) proposed that public health efforts to reduce obesity should focus on making changes to the existing political, education, and medical climate. They recommended the following measures that could be implemented to specifically target the problem of overweight and obesity in children.

- Putting a stop to advertisements for non healthy foods targeted at children
- Changing lifestyle patterns,
- Decreasing sedentary behaviors such as playing video games
- Increasing physical activity
- Incorporating more healthy and satisfying foods into the diet

Over time research has shown that most of these strategies were not effective in reducing the prevalence of overweight and obesity in children and yet these same strategies continue to be put forward as solutions today. As a part of their overall assessment of policy issues, Bor-Or presented several potential policy measures that could be considered as weapons in a war on obesity; however, they cautioned that specific policy recommendations should wait for research to confirm which approaches would be most effective in coping with the obesity epidemic. The policy proposals they presented consisted of subsidizing healthy foods, increasing the price of unhealthy foods, regulating advertising aimed at children, and
devoting public funds to build exercise facilities. Unfortunately, even today there is still a dearth of empirical evidence about what impact those policies will have. What then should the next steps be in order to move policy development in this area forward?

Paxson, Donahue, Orleans, and Grisso (74), provided insight into the progress of public policy development for childhood obesity. In their summary of findings in the 2006 special edition of *The Future of Children* focusing on the problem of obesity in children and adolescents, they state that even with all of the public attention, there is still no definitive evidence pinpointing programs and policies to effectively combat childhood obesity. They discuss some innovative new policy recommendations that show promise but caution that their effectiveness is not yet supported by evidence. Will these recently developed policy recommendations for “improving access to healthful foods in low-income neighborhoods by bringing in farmers’ markets and grocery stores; constructing sidewalks so that children can walk or bike to school; building or enhancing hiking trails and parks so that children and their families can be more physically active; and requiring restaurants to provide more helpful nutrition information to consumers” be the ones that reduce the prevalence of childhood obesity in the U.S? Only scientifically sound studies to produce empirical evidence of program effectiveness will be able to answer this question. However, until childhood obesity moves higher on the public agenda the funding necessary to address these research needs will not be forthcoming.
References


*NRP, April 29.* Retrieved April 11, 2006 from the NPR Web site:

