ASSESSMENT OF FUN TO BE FIT: A SCHOOL-BASED APPROACH TO CHILDHOOD OBESITY

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Submitted to the Graduate Faculty of

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Doctor of Public Health

University of Pittsburgh

2006

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

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Childhood obesity is the most prevalent nutritional disease of children and adolescents, affecting approximately 24% of the United States population ages 2-17. Childhood obesity is of public health significance because of increasing prevalence, costly consequences on disability and mortality, and the potential to promote health disparities. The Fun to Be Fit curriculum was piloted in nine Pittsburgh Public School System elementary schools during the 2001-2002 academic year. The curriculum incorporates two evidence-based programs: FRESH (Food Re-Education for Elementary School Health) and SPARK (Sports, Play and Active Recreation for Kids). The curriculum included 10 minutes of nutrition education and 40 minutes of physical fitness activities, offered twice a week. A total of 576 third and fourth grade children from five treatment schools (n=332) and four control schools (n=244) participated. Treatment school teachers received training in SPARK and FRESH, fitness assessments, and coaching strategies. The nutrition component was evaluated with a 20 item nutrition knowledge survey and a 51 item food frequency questionnaire. Fitness was assessed through curl-ups and push-ups completed in 30 seconds, and a half mile run/walk test. Both treatment and control schools completed the nutrition surveys and fitness assessments at the beginning and end of the school year. The purpose of this study was to determine whether the Fun to Be Fit curriculum was more effective than the existing physical education curriculum offered in the control schools in improving nutrition and fitness behaviors. An analysis of covariance (ANCOVA) examined between-group differences at post-test in nutrition and physical activity scores, statistically controlling for gender, grade level, and variation in pre-test scores. Results showed a greater increase in nutrition knowledge among Fun to Be Fit students ($p=.002$), and greater reductions in the consumption of high fat ($p=.001$), high sodium ($p<.001$), and high sugar ($p<.001$) foods as compared to the control students. Physical activity outcomes were mixed, with Fun to Be Fit students showing greater increases in push-ups ($p<.001$) but significantly fewer curl-ups ($p= .033$) as compared to the control students. There were no significant differences ($p> .05$) for the half mile run/walk assessment. The Fun to Be Fit program appears to be an effective strategy for improving nutrition knowledge in elementary school students and to some degree for increasing physical activity.

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PREFACE

Childhood obesity is one of the most researched health concerns today. Each day there are numerous news broadcasts and journal articles published about the problem of childhood obesity. Because of the voluminous amount of information available, selecting relevant articles became quite a challenge. I first learned about the seriousness of childhood obesity from a course taught by Dr. John Jakicic titled, *Obesity Research*. I have many research interests; however when it was time to select a research topic for my dissertation, my thoughts returned to that particular course. My intent was to research and read as many articles as possible related to childhood obesity, to become an expert. Although I am not sure of the depth of my expertise, I certainly enjoyed learning about it. With that said, as the end of this final phase in my quest for higher learning comes to a close, there are many people who traveled and finished this journey with me. Heartfelt thanks are extended to my family and extended family including my parents, stepmother, sisters, stepdaughter, church family, sorority, friends and colleagues at Highmark Blue Cross Blue Shield for their continuing support and encouragement.

Thank you Chloe, Windsor, and Pedro for keeping me company night after night. More important, I could not have accomplished my dream of completing this labor of love were it not for my faith and the support of my wonderful husband, who always stressed the positive, believed in me, and persuaded me never to give up. Balancing a family and a successful career while writing this dissertation, taught me that I could endure all things.

I appreciate the patience of my dissertation committee: Dr. John Jakicic, Dr. Chyongchiou Jeng Lin, and Dr. Ravi Sharma who waited and waited and waited. Dr. Donald Musa was truly a blessing as he guided the statistical analyses and helped me to see statistics in a whole new light. His expertise was invaluable. I also am eternally grateful to Highmark Blue Cross Blue Shield for thinking out of the box and supporting Fun to Be Fit; and to the students, faculty, and administration of the Pittsburgh Public Schools for being trailblazers.

I thank Dr. Abi Fapohunda, Dr. Janine Pearson, and Holly Shields, who provided much-needed encouragement. Lastly, I owe a debt of gratitude to Dr. Stephen Thomas, my dissertation chair and motivating force, who guided me throughout this arduous process. He kept me on track and "ordered my steps." He inspired me to think constantly and creatively. After our first meeting, I left his office feeling enthusiastic, convinced, and confident. I appreciated his never ending patience, support, and inspirational words of wisdom. He truly encouraged, and empowered me. Toward the end, I started thinking, "Maybe this wasn't so bad after all." I actually began to see light at the end of the tunnel, instead of the oncoming train. And now that this part of my journey finally is over, I am ready to reclaim my life!

1.0 INTRODUCTION

The health of a nation is largely a reflection of the past and present health of its children. The increasing life expectancy and decreasing rates of disability among elders can be attributed to the healthier childhoods of successive generations. Lower childhood mortality from infectious diseases, improved obstetric and neonatal care, better nutrition, and fewer adverse environmental exposures have had sizeable impacts on children’s quality of life. Policies regarding immunizations, prenatal care, and subsidized food programs for the poor, and laws regarding water quality have contributed to the fact that infectious diseases, malnutrition, and contaminated drinking water are not threats to United States child or adult health. At the same time, the burden of chronic and mental disorders among older Americans has increased dramatically. A growing body of scientific evidence supports the claim that many of these disorders have their roots in childhood (Forrest & Riley, 2004).

Despite steady progress over most of the past century toward ensuring the health of the country’s children, the 21st century begins with a startling setback: an epidemic of childhood obesity. This epidemic is occurring in boys and girls in all 50 states, in younger children as well as adolescents, across all socioeconomic strata, and among all ethnic groups. Specific subgroups, including African-Americans, Hispanics, and Native Americans, are disproportionately affected. At a time when it has been learned that excess weight has significant and troublesome health consequences, we nevertheless see the population, in general; and children, in particular; gaining weight to a dangerous degree and at an alarming rate (IOM, 2005). As a consequence, dietary guidance for children has broadened from an earlier focus on issues of underconsumption and nutrient deficiencies to overconsumption and decreased energy expended in physical activity. The attainment of optimal health through improved diet and physical activity will prevent chronic diseases in children and adolescents (ADA, 2004)

Obesity is associated with numerous health complications, and can cause difficulty in many organ systems. Factors contributing to obesity are wide-ranging. Health complications previously diagnosed in adults are steadily increasing in children (Barlow & Dietz, 1998; Troiano & Flegal, 1998; Atkinson, 2002; Dietz, 2002). Symptoms associated with overweight and obesity include glucose intolerance, headaches, hip pain or limp, abdominal pain, short stature or growth arrest, depression, and elevated blood pressure (Dietz & Robinson, 2005).

There are a multitude of approaches and interventions designed to address the growing rates of childhood obesity through schools, clinic-based models, research studies, communities and the home environment. One of the most important ways is through school-based physical activity programs (IOM, 2005; Sturm, 2005). Coordinated school-based physical education programs that incorporate healthy eating can help children exhibit significantly lower rates of overweight and obesity, eat healthier diets, and participate in more physical activity (Veuglers & Fitzgerald, 2005).

Overweight and obesity must be approached as preventable and treatable problems, with realistic and exciting opportunities to improve health and save lives. The challenge is to create a multifaceted public health approach capable of delivering long-term reductions in the prevalence of overweight and obesity. This approach should focus on health rather than appearance, and empower both individuals and communities to address barriers, reduce stigmatization, and move forward in addressing overweight and obesity in a positive and proactive fashion (DHHS, 2001).

Thus, it seems clear that one of the most compelling challenges of the 21st century is to develop effective strategies to prevent and treat pediatric obesity (Yanovksi & Yanovski, 2003). Interventions or treatments should modify eating and exercise behaviors, along with the factors that regulate these behaviors, so that new, healthier behaviors persist throughout development (Epstein et al., 1998; Goldfield et al., 2002).

1.1 STATEMENT OF THE PROBLEM

Childhood obesity is a serious, nationwide health problem requiring urgent attention and a population-based prevention approach so that all children grow up physically and emotionally healthy. Investigating the causes of childhood obesity, determining what to do about them, and taking appropriate action must address the variables that influence both dietary intake and physical activity. Children in the United States live in a society that has changed dramatically in the three decades over which the obesity epidemic has developed. Several of these changes, such as both parents working outside of the home and the availability of convenience foods often affect decisions about what children eat, how much they eat and the amount of energy they expend in school and leisure-time activities. Many of the social and cultural characteristics that the population has accepted as a normal way of life may collectively contribute to the growing levels of childhood obesity (IOM, 2005).

Despite the plethora of research, constant media attention regarding the pervasiveness of childhood obesity, and efforts to develop prevention focused strategies; this problem continues to be one for which there is no defined, universal plan of action. Successful interventions are subject to appropriateness, access, commitment, involvement, available resources, and the capacity for implementation (IOM, 2005). Because of the multidimensional nature of childhood obesity, no one group can effectively address this issue. Collaborative effort is required to produce measurable outcomes that demonstrate these interventions can make a meaningful difference in childhood obesity prevention. Childhood obesity is a multifactorial problem with a multifactorial solution (IOM, 2005).

Furthermore, the cost of obesity and complications attributable to this condition are staggering. Data on the harmful effects of obesity on health quality of life and social interactions in children are emerging as well. The known and potential causes of childhood obesity are many, but can be categorized as genetic, endocrine, prenatal/early life, physical activity, dietary, and socioeconomic. There are a multitude of factors acting on these seemingly simple variables. These factors influence the basic equation contributing to childhood obesity: energy input greater than energy output. Imbalances in this equation can result in obesity equals weight gain. It seems that gaining a foothold in the battle against obesity has never been more important (Strock et al., 2004).

1.2 PURPOSE OF THE STUDY

Given the link between physical inactivity and one of its resultant causes, obesity in children, the purpose of this study was to assess the effectiveness of a school-based physical fitness and nutrition intervention in addressing childhood obesity. Obesity impacts quality of life and hinders children from participating in physical activity. Childhood obesity often is associated with increased risk of disease and death in adulthood. The purpose of this study is twofold: (1) to assess the efficacy of a school-based approach which incorporates nutrition and physical activity in addressing childhood obesity. Schools have been identified as one of the most effective settings within which to reduce and or prevent childhood obesity, because of the many opportunities to engage children in physical activity; and (2) to examine differences in nutrition knowledge, frequency of food consumption (eating behaviors), and physical activity in a sample of third and fourth grade public school students before and after participation in Fun to Be Fit.

1.3 RESEARCH QUESTIONS

The study will examine the effectiveness of a coordinated school-based approach on outcome variables: reducing frequency of consumption of foods high in fat, sodium, and sugar; and increasing consumption of heart healthy foods, nutrition knowledge and levels of physical activity. The research questions addressed the following:

1. To what degree does participation in the Fun to Be Fit program reduce the frequency of consumption of high fat, high sodium, and high sugar foods, increase consumption of healthy foods, increase nutrition knowledge, and increase physical activity levels in students in the treatment group in comparison to students in the control group over the course of the school year?

2. Are similar effects from the Fun to Be Fit program observed on food frequency consumption, nutrition knowledge, and physical activity levels for both boys and girls?

3. Are similar effects from the Fun to Be Fit program observed on food frequency consumption, nutrition knowledge, and physical activity levels for third and fourth grade students?

4. How effective is Fun to Be Fit in students with less healthy food consumption, low nutrition knowledge, and physical activity levels at pre-test in comparison to students with more healthy food consumption, greater nutrition knowledge and higher physical activity levels at pre-test?

These questions and the results will be discussed in detail in Chapter 4.

1.4 SIGNIFICANCE OF THE STUDY

Overall, among children and adolescents living in the United States aged 2 to 19 years, 24% were overweight in 2003-2004. Tests for trends were significant for male and female children and adolescents, indicating an increase in the prevalence of overweight in female children and adolescents from 13.8% in 1999-2000 to 16.0% in 2003-2004, and an increase in the prevalence of overweight in male children and adolescents from 14.0% to 18.2% (Ogden et al., 2006). The current generation is the fattest in United States history (CDC, 2005).

Poor dietary habits and lack of exercise are largely responsible for childhood obesity, a disorder whose consequences can be devastating socially, psychologically, and physically. Moreover, the increasing prevalence of pediatric obesity represents a serious public health concern (Gortmaker et al., 1987).

Obesity is now the most prevalent nutritional disease of children and adolescents in the United States. Significant consequences of obesity, as well as the antecedents of adult disease, occur in obese children and adolescents (Dietz, 1998b). In addition, the economic burden of obesity in youth has dramatically impacted health care costs. Wang & Dietz (2002) examined the trend of obesity-associated diseases in youth aged 6 to 17 years and economic costs, and discovered that obesity-associated annual costs (based on 2001 constant United States dollar value) increased more than threefold from $35 million (43% of total hospital costs) during 1979-1981 to $127 million (1.70% of hospital costs) during 1997-1999. Days spent in the hospital for obesity-related disease more than doubled, from 152,000 over the three years of 1979-1981 to 310,000 days during 1997-1999. In addition, the average hospital stay increased by about one-third, from 5.32 days to 7 days. At a time when hospital stays overall were shortening; this change attests to the health dangers of childhood weight problems.

Children in Pennsylvania are not immune from the escalating effects of childhood obesity. In Pennsylvania, 27% of low-income children between 2 and 5 years of age are overweight or at risk of becoming overweight (Polhamus et al., 2004), and 18% of middle-school students (grades 6, 7 and 8) are overweight. According to the Pennsylvania Department of Health (2004), the percentage of overweight youth in Pennsylvania (35%) is higher than the national average (30%). These statistics substantiate the need for structured school environments that promote healthy eating and increased physical activity behaviors by implementing innovative coordinated programs focused on improving student nutrition and increasing physical activity levels.

This study is significant for several reasons: First, childhood obesity increases the risk of adult obesity, morbidity, and mortality (Dietz, 1988a; 1988b; Dietz, 2004). If obesity and overweight can be prevented or reduced prior to adulthood, the possibilities of developing health risks that may impact quality of life also are reduced. Second, because schools are one of the most effective environments for physical activity and physical education, it is important to address the issue of childhood overweight and obesity in this setting (IOM, 2005). Third, the rise in childhood obesity is due to complex interactions across a number of relevant social, environmental, and policy contexts that influence eating and physical activity. Over decades, these have collectively created an adverse environment for maintaining a healthy weight (IOM, 2004).

Evidence-based interventions such as Fun to Be Fit, Sports, Play and Active Recreation for Kids (SPARK), Planet Health, and Child and Adolescent Trial for Cardiovascular Health (CATCH) provide opportunities to reach students in the school setting where nutrition education and physical activity already are part of the school curriculum. Clinical studies such as The Dietary Intervention Study of Children (DISC), Bogalusa Heart Study and Stoplight Diet (also referred as the “Traffic Light Diet”) also have been effective in translating research results into school-based approaches. Outcomes of these programs should be helpful in developing ways to prevent childhood obesity, thereby preventing the chronic diseases that often accompany it.

Implementation of the Fun to Be Fit Program in the Pittsburgh Public Schools in the 2001-2002 school year provides opportunities for children who are at greater risk for becoming overweight and obese to reduce their risk of developing obesity-related conditions by learning new behaviors, engaging in physical activity, and developing new attitudes toward physical fitness and nutrition. In addition, reducing the risk of obesity at an early age may reduce the gaps in health disparities.

The effects of overweight, obesity and a sedentary lifestyle substantially raise the risk of preventable illness in children; specifically early heart disease and diabetes (DHHS, 2000). More than 28% of overweight children have at least two risk factors for coronary heart disease (CHD), and 60% of children in the United States exhibit at least one modifiable risk factor for CHD by age 12. That risk status continues to adulthood. Among the more common CHD risk factors that have been found to continue into adulthood is physical inactivity. Therefore, the most effective strategy in addressing overweight and obesity in children is to focus on prevention in preadolescent years. The return on investment at this stage can have long-term benefits in the future; specifically decreased risk for adult disease and disability (Francis, 1999).

2.0 REVIEW OF THE LITERATURE

2.1 OVERVIEW OF CHILDHOOD OBESITY

Awareness of the association of obesity with health problems is longstanding. A classical example of the emergence of an obesity-disease link was the 1921 observation by Joslin that a large proportion of diabetes patients were overweight. Another classical observation was the notation, by Hinsworth, of a decrease in the prevalence of diabetes in countries with food shortages in World War I. Additionally, the Metropolitan Life Insurance Company's development of "desirable weight" tables with respect to greatest expected longevity is a major marker for concern about the health effects of obesity (Visscher & Seidell, 2001).

The increase in obesity worldwide has had an important impact on the incidence of cardiovascular disease, Type 2 diabetes, cancer, osteoarthritis, work disability [in adults], and sleep apnea. Obesity has a more pronounced impact on morbidity than mortality; and diabetes is, by far, the most expensive public health consequence of obesity. The direct costs of obesity are estimated to be approximately 7% of total health care costs on the United States, and 1% to 5% in Europe (Visscher & Seidell, 2001).

Because of the increasing prevalence and costly consequences, obesity now is recognized as not only as a risk factor in the clinical setting, but also as an important threat to public health. The public health impact of obesity should be measured by its combined effect on morbidity and mortality. Obesity can act through its relationship with other morbidities, and appears to have a direct effect on disability for children and adults (Figure 2-1). The current focus also is on outcomes such as quality of life and physical, social, and mental functioning (Visscher & Seidell, 2001).

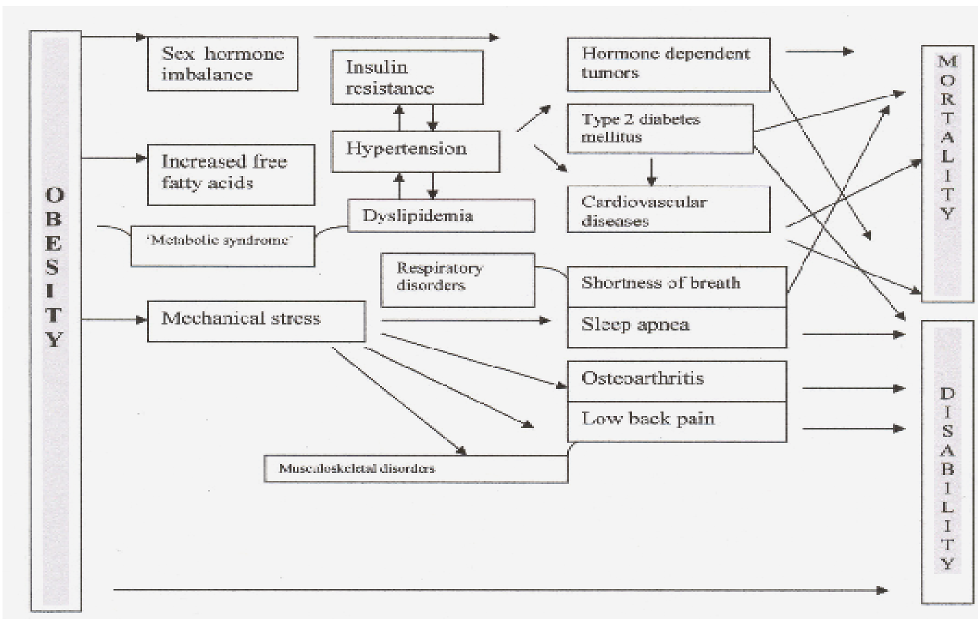

Figure 2-1. The Public Health Impact of Obesity

(Source: Vischer & Seidell, 2001)

Glucose intolerance, hypertension, and atherosclerosis; precursors of adult diabetes and cardiovascular disease; are clinically evident among youth. Children with high levels of cardiovascular risk factors tend to have high levels as adults, and vice versa for those with low levels, a phenomenon known as "tracking." Tracking of cardiovascular risk states and evidence of early stages of atherosclerotic disease in childhood provide support for preventive interventions in children that are targeted at reducing cardiovascular disease (Forrest & Riley, 2004).

Testimony from Dr. William Deitz (2002) before the House Government Reform Committee validates the burden of obesity and its impact on public health. The burden placed on society by obesity and chronic diseases is enormous, and the impact already has been observed on other diseases. For example, Type 2 diabetes, a major consequence of obesity, also has increased rapidly over the last 10 years. Although Type 2 diabetes in children and adolescents was virtually unknown 10 years ago, it now accounts for almost 50% of new cases of diabetes in some communities. Obesity also is a major contributor to heart disease, arthritis, and some types of cancer. Left unabated, overweight and obesity may soon cause as much preventable disease and death as cigarette smoking. While dramatic progress has been made over the past decades in achieving so many health goals, the statistics on overweight and obesity have steadily headed in the wrong direction. If the situation is not reversed, it could erase gains made in the areas such as heart disease, diabetes, several forms of cancer, and other chronic health problems (DHHS, 2001). Childhood obesity also is threatening child health gains made over the past three decades. At this rate the current generation of children will not live as long as their parents (NIHCM, 2004).

Defining Childhood Overweight and Obesity

The term “childhood obesity” may refer to both children and adolescents. In general, “children” is used to refer to 6 to 11 years of age; and “adolescents” to 12 to 17 years of age (American Obesity Association, 2002).

In view of the fact that there was no universally accepted definition for obesity in children, a panel of experts from the Centers for Disease Control and Prevention (CDC) convened in 1997 and recommended that a BMI of ≥95th percentile for age and sex be used as a definition of obesity. A child with a BMI-for-age that is equal to or between the 85th and 95th percentiles is considered to be at risk of being overweight. The most accepted and commonly used definition of childhood obesity is children and youth between the ages of two and eighteen years who have a BMI equal to or greater than the 95th percentile of the age- and gender-specific BMI charts developed by the CDC (Figure 2-2 and Figure 2-3). Growth charts are a well-known example of statistical criteria used to define children with a BMI equal to or greater than the 85th percentile as overweight or at risk for obesity (DHHS, 1996; Barlow & Dietz, 1998; Dietz & Robinson, 1998; CDC, 2003; IOM, 2005).

The crossing of major growth percentiles upward is an early indication of risk. It appears less than 5% of children cross two major percentile lines upward on the growth charts after four years of age. Thereafter, children who cross major percentile lines upward may be at increased risk of becoming overweight. Although visceral fat increases the likelihood of morbidity in adults and youth, no widely accepted clinical measure of central adiposity yet exists for youth (Dietz & Robinson, 2005).

Growth charts are used differently in clinical and epidemiologic applications. In clinical practice, growth charts are used to monitor individual children as they develop over time. In epidemiologic applications, growth charts can form the basis for evaluations of cross-sectional data by serving as the reference population from which a particular percentile cutoff is chosen to classify the weight status of individuals (DHHS, 1996; Barlow & Dietz, 1998; Troiano & Flegal, 1998).

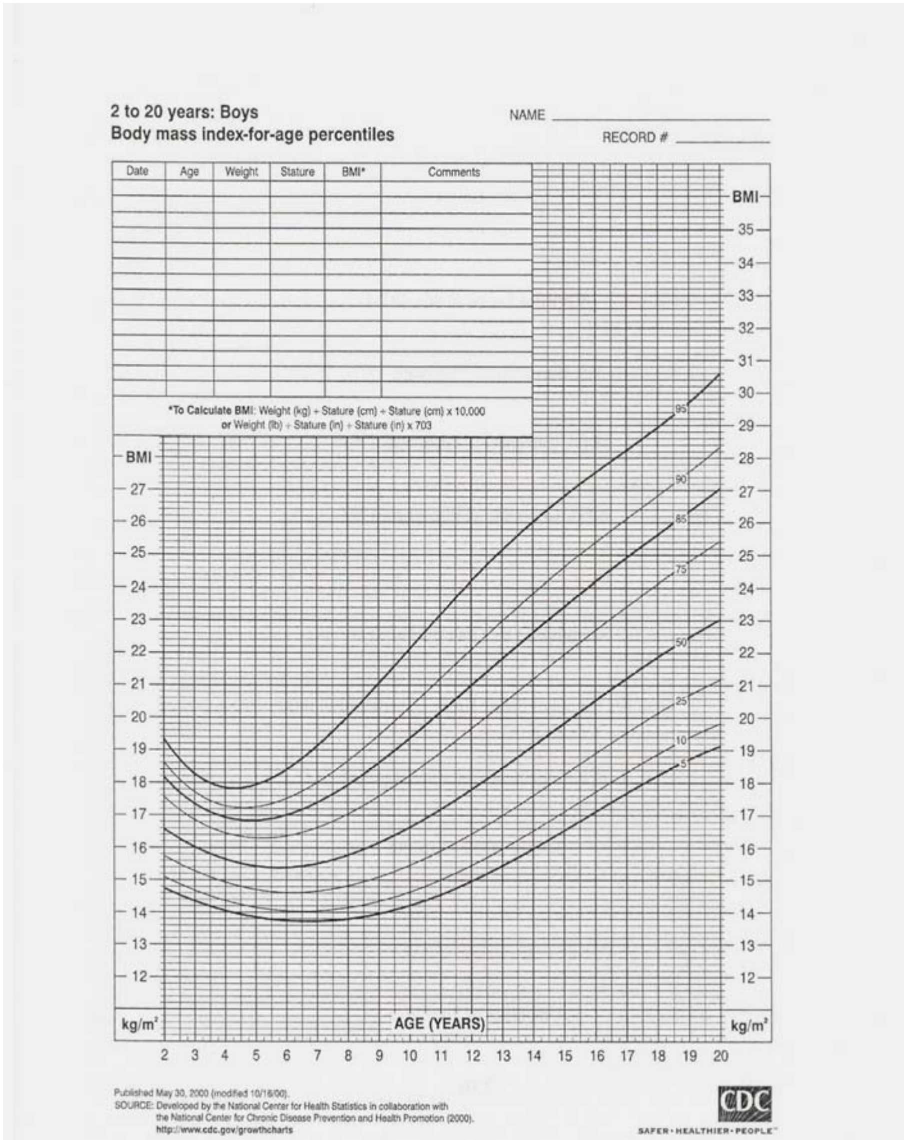

Figure 2-2. 2000 CDC Growth Charts for the United States, BMI-for-age Percentiles, 2 to 20 Years, Boys

(Source: CDC, 2000)

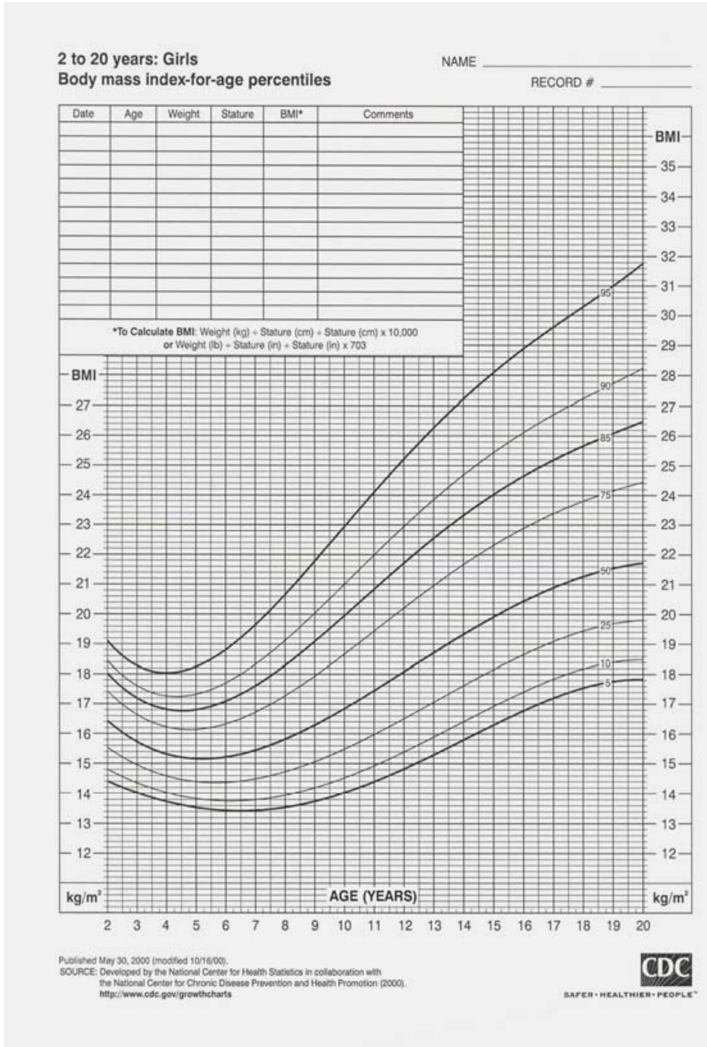

Figure 2-3. 2000 CDC Growth Charts for the United States, BMI-for-age Percentiles, 2 to 20 Years, Girls

(Source: CDC, 2000)

The 2000 CDC growth charts for boys and girls more closely match the national distribution of birth weight than did the 1977 NCHS growth charts, and the disjunction between weight-for-length and weight-for-stature or length-for-age and stature-for-age found in the 1977 charts has been corrected. Moreover, these growth charts can be used to obtain both percentiles and *z* scores (Ogden et al., 2002b).

Definition of Body Mass Index (BMI)

Body Mass Index (BMI) correlates positively with body fat, and is the recommended indicator of obesity-related risks in both adults and children. Although there are limitations on the use of BMI to assess overweight and obesity in children, it remains the most widely accepted measure of adiposity in children and adolescents (Dietz, 2004).

BMI is an indirect measure of body fat calculated as the ratio of a person's body weight in kilograms to the square of a person's height in meters (IOM, 2005). BMI is used as the measure of weight status; and children are described with respect to overweight, not obesity (Troiano & Flegal, 1998). A problem with this recommendation is that a specific prevalence of overweight is imposed without regard to health outcomes. To address this concern, the International Obesity Task Force workshop suggested defining overweight and obesity at childhood percentiles that correspond to the adult values for overweight and obesity (Maynard et al., 2001).

The adult BMI values for overweight and obesity, 25 and 30 kg/m^2, respectively, correspond to the 80th and 95th percentiles of the National Center for Health Statistics (NCHS) reference values for 2 to 18 year olds, and are known to be related to morbidity and mortality (Maynard et al., 2001; Ogden et al., 2002b). Because children's development varies with age, and because boys and girls develop at different rates, the use of BMI to assess body weight in children requires growth and gender considerations. Thus, BMI values for children and youth are specific to both age and gender (Barlow & Dietz, 1998; Dietz & Robinson, 1998).

BMI is the standard obesity assessment in adults, and its use in children provides a consistent measure across age groups. International support for BMI use in children also exists because it provides a reasonable index of adiposity (Barlow & Dietz, 1998). Although BMI may not be an ideal way to measure adiposity in infants and children because it does not describe lean mass or fat mass, or account for developmental changes, it does appear to predict BMI in adulthood (Berkowitz & Stunkard, 2002). Because children often exhibit idiosyncratic growth patterns, it is important to evaluate a child within the context of his or her own particular growth history, as well as relative to healthy and appropriate reference population (IOM, 2005). It also is important to keep in mind that BMI is an effective screening tool; it is not a diagnostic tool (CDC, 2000).

BMI changes drastically with age during childhood and adolescence. For individuals under 20 years of age, BMI is a complex concept. Not only do weight and height change as the body grows, but body-fat content and muscular development also are changing; and there are significant gender differences in the pattern of change. Thus, it is important to use gender- and age-specific BMI percentiles to determine whether a particular child has excess weight (IOM, 2005). This age dependence of BMI indicates that the measure is not independent of height. Body composition also affects BMI. The timing of these body composition changes may be related to development of overweight and obesity. These findings imply that many children who are at risk for the health-related problems accompanying overweight and obesity may not be effectively targeted for intervention programs designed to treat or prevent the progression of obesity, when selection of these programs are based solely on BMI (Maynard et al., 2001).

It has been established that BMI correlates with measures of body fatness in children and adolescents (Maynard et al., 2001). The correlation of coefficient ranges from 0.39 to 0.90, depending on the method of fatness measurement and the age and sex of the subjects (Barlow & Dietz, 1998). Children's body fatness changes over the years as they grow. Also, boys and girls differ in their body fatness as they mature. There also have been concerns about misclassification, because BMI is only a surrogate measure of body fatness in children as in adults. Furthermore, children may experience functional impairment (physical and emotional) at different levels of body fatness (IOM, 2005). BMI has some limitations in that it can overestimate body fat in persons who are muscular, and can underestimate body fat in persons who have lost muscle mass (DHHS, 2001).

Moreover, there are no BMI-for-age references or accepted definitions for children younger than 2 years of age. Therefore, the term “obese” probably is not appropriate in describing children younger than 2 years of age because the relationships among BMI, body fat, and morbidity are less clear at these ages. Additionally, a high BMI in children younger than two years of age is less likely to persist than a high BMI in older children. Weight-for-length greater than the 95th percentile is used by the CDC and the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) to define overweight for this age group (Ogden et al., 2002a).

The CDC and NCHS created new weight-for-age (WFA) and stature-for-age (SFA) growth charts with direction from the Supplemental Food Programs Division (Figure 2-4 and Figure 2-5). These charts are available as alternatives to the 2000 CDC Growth Charts to accommodate children ages 2-5 years who are not evaluated beyond the preschool years. These new charts focus only on WIC-aged children, making documentation and tracking easier. No changes have been made to any of the boys and girls BMI-for-age 2000 CDC Growth Charts. However, all health care providers should consider using the BMI-for-age charts to be consistent with current recommendations (CDC, 2002).

The following characteristics will help with understanding these new charts: only the 2-5 year age range is represented - which allows for more space between age indicators and percentile curves, making it easier to plot and read; weight is labeled every 5 pounds, with a line for every pound; stature is labeled every inch with a line for every quarter-inch; age is labeled for every year and half-year (2-5) with a line for every 2 months; English units are on the primary scale, and metric units are on the secondary (outside) scale; and the WIC logo has been added to the border (CDC, 2002).

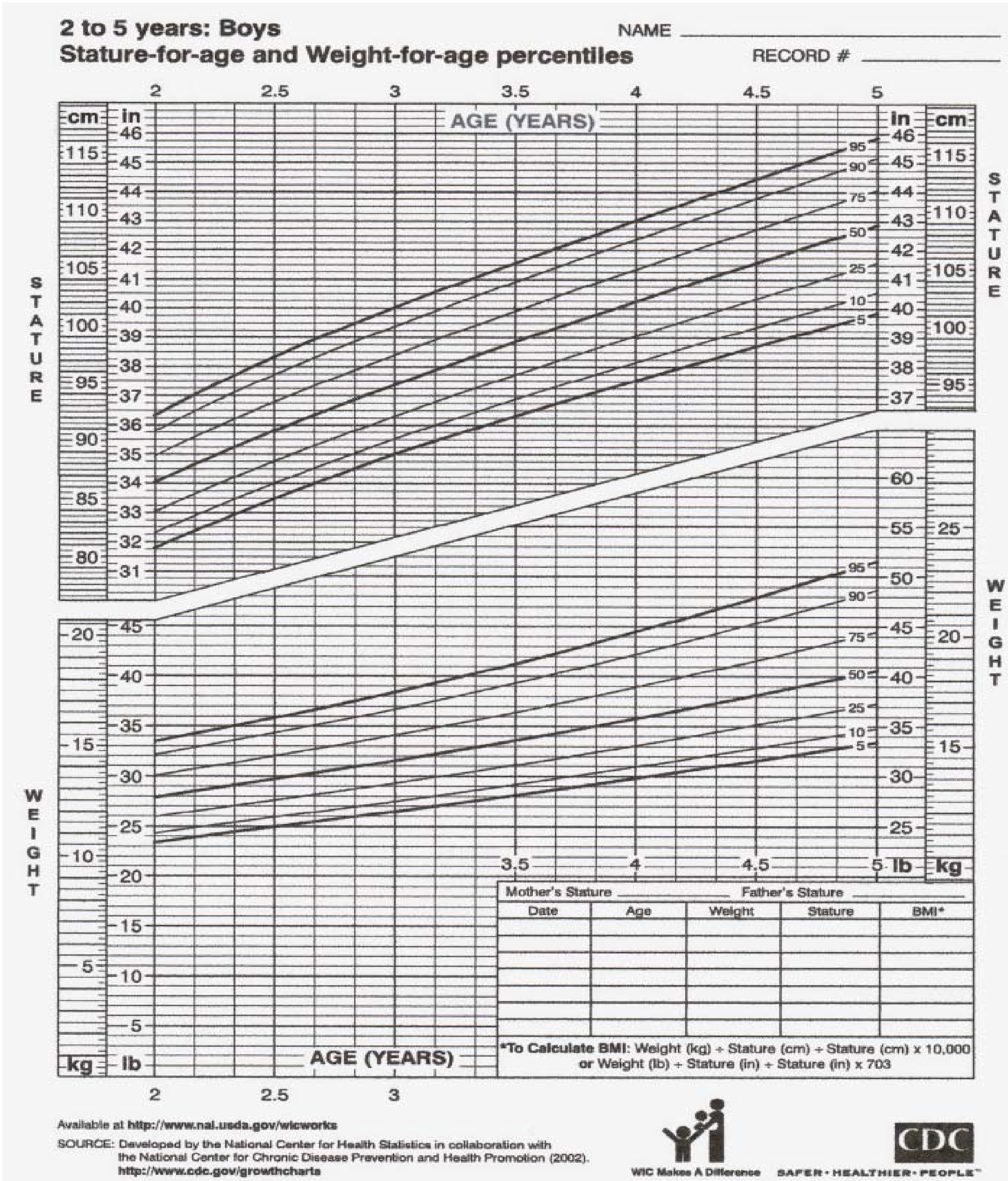

Figure 2-4. WIC Growth Charts for the United States, Stature-for-age and Weight-for-age Percentiles, 2 to 5 Years, Boys

(Source: CDC, 2002)

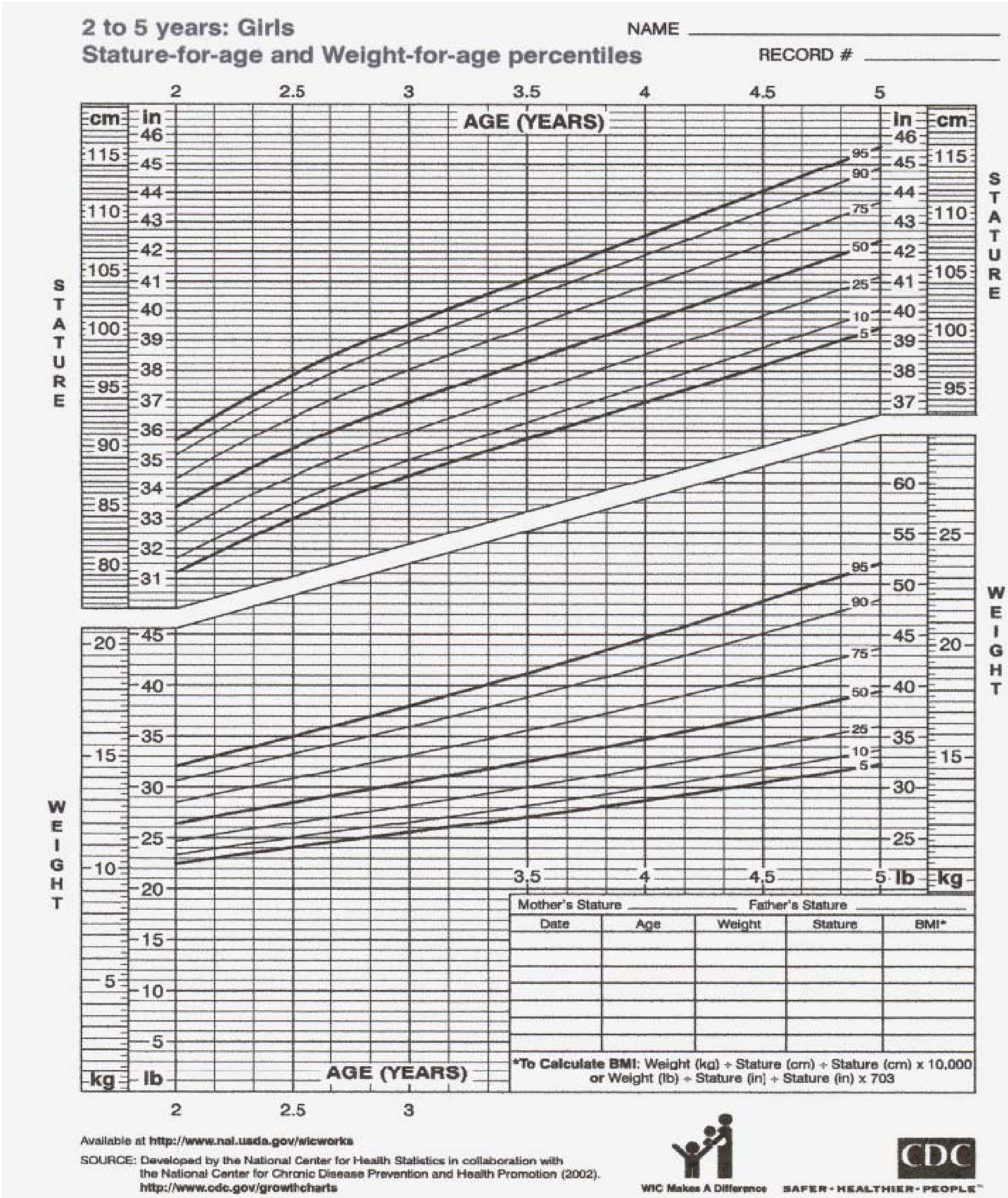

Figure 2-5. WIC Growth Charts for the United States, Stature-for-age and Weight-for-age Percentiles, 2 to 5 Years, Girls

(Source: CDC, 2002)

Overweight and Obesity Prevalence and Trends

Trends in childhood and youth obesity mirror a similar profound increase over the same approximate period in United States. adults as well as a concurrent rise internationally, in both developed and developing countries. The obesity epidemic affects both boys and girls, and has occurred in the lightest to the heaviest, based on their BMI levels from the 1970s; and another line of children were lined up based on their BMIs from the 1990s; approximately the first 25 children in each line would have the same BMI. However, the last 10 (the heaviest) children in the 1990s would be much heavier than their counterparts in the 1970s. In adults, the prevalence of overweight and obesity has increased; meaning that more adults have become overweight or obese, and the fact that they have become heavier has shifted the adult BMI curve to the right (IOM, 2004).

The prevalence of overweight doubled among children 6 to 11 years of age, and tripled among those 12 to 17 years of age, between the second National Health and Nutrition Examination Survey (NHANES), conducted between 1976 and 1980, and in 1999 and 2000. When the current overweight definition is applied to data from earlier NHANES, it is apparent that overweight in children and adolescents was relatively stable from the 1960s to the 1980. However, from NHANES II (1976-1980) to NHANES III (1988-1994), the prevalence of overweight among children ages 6-11 years increased from an estimated 7% to 11%, and among adolescent ages 12-19 years, increased from 5% to 11% (Dietz, 2004; Hedley et al., 2004).

NHANES IV, the most current survey conducted, (2003-2004) reports the prevalence of overweight among children and adolescents increased significantly during the six year period, from 1999 to 2004 (Figure 2-6). Figure 2-6 reports significant increases in prevalence of overweight in children (ages 6-11) and adolescents (ages 12-19) from NHANES I through

NHANES IV. The prevalence of overweight among children ages 6-11 increased from 15.1% in 1999-2000 to 16.3% in 2001-2002. In 2003-2004, the prevalence increased to 18.8%. Among adolescents ages 12-19, at risk for overweight increased from 14.8% in 1999-2000 to 16.7% in 2001-2002; continuing to increase to 17.4% in 2003-2004. These estimates were based on a 6-year period and suggest that the increases in body weight are continuing to rise in children and adolescents (Ogden et al., 2006).

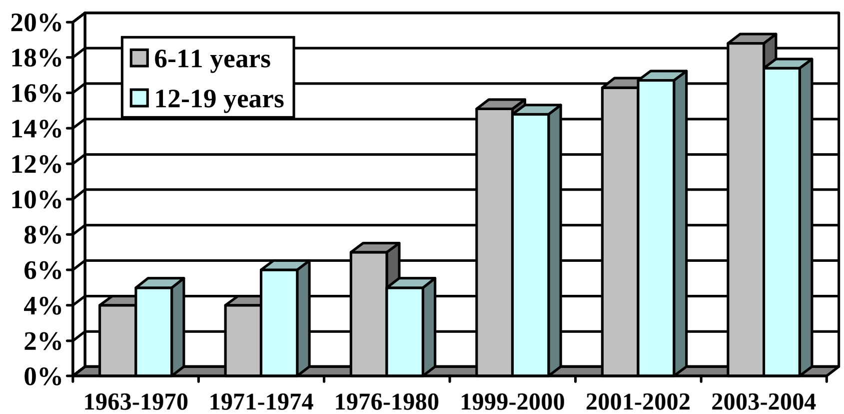

Figure 2-6. Prevalence of Overweight among Children and Teenagers, by Age Group and Selected Period – United States, 1963-2004*

Note: *Children with BMI values at or above the 95th percentile of CDC sex-specific BMI growth charts for 2000 are categorized as overweight
(Source: Ogden et al., 2003; Ogden et al., 2006)

The prevalence of overweight and obesity represents a 45% percent increase from the overweight estimates of 11% obtained from NHANES III (1988-94). An additional 15% of children and 14.9% of adolescents were at risk for overweight (BMI for age between the 85th and 95th percentiles). The data for adolescents is of notable concern because overweight adolescents are at increased risk to become overweight adults. The NHANES IV (2003-2004) findings for children and adolescents suggest the likelihood of another generation of overweight adults who may be at risk for subsequently overweight and obesity related health conditions (CDC, 2005). Although only 25% to 30% of obesity in U.S. adults begins during childhood or adolescence, early childhood overweight that persists into adulthood is associated with more severe obesity among adults (Dietz, 2004). These rates of obesity parallel the trend seen in adults in the United States, among whom an estimated 64% are now overweight or obese (CDC, 2005).

The prevalence of overweight and obesity in the United States remains high. The prevalence of obesity has continued to increase in men, and the prevalence of overweight has continued to increase in children and adolescents between 1999 and 2004. However, no significant increases were observed among women. There is little indication that the prevalence is decreasing in any subgroup of the population. These prevalence estimates suggest that the increases in body weight may be leveling off in women (Ogden et al., 2006).

Racial Disparities in Overweight and Obesity

Disparities in overweight and obesity prevalence exist in many segments of the population, and are particularly common among minority groups and those with a lower family socioeconomic status (DHHS, 2001). Although the prevalence of overweight among African-Americans, Mexican-Americans, and Native Americans exceeds that of other ethnic groups; between the second and third NHANES Surveys (II and III); the prevalence of overweight and obesity (BMI $\geq$25 for adults and $\geq$95th percentile for age and gender in children) doubled in both sexes and among all racial, ethnic and socioeconomic groups (Dietz, 2004; Dietz & Robinson, 2005).

Data for youth from NHANES IV showed a similar pattern to that of previous NHANES surveys. During 1999-2004, significant differences between racial/ethnic groups existed among children and adolescents (Ogden et al., 2006). Among children and adolescents, differences by racial/ethnic group existed for both sexes. These racial/ethnic group differences in female children and adolescents were observed during 1988-1994, but these differences were not observed among male adolescents during 1998-1994 (Ogden et al., 2003; Ogden et al., 2006).

From 1999-2004, the prevalence of overweight among non-Hispanic white male children and adolescents did not differ significantly from non-Hispanic black male children and adolescents. Mexican-American and non-Hispanic black female children and adolescents were significantly more likely to be overweight compared with white-non-Hispanic white female children and adolescents. Adolescents were more likely to be overweight compared with children. Among children aged 2 to 19 years in 2003-2004, no significant difference in prevalence of overweight was found between sexes (Ogden et al., 2006). Table 2-1 illustrates the disparities in prevalence of overweight among racial/ethnic group among children living in the United States.

Table 2-1. Percentage of Overweight among U.S. Children by Ethnicity Ages 2-19 years, 1999-2004

	Non-Hispanic Whites (%)	**Non-Hispanic Blacks (%)**	**Mexican-Americans (%)***
1999-2000	11.0	18.8	20.2
2001-2002	13.9	17.5	19.6
2003-2004	18.3	20.01	19.2

Note: Data for Mexican-Americans are as reported by government agencies for specific studies. There is limited data for all other Hispanic groups.
(Source: Ogden et al., 2006)

These estimates from the NHANES conducted in 2003-2004 provide the most recent prevalence estimates of overweight and obesity in the United States (Ogden et al., 2006). There is no indication that the prevalence of obesity among adults and overweight among children is decreasing, especially among minority populations (Ogden et al., 2002a; Ogden et al., 2003; Hedley et al., 2004; Ogden et al., 2006). An explanation for increased body weight may be due to contributing factors such as greater physical inactivity at home and in schools, changes in eating patterns and more hours of television viewing (Robinson & Killen, 1995; Nicklas et al., 2001b). The high levels of increasing overweight among children and obesity among adults remain a major public health concern for all (Ogden et al., 2002a).

Results from NHANES IV confirm disparities in overweight and obesity reported in previous studies. These studies, innovative for their time, are valid even now. Significant studies such as the National Heart, Lung, Blood Institute (NHLBI) Growth and Health Study (NGHS) tracked the changes of adiposity and obesity development during adolescence in black and white girls ages 9 to 19, a critical time of pubertal maturation and increase in body size. Findings from a previous NGHS report showed, even at age 9, the mean BMI of black girls was higher than that of white girls at the 85th percentile. There were, however, no racial differences among the lean girls (15th percentile). Although the prevalence of overweight in black girls (17.7%) was more than one-third greater than white girls (7.7%) even at age 9, there was a greater racial disparity in obesity with the prevalence more than twofold higher among black girls compared with white girls (Kimm et al., 2002).

The prevalence of overweight and obesity continued to increase with age, however because the increases were similar in both groups, the black-white ratio of the prevalence remained the same during the 10 years of NGHS. Due to racial differences in the secular trend, this dramatic doubling of the prevalence of both conditions resulted in approximately one half of the NGHS cohort being overweight by age 19, and approximately one third of black participants and one fifth of white participants being obese (Kimm et al., 2002).

Another landmark study, the Bogalusa Heart Study documented an unusually high prevalence of obesity among young black females, and it is recognized that a higher incidence of diabetes occurs in black adults. This study also confirmed findings from the NGHS Study. Black females begin to develop a greater amount of obesity than that observed in white females; and the emergence of obesity tends to accelerate after puberty (Nicklas et al., 2001a)

Socioeconomic Disparities in Overweight and Obesity

There is evidence that certain ethnic minority populations, children in low socioeconomic status families, and children in the country's southern region tend to have higher rates of obesity than the rest of the population. Although it should be noted that is difficult to separate racial and ethnic influences from socioeconomic factors that increase obesity risk. The current increase is especially evident among African-American, Hispanic, and Native American adolescents. With both sexes combined, up to 24 percent of African-American and Hispanic children are above the

95th percentile. Among boys, the highest prevalence of obesity is observed in Hispanics and among girls, the highest prevalence is observed in African-Americans (IOM, 2004).

Poverty is a strategic measure of socioeconomic status in studies of overweight because poverty is linked to both poor diet and physical inactivity (Miech et al., 2006). In addition, body size often is associated with socioeconomic status. However, the magnitude and direction of the association tend to differ by both level of economic development and by gender. In less developed countries, greater weight may be associated with affluence. There may be a positive association between socioeconomic status and body size for both men and women. For men in developed countries, height is positively correlated with socioeconomic status, but weight and BMI tend to be weakly, if at all, associated with socioeconomic status. For women in developed countries, however, weight and BMI have a strong association with socioeconomic status. Findings from several studies show that obesity is predictive of subsequent education and earnings for women, but not for men. Weight seems to vary considerably more by socioeconomic status, race/ethnicity, and nationality for women than for men (Ogden et al., 2003).

Additional evidence also suggests significant variation in BMI as a function of both socioeconomic status and ethnicity, although this relation is complex and poorly understood (Strauss & Pollock, 2001). Whether the increasing prevalence of adolescent overweight is characterized by larger, smaller, or unchanged disparities in overweight status across socioeconomic strata is not known, but is important for evaluating the success of recent efforts by the United States Department of Health and Human Services to reduce health disparities (Miech et al., 2006).

The objective of a study by Miech et al. (2006) was to examine the trends in adolescent overweight from NHANES surveys for the period of 1971-2004 by family poverty status, as well as trends in potentially relevant eating and physical activity behaviors. The surveys were examined for trends in the prevalence of overweight among adolescents aged 12 to 17 years by family poverty status. Results showed trends in the association of adolescent overweight with family poverty differed by age stratum (p=.01). The absolute difference between the prevalence of overweight for adolescents from poor families versus non-poor families increased by approximately 11% during the course of the survey.

In 12 to 14 year old adolescents, prevalence did not significantly differ by family poverty status in any of the surveys; however, among non-Hispanic black adolescents, overweight prevalence increased faster in non-poor versus poor families. In contrast, a widening disparity that disfavored adolescents from poor families was present in the 15 to 17 year old adolescents (Meich et al., 2006).

This trend was similar among female, male, non-Hispanic white, and non-Hispanic black adolescents, resulting in an overall prevalence of overweight during 1999-2004 more than 50% higher among adolescents in poor versus non-poor families (23.3% vs. 14.4%, respectively; p<.001). The study concluded that trends of increasing overweight showed a greater impact in families living below the poverty line versus not living below the poverty line among older (15-17 years) but not younger (12-14 years) adolescents. Furthermore physical inactivity, high consumption of sweetened beverages, and breakfast skipping may be candidate targets for prevention programs aimed at reducing this recently emerged disparity (Meich et al., 2006).

Nonetheless, two earlier studies, (National Longitudinal Survey of Youth and National Longitudinal Study of Adolescent Health) have addressed the effect of SES (represented by parental education level) on the development of obesity from childhood into early adulthood, and showed that youth with a lower SES had the largest increase in BMI six or seven years later. Using individual growth-curve modeling, results suggest that the rate of development of adiposity from childhood is influenced by sex and SES, but not by race. However, race, sex and SES have joint effects on adiposity levels (Dekkers et al., 2004). These analyses have suggested that family SES is inversely related to obesity prevalence in children, and that effects of SES and race or ethnicity were independent of other variables (Strauss & Pollock, 2001).

An increase in obesity prevalence among African-Americans appears greatest for those in the lowest income (Strauss & Pollock, 2001). Those disparities are not the same across ethnic groups nor do they emerge at comparable times during childhood. Also, despite many theories, there is almost no consensus about the mechanisms through which disparities occur. For instance, analysis of the data from the 1988-1994 NHANES shows that prevalence of overweight and obesity in white adolescents is higher among low-income families, but there is no clear relationship between family income and obesity in other age or ethnic subgroups (Troiano & Flegal, 1998).

Among children, girls from lower-income families had not consistently been found to be overweight compared to girls from higher-income families. Among Mexican-American and non-Hispanic black children and adolescents, family income does not reliably predict overweight prevalence. However, non-Hispanic white adolescents from lower-income families, experience a greater prevalence of overweight than those from higher-income families (DHHS, 2001). Moreover, African-American females and persons from low SES backgrounds have the highest risk of becoming obese in adulthood (Ogden et al., 1997; Kimm & Obarzanek, 2002; Dekkers et al., 2004).

The NGHS study of 9-and 10-year-old black and white girls, also found there was no variation in the risk of obesity across household income or parental education. Based on the findings from the NGHS, parental education, not household income, tended to exert a greater effect on BMI. Because of the uncertainty between SES and obesity prevalence, additional research efforts will be needed to identify variables that have the greatest influence on childhood overweight and obesity (Kimm & Obarzanek, 2002).

While findings from these studies suggest that obesity has contributed to disparities in minority groups, Truong and Strum (2005) suggest otherwise. These researchers found that although socioeconomic differences in the prevalence of unhealthy weight contribute to health disparities, it is not clear how the current obesity epidemic has contributed to these disparities.

To better understand health disparities, Truong and Sturm (2005) compared United States weight gain trends across sociodemographic groups between 1986 and 2002 by analyzing mean and 80th percentile BMI, calculated from self-reported weight and height, for subpopulations defined by education, relative income, race/ethnicity, and gender. Findings from the study concluded that weight gain among Americans is more uniform than expected on the basis of cross-sectional differences in the prevalence of obesity among subpopulations. No statistically significant difference was found in increase in mean BMI by educational attainment, except that a college degree was a protective factor. The lowest income group gained as much weight on average as the highest income group, but the lowest income individuals gained weight faster than the highest income heavier individuals. No differences were found especially by relative income and education across racial/ethnic groups, except that non-Hispanic blacks and women gained more weight than other groups.

One possible explanation for the uncertainty in how the obesity epidemic has contributed to health disparities is that factors leading to differential weight gain across population subgroups are less important secular changes that affect all groups, such as motorization, suburbanization, and increased food availability. If that were so, weight would be expected to increase similarly across groups (DHHS, 2001)

Health Insurance Status

One explanation for the difference in prevalence of overweight is relationship of SES to health insurance status. The uninsured may face barriers to receiving health care, which make medical prevention and treatment difficult. Health insurance status has been associated with prevalence of obesity in children and adolescents (Haas et al., 2003).

During childhood, health insurance was not associated with overweight. During adolescence, however, having health insurance offered a protective association. Adolescents with public insurance also were more likely to be overweight than children with private insurance. Younger children may have better access to the medical care system regardless of insurance status (private or public), because of the need for routine immunizations required for school attendance. For adolescents, having private insurance may be an important resource for facilitating access to health services, because fewer services are available for adolescents than younger children (Haas et al., 2003). Furthermore, an analysis of the 1996 Medical Expenditure Panel Survey Household Component found that, among adolescents, lacking health insurance and having public health insurance (Medicaid, Medicare, or other public health coverage) were both positively associated with the prevalence of overweight (Haas et al., 2003).

With evidence to support the health benefits of preventing childhood obesity in minority populations and the uninsured; health insurers and health plans should designate childhood obesity prevention as a priority health promotion issue. It will be particularly important for health insurers and health plans to consider incentives, as well as develop innovative strategies, that are useful to high-risk populations who often live in areas where certain types of activities are inaccessible (IOM, 2005).

2.2 ORIGINS OF CHILDHOOD OBESITY

There are critical periods of development for excessive weight gain. However, at any age, an excessive rate of weight gain relative to linear growth should be recognized, and underlying predisposing factors should be addressed (American Academy of Pediatrics, 2003).

Identifying periods of risk for adult obesity or its complications in children may help to narrow the focus of preventive efforts. Dietz & Gortmaker (2001) proposed that the pre-natal period, the period of adiposity rebound, and adolescence represented three critical periods for the development of obesity in children that persisted into adulthood. Effects of the intrauterine environment on cell numbers, satiety centers in the brain and endocrine function represent mechanisms that may logically account for the apparent prenatal channeling of either restricted or exuberant growth (Dietz, 2004).

Prenatal Period

The earliest suggestion that the prenatal period constituted a period of increased risk for the development of obesity came from follow-up studies of children of mothers exposed to the

Dutch famine (Dietz & Gortmaker, 2001). Ravelli et al. (1976) tested the hypothesis that prenatal and early postnatal nutrition determined subsequent obesity in a historical cohort study of 300,000 19-year-old men who were exposed to the Dutch famine of 1944-1945 during the last trimester of pregnancy or early infancy. These men were evaluated at the time of their military induction. Results of the study showed the effect of prenatal exposure to famine depended on its timing. Outcomes were opposite depending on the time of exposure. During the last trimester of pregnancy and the first six months of life, exposure produced significantly lower obesity rates ($p<0.005$), indicating these men were less likely to be obese than those exposed during the first half of pregnancy. The rate of obesity (body weight for height >120% according to the external standard) was higher in men exposed in the first half of gestation (2.8%), and lower in men exposed in the last trimester of gestation or the immediate postnatal period (0.8%), than in non - exposed men (1.8%).

In a more recent study, the effects of prenatal exposure to the Dutch famine on obesity in 741 men and women 50 years of age born between 1943 and 1947 in Amsterdam were observed. The findings indicate that at 50 years of age, body weight, BMI, and waist circumference were higher in participants exposed to famine in early gestation and differed between men and women. In women, body weight, BMI, and waist circumference were higher in those exposed (7.4%) than that of non-exposed women. There were no significant differences in BMI in women exposed any other time during gestation. In men, these measures were hardly affected for any of the trimesters (Ravelli et al., 1999). The authors of both studies hypothesized that the developing fetal hypothalamus may be sensitive to the nutritional deprivation experienced during famine, “programming” the organism to eat more and to produce more body fat throughout life. The mechanism by which the fetal brain defines this level of programming deserves further study.

Appropriate maternal nutrition during pregnancy may well be one way to minimize the risk of obesity for the developing child (Berkowitz & Stunkard, 2002).

These studies suggested that individuals exposed to famine *in utero* in the first trimester of pregnancy were more likely to be overweight 18-year-olds than were individuals exposed at other times during pregnancy. In addition, individuals exposed to famine late in pregnancy appeared to be less likely to be overweight at the age of 18 years. Interest in these observations was heightened by the observation that low-birth-weight infants appear to be at increased risk of the cluster of hypertension, hyperlipidemia, and glucose intolerance (syndrome X) in adulthood, and by the suggestion that these abnormalities were mediated by either catch-up or abdominal fat deposition (Dietz & Gortmaker, 2001).

However, it appears less likely that low birth weight contributes substantially to adult obesity for the following reasons. First, during the Dutch famine, the mean birth weight of infants exposed in the first trimester of pregnancy was approximately 2950g which, after adjustment for the effects of weight gain and other covariates, amounts to a difference of only 148g compared to infants exposed at other times. Second, low-birth-weight infants appear to remain small in early childhood, and continue smaller until at least 26 years of age. Additional analyses have failed to show an increase in the prevalence of low-birth-weight infants in adulthood. Third, increased birth weight, not low birth weight, appears to be consistently associated with an increased BMI in adulthood. Finally, even if low birth weight does contribute to obesity in adulthood, infants with birth weights lower than 2500g, do not account for more than a small percentage of the general population, and thus cannot account for more than a few percent of adult obesity (Dietz & Gortmaker, 2001).

Adiposity Rebound

The normal growth of a child is such that adiposity increases rapidly during the first year of life then decreases until approximately 6 years of age, when adiposity again develops (Ogden et al., 1997). The subsequent increase in BMI is known as "adiposity rebound." Three potential factors have been identified as to why adiposity rebound may contribute to later weight gain (Dietz & Gortmaker, 2001; Dietz, 2004).

First, the absence of overweight among children with early rebound does not rule out an effect of early rebound on abdominal fat deposition, either at the time of rebound or later. Second, whether body-mass index at the time of rebound is more important than at the time in which the rebound occurs remains uncertain. Third, the relative contribution of physiological and environmental factors to early rebound remains to be defined. Finally, early rebound of the body-mass index can be recognized only in retrospect. Therefore, it is unclear whether or how the rebound could be delayed, and whether such a delay would alter or reverse the effects of early rebound (Dietz & Gortmaker, 2001; Dietz, 2004).

Adolescence

Adolescence represents a third critical period when overweight may occur, and may increase the consequences of obesity in adulthood. The highest risk for childhood obesity that persists into adulthood occurs among overweight adolescents. The risk of becoming overweight during adolescence appears to be higher among girls than boys, perhaps because adolescence in girls is characterized by a relative increase in fatness. Overweight adolescent males have an increased early mortality in adulthood, and overweight adolescent males and females both have an increased adult morbidity that appears independent of the effects of adolescent weight on adult weight. Rapid maturation in both boys and girls also appears to influence the severity of obesity in adulthood. Several studies have suggested that up to 80% of overweight adolescents will become overweight adults (Dietz & Gortmaker, 2001; Dietz, 2004).

In summary, the relative contribution of each of these periods to the prevalence of adult obesity remains uncertain. The best evidence suggests that the majority of overweight adolescents will likely become overweight adults. Whether adiposity rebound represents another crucial period remains uncertain because it is not clear that adiposity accounts for the early increase in BMI (Dietz & Gortmaker, 2001). Observations during these three periods emphasize the need to identify factors that contribute to the onset and persistence of childhood overweight. The association of adult obesity and its complications with birth weight, rebound of the body-mass index, and overweight during adolescence suggests that these periods may prove critical for the prevention of early overweight and its effects on adult disease (Dietz, 2004).

2.3 PHYSICAL AND PSYCHOSOCIAL EFFECTS OF CHILDHOOD OBESITY

The recent epidemic of childhood obesity has raised concern because of the possible clinical and public health consequences. Many health professionals and clinicians now understand that childhood obesity is not a minor problem, but a problem with serious clinical effects. Medical and psychosocial are the two principal categories of health consequences in relation to childhood overweight and obesity (Reilly et al., 2003). Young people are at risk of developing serious psychosocial burdens related to being obese in a society that stigmatizes this condition, often fostering shame, self-blame, and low self-esteem that may impair academic and social functioning and carry into adulthood (IOM, 2004).

Health consequences associated with childhood obesity are wide-ranging. Obesity and overweight has been linked to multiple physical and emotional health problems in children and adolescents. Epidemiologic studies show that the increase in morbidity and mortality associated with overweight and obesity is similar in both Caucasians and ethnic and racial minorities. Many of these studies have shown that overweight in childhood is a significant predictor of obesity in adulthood (DHHS, 2001).

Overweight children are more likely to become overweight adults and overweight in adulthood is a health risk. Although childhood overweight may not always result in excess adult health risk, immediate consequences of overweight in childhood are psychosocial and include cardiovascular risk factors, such as hypertension, high cholesterol, and abnormal glucose tolerance. The causes of obesity are poorly understood, and both the prevention and treatment are difficult (Ogden et al., 2003).

Childhood weight affects adult morbidity and mortality. During adolescence, obesity has a variety of adverse psychosocial consequences among women, but not among men. These include fewer years of education, higher rates of poverty, and lower rates of marriage, and lower SES. These effects seem to be related to both the persistence of obesity and to the effects of childhood or adolescent obesity on the quantity and location of fat disposition. Furthermore, the risk factors for adult disease that are associated with obesity in children and adolescents persist into adulthood or increase in prevalence if weight gain occurs. The contribution of pediatric obesity to adult mortality indicates that treatment of overweight children and adolescents should become a high priority (Dietz, 1998a).

Medical Consequences

Historically, childhood obesity has been regarded as primarily an aesthetic problem. Now the prevalence of childhood obesity is at epidemic proportions, and the serious medical complications of this condition are increasingly recognized in children (Dietz, 2004). Overweight and obesity lead to adverse metabolic effects on blood pressure, cholesterol, and insulin resistance. The non-fatal but debilitating health problems associated with obesity include chronic respiratory, musculoskeletal and skin problems, and infertility. The more life-threatening conditions can be separated into four main groups: cardiovascular disease, conditions associated with insulin resistance diabetes, certain types of cancers, and the hormonally related and gastric complications (WHO, 2005).

Common medical consequences of morbidity associated with childhood obesity include cardiovascular risk factors, early maturation, sleep apnea, and orthopedic complications (Dietz, 1998b). The rapid prevalence of overweight children and adolescents suggests an increase in obesity-associated chronic diseases. For example, 60% of overweight 5- to 10-year-old children already have one associated cardiovascular disease risk factor such as hyperlipidemia, elevated blood pressure, or hyperinsulinemia; and more than 20% have two or more adverse cardiovascular disease risk factors. The incidence of Type 2 diabetes, until recently thought to be an almost exclusively adult-onset disease, has dramatically increased among youth (Dietz & Gortmaker, 2001).

Increased blood lipids occur among obese children and adolescents. The characteristic pattern observed consists of elevated serum low-density lipoprotein (LDL) cholesterol and triglycerides, and lowered high-density (HDL) lipoprotein levels. Central fat distribution, perhaps through its effects on insulin levels, appears to be an important mediating variable between lipid levels and obesity (Dietz, 1998b). Potential mechanisms are similar to those operative in adults. Increased free fatty acids produced by increased lipolysis by visceral adipocytes and hyperinsulinemia may promote hepatic triglycerides and LDL-cholesterol synthesis. Weight reduction clearly has a beneficial effect on these cardiovascular risk factors and may have a greater effect among girls with abdominal obesity. Higher body weights in children and adolescents are associated with increased risks of cardiovascular mortality and morbidity in adulthood (Dietz, 1998b).

Distribution of body fat, in particular excess visceral abdominal fat has been suggested as part of what has been variously called insulin resistance syndrome, syndrome X, or the deadly quartet; a cluster of metabolic abnormalities related to hypertension, hyperinsulinemia, hypertriglyceridemia, and perhaps also hypercholesterolemia, diabetes and cardiovascular disease (Ogden et al., 2003). In addition, a variety of orthopedic complications accompany childhood and adolescent obesity (Dietz, 1998b).

Psychosocial/Emotional Consequences

In addition to risk factors for disease, obesity also is associated with depression, discrimination, weight-related bias; and various other physical, psychological, and social morbidities (Katz et al., 2005). The most widespread consequences of childhood overweight and obesity are psychosocial; specifically discrimination. Obese children become the targets of systematic discrimination, stigmatization, negative stereotyping, teasing and bullying, and social marginalization (IOM, 2004).

Just as there are social and emotional consequences of stigmatization, there also are social and health consequences for obesity becoming the accepted social norm. This tension between stigmatization and normalization can be addressed, as it has been for other public health concerns, by focusing on the behaviors than can be changed to promote health rather than on the individual and his or her appearance (IOM, 2005).

Children express concern about weight at an early age. The negative image and self-concept are more prevalent in adolescents than younger children. Although several studies have clearly shown that, at a young age, children are sensitized to obesity and have begun to incorporate cultural preference for thinness. Moreover, overweight children were less likely to be selected as a friend or playmate, and are associated with a variety of negative characteristics (Dietz, 1998b).

To address the influence of childhood obesity on self-esteem, obese and non-obese children were measured on scholastic and global self-esteem. The study found that scholastic and global levels of self-esteem were not significantly different among obese and non-obese children. However, over the four-year period (children are now 13 to 14 years of age), obese Hispanic females and obese white females showed significantly decreased levels of global self-esteem compared to non-obese Hispanic females and non-obese white females, respectively. Mild decreases in self-esteem were also observed in obese boys compared with non-obese boys. As a result, by 13 to 14 years of age, significantly lower levels of self-esteem were observed in obese boys, obese Hispanic girls, and obese white girls; compared to their non-obese counterparts (Strauss, 2000).

Decreasing levels of self-esteem in obese children were associated with significantly increased rates of sadness, loneliness, and nervousness compared to non-obese children whose self-esteem increased or remained unchanged. In addition, obese children with decreasing levels of self-esteem, over the four-year follow-up period, were more likely to engage in high-risk behaviors such as smoking and drinking alcohol, compared to obese children whose self-esteem increased or remained unchanged (Strauss, 2000). As a result, self-esteem in preadolescence (9 to 10 years of age) was not related to obesity in this study. In contrast, global self-esteem by 13 to 14 years of age was related to the presence of obesity. These findings, along with other data, indicate that early adolescence is a critical time for the formation of self-worth in obese children. These findings also are consistent with those that demonstrate that approval from peers is particularly important to the development of self-esteem in adolescence. In contrast, preadolescent self-esteem is more related to family interactions and family support (Strauss, 2000).

Although much is known about childhood obesity and self-esteem, little is known about how obese children perceive their quality of life. A study by Schwimmer et al., (2003) found that obese children and adolescents had low self-esteem, and were more likely to have impaired health-related QOL (quality of life) than healthy children and adolescents. These children equated their QOL similar to children and adolescents diagnosed as having cancer.

Data from this study demonstrates a significant relationship between severe obesity and impaired health-related QOL. A majority (65.1%) of the sample had one or more co-morbid conditions. In addition, anxiety or depression was preexisting or subsequently diagnosed in 14 children and adolescents, which is somewhat higher than the national childhood prevalence. Although obese children and adolescents in this study also may experience physical limitations, they are often not exposed to the intense medical interventions (and subsequent adverse effects) that are common to pediatric cancer. Thus, similar health-related QOL of the obese sample was an unexpected and important finding (Schwimmer et al., 2003).

2.4 EPIDEMIOLOGY OF CHILDHOOD OBESITY

2.4.1 RISK FACTORS

Many behavioral risk factors; chief among them smoking, heavy drinking, and obesity, are known as chronic health conditions. Chronic health conditions, such as cancer, diabetes, or heart disease, in turn, are primary forces of health care spending, disability, and death. All three risk factors are prevalent, although only obesity has dramatically increased over the past 25 years. There is extensive literature on the association of individual risk factors with selected clinical problems (Sturm, 2002).

Overweight prevalence has increased dramatically over a relatively brief period of time. Evaluation of BMI indicates that most of the change has occurred among the heaviest portion of the population. The probability of overweight continuing into adulthood is greater with more severe overweight. Therefore, high prevalence of overweight is likely to continue, if not increase, under current conditions. Behaviors that contributed to the increase in overweight prevalence for adults may be transmitted within the family setting and affect the weight status of children (Troiano & Flegal, 1998).

Ironically, adverse conditions associated with overweight have declined in the population despite the increase in overweight prevalence. NHANES III data reports lower total serum cholesterol levels among adults and youth than previous surveys. Mean blood pressure also has declined. These observations and the dangers of interference with growth and eating disorders that may result from extensive attention to body weight and food restriction among youths send a reminder that addressing the issue of overweight prevalence and obesity among children and adolescents must be through a coordinated approach (Troiano & Flegal, 1998).

The increase in overweight prevalence reflects a population shift toward positive energy balance. Dietary intake and physical activity represent the behavioral, and therefore modifiable, aspects of this balance equation. While consumption of readily available calorie-dense foods is abundant, neither NHANES nor other national data indicate an increase in caloric intake among children and young adolescents. In addition, estimated caloric intake has increased for adults and older adolescents (16 to 19 years of age). Percentage of calories from fat has continued a downward trend that has been observed since the mid-1960s (Troiano & Flegal, 1998).

Concurrent with the availability of calorie-dense foods, the United States has moved toward a sedentary lifestyle. Physical education declined from 1984 to 1990. Changes in safety, parental work habits, television viewing, and the availability of electronic games, computers, and videos; along with other cultural aspects of the environment may have further decreased the opportunity to engage in physical activity (Troiano & Flegal, 1998).

Weight gain results when energy expenditure is consistently exceeded by energy balance over time; while energy expenditure in excess of intake produces weight loss (IOM, 2004; IOM, 2005). The only discretionary elements of energy balance are food and the energy spent on activity. Children are eating more and moving less, as opposed to eating less and moving more. The latter is necessary to achieve energy balance so that energy intake is equal to energy expenditure, while supporting normal growth and development, without promoting excessive weight gain. Therefore, both are important components in reversing the obesity trend (IOM, 2005; Dietz & Gortmaker, 2001).

Physical Activity

Physical activity is a component of energy expenditure that may be a strong predictor of childhood obesity. The health and quality-of-life benefits associated with regular moderate physical activity extend beyond the prevention of obesity (IOM, 2005).

Although children are the most active segment of the population, physical activity levels decline as children age; and boys are 15% to 25% more active than girls. Annual rates of decline in activity are 2.7% for boys and 7.4% for girls (Sallis, 1993). As children grow, they become less physically active in adolescence and adulthood. Additionally, children's patterns of physical activity differ from those of adults and older adolescents. Children often engage in intermittent activity mixed with brief periods of rest, rather than prolonged exercise (IOM, 2005).

To ensure that children achieve an adequate level of physical activity, the National Association for Sports and Physical Education (NASPE) current recommendations for children and adolescents aged 5 through 12 years are to accumulate a minimum of 60 minutes of moderate to vigorous physical activity each day. Most of it is intermittent, and should be as much as several hours per day on most days of the week. Furthermore, long periods (two hours or more) of inactivity during the day are discouraged in this age group (NASPE, 2004).

The direct surveillance of physical activity trends in U.S. adults began only in the 1980s and was limited to characterizing leisure-time physical activity. In 2001, CDC began collecting data on overall frequency and duration of time spent in various activities of both moderate and vigorous intensity through the state-based Behavioral Risk Factor Surveillance System (BRFSS) (CDC, 2003). The physical activity trend data for children and youth are even more limited than for adults. Most available information is on the physical activity levels of high school youth, with limited data available on levels in younger children. Based on the Youth Risk Behavior

Survey (YRBS), daily enrollment in physical education classes declined among high school students from 42% in 1991 to 25% in 1995 (DHHS, 1996), and increased slightly to 28.4% in 2003 (CDC, 2004a). Cross-sectional data collected through the YRBS for 15,214 high school students indicated than one-third (33.4%) of 9th to 12th graders nationwide are not engaging in recommended levels of moderate or vigorous physical activity, and an estimated 15% report that they are inactive (CDC, 2004a). In 2002, the CDC collected baseline data through the Youth Media Campaign Longitudinal Survey (YMCLS), a nationally representative survey of children aged 9 to 13 years and their parents, which revealed that 61.5% of youth in this age group do not participate in any organized physical activity during their non-school hours, and 22.6% do not engage in any free-time physical activity (CDC, 2003).

Most studies of physical activity in children and adolescents have been cross-sectional. Most found that obese subjects were less active than their lean peers, although some did not. Two prospective studies failed to find a relationship between physical activity in infancy and the development of body fat in early childhood, although two studies did. The Framingham Children's Study assessed physical activity twice yearly. When age, television viewing, energy intake, and baseline weight status (of the child and parents) were controlled, inactive preschoolers were 3.8 times more likely than active children to have greater skinfold thicknesses over time. Berkey and colleagues (2000) evaluated physical activity patterns by questionnaire in more than 10,000 children aged 9 to 14 years, and found greater increases in BMI in those who reported lower levels of physical activity and higher levels of television viewing (Stunkard & Berkowitz, 2002). Gordon-Larsen et al. (2002) examined the relationship between physical activity, inactivity patterns, and overweight using baseline and one-year change in activity and inactivity data to inform interventions to reduce overweight. Study outcomes demonstrated a significant association between moderate-to-vigorous physical activity and overweight. In addition, one-year changes in inactivity and activity showed, on average, that adolescents decreased weekly moderate to vigorous physical activity.

Physical activity and inactivity have been shown to be related to obesity, but exert influence through different behavioral pathways. Evidence suggests that physical activity is inversely associated with overweight. Inactivity, specifically television viewing, is an important risk factor for obesity development. Physical activity and inactivity track into adulthood, although inactivity shows better tracking. A substantial body of research has shown that reducing physical inactivity in children can increase physical activity and reduce obesity (Gordon-Larsen, et al., 2002).

The Surgeon General's report, Physical Activity and Health (DHHS, 1996), identified substantial benefits of regular participation in physical activity during childhood and adolescence. Regular participation helps reduce the risk of osteoporosis and musculoskeletal disorders; promotes weight management by building lean muscle and reducing fat; prevents or delays the development of high blood pressure; and could reduce blood pressure in some adolescents with hypertension. Regular participation also improves plasma lipid/lipoprotein profile, including reduction of low-density lipoproteins (LDLs) and increase of high-density lipoproteins (HDLs) in children and youth with at-risk levels, and improves social well-being and mental health. Research has shown that students who participate in physical activity are less likely to engage in risky behaviors such as smoking or using drugs, and are more likely to remain in school, exhibit appropriate behavior, and have high academic achievement.

Physical Education

Daily physical education for all students is a goal supported by several national health- and education-related organizations, including the NASPE, the American Academy of Pediatrics, and the U.S. Department of Health and Human Services (DHHS, 2000; NASPE, 2004). Although more than three-fourths of the states and school districts responding to the SHHP (School Health Polices and Program Study) survey required that PE be taught, the nature and duration of the classes varied widely in practice, and the percentages of requiring PE for all students were low. Only 8% of elementary schools and 6.4% of middle/junior high schools provided daily PE for the entire school year for all of the students in each grade. Higher percentages of schools (though generally less than one-third) provided PE three days per week or for part of the school year for all students but, for grades after elementary school, the percentages steadily decreased (CDC, 2004a).

Most United States students do not participate in daily physical education, and the proportion of students with daily physical education (PE) has been declining over time. Based on the Youth Risk Behavior Survey (YRBS), daily attendance in PE classes declined among high school students from 43% in 1991 to 25% in 1995 and increased slightly to 28.4% in 2003 (DHHS, 1996; CDC, 2004a). States and school districts have reduced the amount of time students are required to spend in physical education classes, and many of these classes have more students than teachers are able to instruct (DHHS, 2000).

There also have been concerns about the nature and duration of physical activity levels during PE classes. The 2000 SHHPS survey found that in a typical PE class (lasting an average of 45 minutes) of students at all levels, spent an average of 15.3 minutes participating in games, sports, or dance and 9.6 minutes doing drill skills (CDC, 2004b). Of the 55.7% of high school students who reported participating in PE classes in the YRBSS survey, 80.3% reported they exercised or played sports for more than 20 minutes in the average PE class (CDC, 2004a). A study by Simons-Morton and colleagues (1993) of fifth grade students during PE class found that in a typical 30-minute elementary school PE class, the average child was vigorously active for only two to three minutes (approximately 9% of the class time).

Traditionally, PE teachers have been trained to conduct classes around a motor skill instruction paradigm. There are opportunities for exploring a variety of teaching methods that both optimize physical activity and that make PE classes more fun (IOM, 2005). Leading professionals in the field of physical education have developed a new kind of physical education that is fundamentally different from the stereotypical competitive classes of past decades, such as SPARK, CATCH, and the Stanford Dance for Health interventions (DHHS, 2000). Alternative approaches for incorporating physical activity into the school day continue to be explored and include integrating brief episodes of physical activity into the classroom curriculum (IOM, 2005).

Recess is another opportunity to promote physical activity, particularly for young students. Recess generally is defined as unstructured but supervised play during the school day. The Centers for Disease Control and Prevention’s Guidelines for School and Community Programs to Promote Lifelong Physical Activity among Young People (1997) recommend that schools provide ample time for unstructured physical activity, and that this time should complement, not substitute, for PE classes (CDC, 2004b). However, elementary schools differ greatly in their in their recess policies. While only a small minority of states actually requires elementary schools to provide students with regularly scheduled recess, many more (22.4%) recommend this practice. Among elementary schools surveyed in the 2000 SHHPS, 71.4%

provided recess for all grades, and 96.9% offered regularly scheduled recess during the school day for students in at least one grade. Among these schools, students were scheduled to have recess an average of 4.9 days per week for an average of 30.4 minutes per day. Although recess is scheduled, similar to PE, it often is sacrificed for other activities (CDC, 2004b).

While providing physical education is important, assessing the quality is equally as important to ensure that children and youth are receiving proper instruction. The System for Observing Fitness Instruction Time (SOFIT) is an objective tool for assessing the quality of physical education. It is a comprehensive system that provides a measure of student activity levels, lesson context, and teacher behavior during class time. SOFIT involves the direct observation of lessons by trained observers, and has been used to assess physical education in schools throughout the United States. These include the CATCH, M-SPAN, and SPARK Projects. SOFIT enables teachers, school management, and researchers to make judgments about physical activity programs and make modifications to meet student needs (McKenzie, 2002).

How effective are school PE programs in preventing obesity and promoting physical activity? School boards are receiving mixed messages about PE. Government organizations such as the CDC recommend that all schools require daily PE for all students from kindergarten through 12th grade. However, the predominant conclusion emerging from research studies is that typical school PE is of low quality when compared to ideal PE instruction. School boards, principals, and teachers facing other competing goals, especially academic achievement, may conclude that if existing PE is of limited value, it should be abolished or at least reduced in favor of other academic instruction. However, PE in elementary schools as currently implemented plays an important role in containing excess weight gain among girls (Sturm, 2005).

Although certain research findings regarding physical education are inconclusive, in some cases, school PE constitutes the majority of physical activity most children receive. The positive most assuredly outweighs the negative (IOM, 2005).

Genetic Variation, Biological Considerations, and Impact of Family History

Obesity has long been recognized to occur in families, and having overweight or obese parents increases a child's risk of being obese. Obese children under three years of age without obese parents are at low risk for obesity in adulthood but, among older children, obesity is an increasingly important predictor of adult obesity, regardless of whether the parents are obese. Parental obesity more than doubles the risk of adult obesity among both obese and non-obese children less than 10 years of age (Whitaker et al., 1997). Genetics is a factor in excess weight but it is not the explanation for the recent epidemic of obesity. While having obese parents does more than double a child's risk of being obese, genetic characteristics of human populations have not changed in the last two decades, while the prevalence of obesity has approximately doubled (IOM, 2004).

Turning to the first two years of life, studies of the relationship between the weights of mothers and their offspring showed discrepant results. Only four studies showed a relationship; five did not. Hashimoto et al. reported a correlation of 0.275 between maternal and offspring weights during the first year of life. Three other studies found that the offspring of obese mothers were heavier than those of non-obese mothers, but only after ages that varied from six months to four years. By contrast, five studies, including a personal communication from Whitaker, found no relationship between measures of maternal and offspring weight during the first two years of life. The study by Cardon is particularly important in revealing that the resemblance between parents and offspring began at three years of age (Stunkard et al., 1998). However, the familial clustering of obese individuals does not alone predict an individual's weight characteristics, which reflect the combined effects of genetic variation within family (which may include both intrauterine and infant feeding factors), and the environmental variations external to the family (IOM, 2005).

It appears that, for reasons that are not all that clear, that the relationship between the body weights of mothers and their offspring may be weaker during the first two years of life than it is at birth. The disagreement among studies regarding this relationship during infancy suggests that the failure to find it is not unusual. If the relationship is as weak as it appears to be, it implies that genetic influences on the body weights of infants are independent of genetic influences on the body weights of adults. If these influences are in fact independent, it would complicate the search for genes for obesity; making it necessary to determine which genes exerts their influence at which periods of human development (Stunkard et al., 1998).

Classical genetics has devised ways to explain such examples of heredity and variation. Genes passed from parents to children provide a basis for genetic inheritance, and gene segregation, the process by which only half of a parent's genes are passed on to each child, provides a mechanism for maintenance of genetic variation within families and populations. Differences in living conditions such as diet and exercise provide additional variation (Price, 2002).

It is clear from a number of family studies that obesity and thinness follow family lines. Correlations among first-degree relatives (parents, offspring, siblings, and twins) generally range from .20 to .30, suggesting a moderate heritability. Correlations are slightly higher within than between generations, suggesting the possibility of nonadditive or even nongenetic inheritance (Price, 2002).

From the earliest reports, these studies have tended to support a genetic basis for obesity. In fact, twin studies have found that identical twins are more highly correlated in body composition than are fraternal twins. Across multiple studies, correlations for adult monzygotic twins generally range from .60 to .70, with values generally being higher and more variable than in younger twins. Correlations from dizygotic twins are similar to those of other first-degree relatives. Adoption studies have found that adoptees resemble their biological relatives in body composition, but not members of their adoptive families. These and other studies show that obesity is highly heritable, and that at least for adults, family environment appears to have a negligible influence. Studies of twins reared apart have confirmed this pattern. Identical twins resemble each other to a similar degree, whether they were raised together or apart (Price, 2002).

Television Viewing

American children spend more time using media than doing anything else except sleeping. The amount of time spent using media is 5½ hours, equivalent to a full-time job. Despite the interest in new media such as computers and video games, television remains by far the dominant medium (Robinson, 1999; Rideout, 2004). Children are watching 12 to 14 hours of television a week, and spending 7 hours playing video games (Strauss & Pollock, 2001). The impact of computers and video games on sedentary behavior probably is not very large, especially when compared to television, because together they comprise only about 10% of the average daily media budget of children aged 2 to 18 (Robinson & Killen, 1995; Sturm, 2005). However, time spent watching television is associated with decreased physical activity and increased overweight status (Robinson, 1999). Nonetheless, there are though, large differences by age, sex, and ethnicity (Robinson & Killen, 1995).

There is widespread speculation that television viewing is one of the most easily modifiable causes of obesity among children. Two primary mechanisms by which television viewing contributes to obesity have been suggested: reduced energy expenditure from displacement of physical activity, and increased dietary energy intake; either during viewing or as a result of food advertising (Robinson, 1999; Rideout, 2004).

Television viewing may have a negative effect on both sides of the energy balance equation. It may displace active play and physical activity time, and it is associated with increased food and calorie intake, as an accompaniment to television viewing, as a result of food advertising or both. Many epidemiological studies have found positive associations between increased prevalence of obesity or overweight, and greater lengths of television viewing time, although comparing the results is difficult due to methods of reporting (IOM, 2005).

In a 1996 study, Gortmaker et al. found a strong positive association between parent reports of children's television watching time and prevalence of obesity. This study of 746 children and youths (ages 10-15 years) concluded that the odds of being overweight were 4.6 times greater for youth watching more than 5 hours of television, compared to those watching for 0-1 hours even when controlling for prior overweight, maternal overweight, SES, and other factors.

However, some cross-sectional and prospective study outcomes are inconsistent; concluding either no or weak associations between television viewing and childhood obesity. Studies by Robinson (1999; 2001) of the nature and extent of associations between increased television viewing and decreased physical activity have produced inconsistent findings, possibly due, in part, to the known limitations of self-reporting on how children spend their time. A review by Sallis and colleagues conducted in 2002, noted that studies of children ages 4 to 12 had mixed results regarding the associations of sedentary behaviors (specifically, watching television and playing video games) with the extent of physical activity; while in teenagers ages 13 to 18, there appeared to be no association (IOM, 2005). In a study of sixth- and seventh-grade girls, more hours of television watching was significantly, but weakly associated with less physical activity. Additionally, one treatment study of thirteen eight - to 12-year-old, non-obese children did not find significant changes in short-term physical activity or energy expenditure when sedentary behavior (including television viewing) was decreased by 50% from baseline (IOM, 2005).

The Kaiser Foundation report, "The Role of Media in Childhood Obesity" (Rideout, 2004) detailed children's use of media and its influence on childhood obesity. In the report, the Foundation reviewed major research that has been conducted over the past twenty years in the U.S. on media (video games and television viewing) and childhood obesity; compiling for the first time research from fields such as public health, marketing media studies, and child development; and evaluating findings from the research.

The report reached three conclusions of which two were significant. The first was that children who spend more time with media are significantly more likely to be overweight than other children; even when controlling for other factors such as SES, parental obesity, or the child's own prior weight. The second conclusion reached from a review of the literature was that, contrary to popular assumptions, research does not currently support the hypothesis that media contributes to childhood obesity by displacing physical activity. What the research suggests is the possibility of children's exposure to food advertising is behind the link between media use and obesity. The final conclusion was there is evidence that the media can play a positive role in helping to address childhood obesity. Research indicates that public service programs can be effective if they are well-crafted and get enough airtime to reach the intended audience. Campaigns to help motivate children to become active and to teach them about healthy eating can be a part of the solution to the obesity crisis (Rideout, 2004).

Experimental studies have demonstrated that even a brief exposure to food commercials can influence children's preferences. In one study, researchers designed a randomized, controlled trial in which one group of 2- to 6-year-olds from a Head Start program saw a popular children's cartoon embedded with commercials. The other group saw the same cartoon without commercials. Asked to identify their preference from pairs of similar products, children who saw the commercials were significantly more likely to choose the advertised products. Another study found that among children as young as age 3, the amount of weekly television viewing was significantly related to their caloric intake as well as their requests and parent purchases of specific foods they saw advertised on television. Children who watch more television have been found to drink more sodas, eat more fast food, and eat fewer fruits and vegetables than other children (Rideout, 2004).

Although the specific mechanism(s) of how reducing television viewing influences weight gain is as yet undetermined, these demonstrated effects on reduced weight gain and obesity provide sufficient rationale to reduce children's screen time. The American Academy of Pediatrics have recommended that televisions not be placed in children's bedrooms, and it urges that parents limit children's television viewing time to no more than one to two hours of quality programming per day. It also recommends that television viewing among children younger than 2 years be discouraged altogether (IOM, 2005).

School Foods

The school food environment can have a significant impact on adolescent's food choices because 35% to 40% of youths' total daily energy is consumed at school (French et al., 2003). It is the change in the physical environment of schools that has prompted questions regarding whether the present day school environment supports and promotes the development of healthy eating as normative childhood behavior. Ironically, the change in school nutrition has occurred during a time when deliberate national efforts have been expended to improve the nutritional health of the population: particularly regarding the consumption of fruits, vegetables and dietary fat. Unhealthy dietary patterns, especially diets low in fruits and vegetables, and high in fats, have been cited as the most frequently occurring chronic disease risk behavior among youth ages 12 to 17 years (Kubik et al., 2003).

Since a large portion of a child's day is spent in school, providing children with healthy food options throughout the school day can be an important step toward good child nutrition. One option is the federally regulated National School Lunch and School Breakfast Programs. Through these programs, students may purchase single food items from snack bars, a la carte programs, vending machines, and school stores. Findings from the School Nutrition Dietary Assessment indicated more than 90% of schools offered a la carte at lunchtime; 76% of high schools, 55% of middle schools, and 15% of elementary schools had vending machines available for student use; and 41% of high schools, 35% of middle schools, and 9% of elementary schools had school stores, snack bars, or canteens that sold food or drinks. Overall, few of the foods offered to students via these venues are lower-fat items, fruit is rarely available, and fruit juice is a less prevalent offering than carbonated or sweetened beverages (Kubik et al., 2003; GAO, 2004).

There is limited research on the association between competitive foods in schools and child nutrition. However, preliminary small-scale research examined these issues and has shown evidence of an association between competitive foods and child nutrition. Research suggests the presence of competitive foods in schools is related to a decrease in fruit and vegetable consumption and an increase in calories obtained from fat. Research also suggests competitive foods are associated with a decreased consumption of healthy foods (GAO, 2004).

One such study examined the association between young adolescents' dietary behaviors and school vending machines, a la carte programs, and fried potatoes being served at school lunch. Kubik et al. (2003) studied the influence of certain school-level factors such as vending machines and a la carte programs on the eating behaviors of a sample of middle-school students. The researchers found that a la carte availability was inversely associated with fruit and fruit/vegetable consumption, and positively associated with total and saturated fat intake. Snack vending machines were negatively correlated with fruit consumption. The results suggest that the primarily high-fat snacks and calorie-dense beverages offered and sold to students via a la carte programs are displacing fruits and vegetables in the diets of young teens, and contributing to total and saturated fat intakes that exceed recommended levels. When given the choice, students will select higher-fat choices, although lower-fat choices such as fruits and vegetables may be available.

French et al. (2003) examined the food environment in 20 Minnesota secondary schools participating in the TACOS (Trying Alternative Cafeteria Options in Schools) nutrition intervention trial. The purpose of TACOS was to increase student purchases of lower-fat a la carte foods by increasing the availability of lower-fat food in a la carte areas and vending machine areas. As in the previous study, fruits and vegetables are being displaced by high-fat, competitive foods. Of the total foods available in a la carte areas, 51.1% were high-fat foods such as cookies, candy, ice cream, and pastry. Low-fat foods such as fruits and vegetables were 4.5% and salads just 0.2%. Approximately 36% of foods in the a la carte areas and 35% in vending machines met the lower-fat criterion (< 5.5 grams/serving). The chips/crackers category constituted the largest share of a la carte foods (11.5%), and contributed little in terms of other important nutrients. The median number of vending machines per school was 12. Soft drink vending machines were prevalent and turned on for the majority of the school day.

Therefore, if most of the foods available are high in fat, students may consume excess fat and energy, thus increasing their risk for excess weight gain. High availability of these foods also conveys the message that these foods are acceptable. In addition, recent studies have linked soft drink consumption to excess energy intake and weight gain among adolescents. As a result, soft drink consumption may be contributing to the upward secular trend in adolescent obesity. Given the epidemic of childhood and adolescent obesity, and the linkages between nutrition and chronic disease, school policy related to food and nutrition clearly needs increased attention (French et al., 2003).

Dietary Intake

Diet is a major contributor to the nutritional status and health of the population; and assessing trends in dietary intake is essential to understanding the role of diet in the public’s health. The relationships between diet and health usually are multifactorial: demonstrating direct or consistent relationships between dietary intake and health conditions is difficult (Briefel & Johnson, 2004). Changes in eating patterns including dietary intake, school foods, beverage consumption, and portion sizes might explain the marked increase in childhood obesity. Because foods generally are not eaten in isolation, the overall pattern of consumption may have a greater cumulative impact on obesity than any single food or nutrient (Nicklas et al., 2001a).

Since 1973, the macronutrient composition of children's diets has changed favorably. The percentage of energy from protein and carbohydrates has increased, and the percentage of energy from fat has decreased from 38% to 33%; and the percentage of energy from saturated and monounsaturated fatty acids has decreased, while that from polyunsaturated fatty acid has increased. The total energy intake of children has remained the same, while energy per kilogram of body weight has decreased. Despite the decline since 1973 in percent energy from fat, close to 75% of children exceeded the current fat and saturated fat recommendations, and overall dietary quality did not improve (Nicklas et al., 2001a).

The food choices of most U.S. children and adolescents do not meet the intakes of food groups outlined in the Dietary Guidelines for Americans. The percentage of 2-19 year olds who did not meet the recommendations ranged from approximately 70% for fruits, grains, meats, and dairy products to approximately 64% for vegetables. Only 1% of children met all of the food group recommendation, only 5% met the recommendations for four or more food groups, and 16% met none of them. Only 44% of school children consumed servings from all four food groups at least two times daily (Nicklas et al., 2001a). The overall diets of Americans age 2 and older, as measured by the Healthy Eating Index (HEI), improved slightly between the 1989 Continuing Survey of Food Intakes by Individuals (CSFII) (mean 61.4) and the 1994-1996 CSFII (mean of 63.6), but did not improve further in the NHANES 1999-2000 (mean of 63.8). HEI scores from NHANES 1999-2000 indicate that 10% of Americans have good diets. Children age 2-3 had the highest mean HEI score (75.7) (Briefel & Johnson, 2004). A low HEI score suggests a poor diet, and it also is associated with overweight and obesity. Thus, the use of the HEI and the Dietary Guidelines for Americans as a way to improve health should be emphasized. However, the overall effectiveness of the Dietary Guidelines for Americans in disease prevention requires further research (IOM, 2005).

Dietary fat intake also has been identified as an influencing factor because of its direct implication as a causal agent for the development of obesity. Dietary fat intake also may displace more micronutrient-dense, fibrous, carbohydrate-containing foods in the diet. In the diets of adults and children in the United States, intakes of fat and carbohydrates are negative correlated (Birch & Fisher, 1998).

According to the United States Department of Agriculture (USDA), approximately 68% to 75% of United States children exceed the current dietary recommendations for intake of total or saturated fats. Between the periods of 1989 to 1991 and 1994 to 1995, the increase in carbohydrate intake among 2- to 17-year-old children and teenagers came primarily from increased intakes of grain mixtures (pizza, pasta, Mexican dishes, and other dough-based dishes) and beverages (particularly soft drinks). Other positive shifts in food consumption include a decrease in eggs, an increase in poultry, and a substitution of margarine for butter. Despite positive shifts, these findings support those of the Bogalusa and other studies: children are consuming far more than the recommended dietary allowances for total and saturated fats, leading to increased adiposity (ADA, 2004).

To reduce risk of coronary heart disease, health organizations recommend that children older than the age of two years consume no more than 30% of kcal from total fat, less than 10% of kcal from saturated at, and less than 300mg of dietary cholesterol. Recent surveys indicate that dietary fat intake in children has been decreasing gradually throughout the past two decades, from 36.3% to 34.0% of energy in children 6 to 11 years of age. This trend toward lower-fat diets is viewed favorably, and should be promoted nationally. Some concerns, however, have been raised as to the safety of reduced-fat diets in growing children. Case studies of poor growth and warnings of nutritional inadequacy, particularly for iron and calcium, from reduced-fat diets have been reported. Cross-sectional analysis indicating significantly lower intakes of essential vitamins in children consuming lower-fat diets have been cited as a cause for concern. In contrast, higher fat intakes have been associated with obesity and greater weight gain in children, and overweight in children has been increasing in prevalence (Obarzanek et al., 1997). Outcomes from studies such as the Dietary Intervention Study in Children (DISC) actually have demonstrated that lower-fat diets are safe and effective in reducing weight gain in children and adolescents (Van Horn et al., 1993; Van Horn et al., 2003).

Few studies have examined caloric consumption and macronutrient intake during childhood as predictors of obesity in adolescence and adulthood. In a thorough review, Parson and colleagues reported that most studies found that neither caloric intake nor macronutrient intake (including fat consumption) was associated with the development of greater adiposity later in childhood or adulthood. Findings from the Bogalusa Heart Study reported an increase in the prevalence of obesity over time, but also found no relationship between caloric consumption and adiposity. Moreover, no increase in caloric intake was reported (Berkowitz & Stunkard, 2002). The following factors contribute to trends in dietary intake:

Portion Sizes

Research has revealed a progressive increase in portion sizes of many types of foods and beverages made available to Americans from 1977 to 1998; the same period during which a rise in obesity prevalence has been observed (IOM, 2005).

Some research on the effects of food portion size has shown that children 3 years old and younger seem to be relatively unresponsive to the size of the portions of food they are served. By contrast, the food of older children and adults is strongly influenced by portion size, with larger portions often promoting excess energy intake. Children ages 3 to 5 years of age consumed more of an entrée and 15% more total energy at lunch when presented with portion sizes that were double an age-appropriate, standard size. Portions currently served and consumed away from home may be several times the USDA-recommended serving size or recommended caloric level. Moreover, the food industry should investigate other approaches for promoting the consumption of smaller portion sizes and standard serving sizes (IOM, 2005).

Fast Food Consumption

Fast food consumption may be one such factor raising public health concerns because of its contribution to the childhood obesity epidemic. Fast food is becoming a staple in the diet of many children (Bowman et al., 2004). Americans now consume more meals outside of the home; and these meals tend to be more calorically dense and higher in fat (IOM, 2005). Children consumed one-quarter of their meals away from home. Older children consumed a higher proportion of meals prepared away from home, increasing from 18% for preschoolers to 26% for school-age children, and 27% to 35% for adolescents. Fast-food restaurants accounted for more than half of away-from-home meals (Nicklas et al., 2001a). Several dietary factors inherent in fast food may cause excessive weight gain such as massive portion size, high energy density, palatability (appealing to taste preferences for fats, sugar, and salt), high content of saturated and trans fat, high glycemic load, and low content of fiber (Bowman et al., 2004).

Several researchers examined trends in food consumption with cross-sectional surveys conducted in the 1970s, 1980s, and the 1990s. These surveys showed that, in adolescents 12-18 years old, there was a decrease in the energy intake from foods consumed at home; while the proportion of energy intake from restaurant food and fast food increased over time. In these adolescents, 74.1% of total daily energy was provided by foods consumed away from home in the 1977-1978 Nationwide Food Consumption Survey, but this proportion decreased to 68.3% and 60.5%, respectively, in the 1989-1991 and 1994-1996 CSFII. The most dramatic increase in the proportion of foods consumed from restaurants and fast food outlets, from 6.5% to 16.6%, occurred in 1997-1998 and 1998-1991. In the latest CFSII (1994-1996), this proportion had risen yet further, to 19.3% (St-Onge et al., 2003).

In a study that examined the effects of fast food consumption among children, Bowman, et al. (2004) found that on a typical day, 30.5% of the study sample reported consuming fast food. Children who consumed fast food more frequently had higher total energy intake, ate fewer fruits and vegetables, consumed sweetened beverages, and had compromised diet quality than those who did not consume fast foods. These study results are largely consistent with those of previous studies: the association between fast food and diet seem to be causally related.

Contrary to the findings of Bowman et al., other cross-sectional studies found no association between fast-food restaurant use and BMI in children (Nicklas et al., 2001b; St-Onge et al., 2003). However, few studies have examined the lasting effects of fast food consumption in children (Bowman et al., 2004). No longitudinal study of the effect of a change in fast-food restaurant use on body weights in children has been reported. Such studies would be complicated by growth in children, who require a greater energy imbalance to present with signs of overweight (St-Onge et al., 2003).

Given the growing public concern about the rise in obesity, particularly childhood obesity, full-service and fast-food restaurants have joined the effort to prevent childhood obesity by offering healthier alternatives to their menus, thereby providing more healthy options other than the standard fast-food meal (IOM, 2005).

<u>Beverage Consumption</u>

Beverages such as flavored drinks, fruit juice (not 100% fruit juice), and soft drinks and the potential role in obesity are one issue that has been raised in childhood obesity. These beverages do not provide nutrients that are needed by growing children, but do increase caloric intake. Nevertheless, soft drink consumption more than tripled among adolescent boys between 1977-1978 and 1994, rising from 7 to 22 ounces per day. By the time they are 14 years of age, 32% of adolescent girls and 52% of adolescent boys are consuming three or more eight-ounce servings of soft drinks daily. There are concerns about the effect of increased soft drink consumption on reducing macronutrient intakes and increasing energy intake (IOM, 2005), and on displacing the intake of more nutrient-rich options such as milk (ADA, 2004).

Several studies have examined the relationship between consumption of sweetened beverages and obesity. A cross-sectional study by Dennison et al. (1997), found that consumption of 12 fl-oz/day of fruit juice by young children aged 2 to 5 years was associated with short stature (height less than 20th sex-specific percentile for age) and obesity. Children who consumed > 12 fl oz/day of fruit juice were more likely (32% vs. 9%) to be obese (75th age-for-sex percentile vs. 90th age-for-sex percentiles compared with those drinking less juice. Welsh et al. (2005) examined the association between sweet drink consumption and overweight among preschool children. The association between sweet drink and development of overweight was positive, but not statistically significant (among normal/underweight children or children at risk of overweight). At the same time, the positive association between fruit juice consumption and persistence of overweight that was observed may explain the association that was found by the analysis by Dennison et al. (1997) because it is not possible to differentiate between incidence and persistence of overweight in a cross-sectional study. Longitudinal studies are needed to establish causality. A study by Bray et al. (2004) also concluded that consumption of beverages, such as fruit juices and soft drinks containing high-fructose corn syrup contributed to obesity, however intake of high-fructose corn syrup and its use in foods and beverages in this study was questionable due to conservative estimates.

Findings from these studies show that consumption of sweetened beverages may increase the probability of becoming overweight for those who are at risk for or those who already are overweight. The link between beverage consumption, obesity, and BMI is not definitive (IOM, 2005). Although no epidemiologic study has found a positive association between fast food or soft drink consumption and body weight, a recent report by the Food and Agriculture Organization and the World Health Organization recognizes that a high intake of sugar-sweetened beverages may promote weight gain. Thus, the increase in the consumption of such drinks is of serious concern (St-Onge et al., 2003). Much remains to be learned about whether a unique association exists between the intake of sweetened beverages and changes in BMI. Because of concerns about excessive consumption of sweetened options and the displacement of more nutrient-rich or lower calorie alternatives, children should be encouraged to avoid high-calorie, nutrient-poor beverages (IOM, 2005).

Meal Patterns and Meal Frequency

Ninety-eight percent of students reported at least three daily eating occasions, and more than 50% reported five or more. A large percentage of students from all age groups consumed breakfast, lunch, and dinner. Two-thirds of students consumed an afternoon snack, and only 15% consumed a morning snack. The incidence of various types of eating occasions differed somewhat by age and gender. Younger students were more likely to consume breakfast, lunch, and afternoon snack (Nicklas et al, .2001a).

Eating a nutritious breakfast may help to control body weight due to a reduced dietary fat intake and minimized impulsive snacking. Unfortunately, breakfast consumption has declined significantly between 1965 and 1991 for children and adolescents. Adolescents with a consistent meal pattern (i.e., three meals a day) were leaner than those with an inconsistent meal pattern. This observation is in agreement with studies showing a link between obesity and skipping meals. An inconsistent meal pattern may mean skipping meals to reduce calories (Nicklas et al., 2001a).

Consumption of Low Nutrient, Low Energy Foods

Using NHANES III data, Kant studied the intake of low-nutrient-dense foods by children age 8-18 and found that items such as soft drinks, candy, table sweeteners, baked and dairy desserts, salty snacks, and discretionary fats accounted for more than 30% of daily calories. More frequent consumption of these low-nutrient-dense foods was associated with higher energy intake and with lower intake of nutrient-dense foods, vitamins A and B6, folic acid, calcium, magnesium, iron and zinc. However, consumption of low-nutrient-dense foods was not a significant predictor of body mass index (Briefel & Johnson, 2004).

Snack food consumption showed trends similar to those of fast food consumption in children and adolescents. When trends in snacking behaviors were examined, findings showed the number of snacking occasions, defined as foods consumed within a 15-minute period distinct from the meal, increased by 24% to 34% in all age categories. With an increase in the consumption of salty snacks, candy, and soft drinks from 1977 to 1996, the prevalence of snacking has increased in the past three decades (St-Onge et al., 2003).

A study by Jahns et al. (2001) to determine snacking trends and changes in nutrient contribution in a sample of 2 to 18-year-olds found that there was no difference across groups. The prevalence of snacking increased in all age groups. The average size of snacks and energy per snack remained relatively constant; however, the number of snacking occasions increased significantly, therefore increasing the average daily energy from snacks. Compared with non-snack-eating occasions, the nutrient contribution of snacks decreased in calcium density and increased in energy density and proportion of energy from fat. The findings concluded that snacking is extremely prevalent in our society. Healthy snack food choices should be emphasized over high-energy density convenience snacks for children and adolescents.

In conclusion, due to the conflicting results reported from various research studies, the goal of dietary interventions should be to decrease the prevalence of childhood overweight and obesity by assisting children and adolescents in developing healthy eating behaviors and providing opportunities for age-appropriate physical activity. The combination of diet and exercise will yield measurable and sustainable outcomes. Each of the risk factors discussed can and do impact quality of life. Certain risk factors can be addressed through behavior and lifestyle changes, such as regulating dietary intake and increasing physical activity; while others such as genetics and those to which children are predisposed typically cannot. Countless published research studies have concluded there is a negative influence of these risk factors relative to childhood overweight and obesity. The concern is that many of these studies provide inconclusive results. The best way to prevent childhood overweight and obesity is to reduce the opportunity and environment for their development.

2.5 DIETARY APPROACHES

For the purpose of this study, clinical child studies and school-based approaches will be reviewed with relevance to pubic health, effectiveness in decreasing risk factors associated with childhood overweight and obesity and the ability to sustain long-term outcomes. Three selected child studies: the Bogalusa Heart Study, The Dietary Intervention Study in Children (DISC), and the Traffic Light Diet/Stoplight Eating Plan will be reviewed relative to their effectiveness in addressing dietary intake and risk factors that influence childhood overweight and obesity. Two of these approaches were multiyear, multi-center, clinical trials that surveyed nutrition trends beginning in childhood through adolescence (Bogalusa and DISC). The third approach, Traffic Light Diet/Stoplight Eating Plan, is an eating plan designed to help obtain the greatest nutritional value from healthy food choices and the development of healthy eating behaviors.

2.5.1 BOGALUSA HEART STUDY

Lifestyle attributes such as tobacco use, physical inactivity, and a high-fat, high calorie diet begin in childhood, and are established risk factors for cardiovascular diseases. While clinical cardiovascular disease occurs later in life, the characteristics of atherosclerosis, hypertension, and diabetes can be present in childhood. The Bogalusa Heart Study began in 1973 as a long-term epidemiologic study of the early natural history of cardiovascular disease in a semi-rural parish of Bogalusa, Louisiana. For nearly 30 years, the investigators identified and followed a biracial (black and white) cohort of 10-year-old children attending the fifth grade, and have described the incidence and prevalence of biologic and behavioral cardiovascular disease (CVD) risk factors in these children (NHLBI, 2004).

Upon completion of the study in 2002, this population enabled investigators to not only document differences between males and females, but also between blacks and whites. Results from the Bogalusa Heart Study and sub-studies conducted over the years have clearly documented that the genesis of atherosclerosis is a long-term process that has its basis in childhood, and that prevention can and must begin at the early ages. Autopsy studies have revealed coronary fatty streaks in obese children, and other studies have shown that blood cholesterol levels show a fairly high correlation as children age into young adults. These findings emphasize the importance of prevention and treatment of obesity in adolescents (NHLBI, 2004).

Results of the Bogalusa Heart Study demonstrate that even among 7 to 8-year-olds, overweight is consistently related to several CVD risk factors. Furthermore, as adults with multiple risk factors will likely be at high risk for CVD later in life, it is of particular interest that a large proportion of these individuals be identified in early life through weight and height measurements (Freedman et al., 1999). Measures of adiposity in the study were fat free body mass and BMI estimated from measured weight, height and, tricep skinfold (NHLBI, 2004).

Though diets of children have changed favorably over the past years, more than 75% of the Bogalusa children exceeded the current dietary recommendations for total fat and saturated fat, and adiposity dramatically increased. Because overweight is associated with various risk factors even among young children, it is possible that the successful prevention and treatment of obesity in childhood could reduce the adult incidence of cardiovascular disease (Freedman et al., 1999; Nicklas et al., 2001b).

In summary, findings from the Bogalusa Heart Study and sub-studies are relevant to what currently is known about childhood overweight and obesity. It is critical to begin obesity prevention early in life by reducing risk factors responsible for adverse consequences. Improving dietary habits, decreasing sedentary behavior, and increasing physical activity are effective in reducing risk factors for cardiovascular disease in children and adolescents. Like many other child studies, the Bogalusa Heart Study provides significant opportunities to address childhood obesity and associated risk factors and to develop appropriate interventions for prevention.

2.5.2 THE DIETARY INTERVENTION STUDY IN CHILDREN (DISC)

Prevention of cardiovascular disease through diet and lifestyle is strongly advocated in adults, and preferably is initiated in childhood. Elevated low-density lipoprotein cholesterol levels in children are likely to track over time and become high-risk levels in adults. The Dietary Intervention Study in Children (DISC) was initiated in 1987 as the first multi-center, collaborative, randomized clinical trial designed to test the feasibility and long-term efficacy, safety, and acceptability of a dietary intervention of a fat-moderate diet in 663 8 to 10-year-old prepubescent children (362 boys and 301 girls) with moderately elevated plasma low-density lipoprotein cholesterol (LDL-C) levels. The upper limit of LDL was chosen to select the children for whom the dietary intervention, rather than medications can be recommended. (Van Horn et al., 1993; Obarzanek et al., 1997; Obarzanek et al., 2001; Van Horn et al., 2003)

The focus of the DISC intervention was on lowering total fat, saturated fat, and cholesterol to reduce LDL-C. Through part of the intervention, polyunsaturated fat changed very little and did not contribute to LDL-C lowering. Other dietary and lifestyle factors that were not a part of the DISC intervention, but that promote a favorable lipid profile including maintaining a healthy body weight, increasing physical activity, and lowering trans-fatty acids. Because physical activity has been related to body fatness, and also may be related to dietary fat intake, physical activity levels were analyzed as an adjustment factor for the relationship between energy intake from fat and body fatness (Obarzanek et al., 1997; Obarzanek et al., 2001).

The DISC study was unique in several, different ways. It was the largest dietary intervention study ever conducted among free-living children with elevated LDL-C levels. Of great importance was the finding that an educational and behavioral dietary intervention in children can result in lower consumption of total fat, saturated fat and cholesterol over three years; and maintenance of lower levels of total and saturated fat, for an additional four years. Similar results for total and saturated fat were observed in a school-based study of third grade children followed for five years. These long-term studies show the potential for effecting long-term dietary change which, if carried into adulthood, could substantially reduce coronary heart disease (Van Horn et al., 1993; Van Horn et al., 2003).

The DISC study reported several findings that have implications for clinical practice. These include children's ability to make dietary changes with parental support and guidance, increased public awareness, utilizing reinforcements to maintain adherence while avoiding recidivism, and use of different techniques to assist with goal-setting. Moreover, while the DISC results indicated that children who require dietary modifications to lower their LDL-C may safely do so, an important public health implication is that current dietary recommendations for healthy children that are less restrictive in saturated fat and dietary cholesterol than the DISC dietary goals, and are appropriate and safe (Van Horn et al., 2003).

Results show that dietary modification can be achieved and safely sustained in pubertal children, with no adverse effects observed up to 7.4 years later. A combination of individual counseling from pediatricians and other primary health care providers, along with community-based programs and public health campaigns, may work together to promote cardiovascular health in children (Obarzanek et al., 2001). It also is important to emphasize that the diet is appropriate for the entire family, but provides even greater long-term benefits for children and adolescents than for adults. Thus, a comprehensive, environmental approach can help to maximize adherence and reduce exposure to the less-desirable dietary behaviors (Van Horn et al., 2003).

Recently, Van Horn et al. (2005) conducted an additional DISC study to determine whether there were differences in patterns of healthy eating in the intervention and usual care groups. The ancillary study involving >4200 dietary recalls collected over three years constitutes one of the largest longitudinal food and nutrient databases in existence among preadolescent children, allowing unique exploration of food groups and food patterns associated with adherence to a fat-reduced diet in this age. The study was conducted to develop a detailed food grouping system and report new analyses on dietary adherence to the recommended eating pattern. The study reported new data regarding changes in eating patterns among the DISC cohort of 663 preadolescent children (362 boys and 301 girls). The objective of the study was to compare children's self-selected eating patterns and approaches to achieving to the DISC fat-reduced diet intervention with children in the usual care group. The DISC intervention group reported increased "go" fats/oils and decreased "whoa" dairy, increased "go" fats/oils and decreased “whoa” fats/oils, and decreased “whoa” vegetables (French fries); but no change in fruit intake compared with the usual care group. Thus, DISC intervention seems to have improved the diet quality as well as quantity in this age group.

2.5.3 STOPLIGHT EATING PLAN (TRAFFIC LIGHT DIET)

A third dietary approach, The Stoplight Eating Plan or Traffic Light Diet is a structured eating plan (900 to 1300 kcal) used to guide participants’ eating patterns to meet age recommendations of the basic four food groups, and now the food pyramid, thereby increasing the nutrient density of the diet. The Traffic Light Diet makes it easy to obtain the most nutrients for the fewest calories, and to help families initiate healthy behaviors. This diet is used for preschool and preadolescent children. In this diet, foods are coded according to colors of the traffic light, and are categorized as red (STOP), yellow (CAUTION), or green (GO) on the basis of their calorie and nutrient content. Foods are divided into five food groups (fruits and vegetables, grains, milk and dairy, high protein, and other). Green foods (primarily vegetables) are those that are less than 20 kilocalories per average serving, and can be eaten as much as desired. Yellow foods (e.g., skim milk, apple) are those within 20 calories of the average value for foods within their food group, and include the dietary staples needed for a balanced diet. Red foods (e.g., potato chips, candy) are those at least 20 calories greater than the average food within their food group, and are higher in calories with low nutrient density (Epstein et al., 1985).

The diet has been used effectively with treatment procedures designed to lower caloric intake, increase physical activity, and decrease sedentary behaviors, or both. Interventions included clinical randomized, family-based studies designed to reduce sedentary behavior in obese adolescents and their families. The diet, when combined with physical activity and exercise, was used to decrease energy intake, promote a balanced diet, and maintain weight change (Epstein et al., 1985; Epstein et al., 1995).

Most interventions using the Traffic-Light Diet as a part of a comprehensive treatment have produced a significant decrease in obesity in preadolescent children. The Traffic Light Diet is associated with an improvement in nutrient density for certain minerals and vitamins, and a decrease in nutrient density for fat in preadolescents. Significant changes in eating patterns have been reported when comprehensive obesity treatment has been combined with the Traffic Light Diet. Reductions in “red foods” have been observed after treatment, with significant associations between changes in intake of “red food” and weight loss or decrease in the percent of overweight. Obese elementary school-age children who were treated with the Traffic Light Diet showed a decrease in palatability for high fat/high sugar foods, and a greater increase in palatability for low fat/low sugar foods than did comparable lean children who were not treated. In addition to short-term effects, long-term obesity changes extending from 5 to 10 years after initiation of treatment have been observed with the Traffic Light Diet in combination with behavioral, exercise, and familial components (Epstein et al., 1998).

Limitations of Dietary Approaches

Although the Bogalusa Heart Study, Dietary Intervention Study for Children (DISC), and the Stoplight Diet have been demonstrated to be effective in reducing or preventing childhood obesity in certain populations, these dietary approaches have advantages and disadvantages.

One of the greatest advantages of the three approaches is that lower-fat diets have been shown to be safe and effective for use in children and adolescents (Van Horn et al., 2003). These interventions show replicability and generalizability, as well as evidence of universal application.

Studies using these population-based interventions have directly impacted changes to dietary intake and physical activity habits. All have demonstrated the importance of initiating healthy eating behaviors early in life to prevent childhood overweight and obesity, and associated health complications such as Type 2 diabetes, heart disease, and elevated cholesterol. As researchers have shown, overweight is associated with various risk factors among young children which track into adulthood. It is evident that successful prevention and treatment of obesity in children and adolescents could reduce the adult incidence of cardiovascular disease.

The most obvious disadvantage of these studies is the difficulty of long-term follow-up in study participants. For example, studies such as the Bogalusa Heart Study and the DISC Study were designed to follow a sample of children for 20 years and 7.4 years, respectively. Thus, the Bogalusa sample had the greatest likelihood with regard to maintaining lifestyle changes at follow-up than participants in the DISC Study and the Stoplight/Traffic Light Diet (NHLBI, 2004; Epstein et al., 1995).

Moreover, at 2-year follow-up, participants in one of the three treatment groups in a study using the Stoplight/Traffic Light Diet intervention had gained 10 pounds, while the subjects in the other two groups had gained more than twice that amount. However, in a more recent study using the Stoplight/Traffic Light Diet, participants showed longer-term obesity changes several years after participation than those who were followed over a shorter time period (Epstein, 1998). Therefore, an extended time frame for follow-up could be necessary to effect long-lasting behavior changes.

The concern with follow-up is that it usually ends at some point in time. Researchers study new concepts and techniques, leaving old ones behind. Children mature and continue their lives. It is unknown whether these participants will continue to practice behaviors learned after the conclusion of the study at the same level of intensity. Failure to show an effect of the intervention may result from inadequate adherence (Epstein et al., 1985). As a result, it is difficult to prove or state with certainty what the long term effects of these dietary approaches are.

Because of the causal relationship of childhood obesity to issues such as quality of life, socioeconomic status, and health disparities, it is essential that any intervention designed to reduce the incidence of childhood obesity must be evidence-based and coordinated through a public health approach. Moreover, these interventions are unlikely to succeed if changes do not occur within other systems associated with children and adolescents (IOM, 2005).

The focus of the randomized DISC Study was similar to the Bogalusa Heart Study: the prevention of cardiovascular disease through diet and lifestyle. A unique feature of the Bogalusa Heart Study was documentation by researchers of the relationship of cardiovascular risk factors to anatomic and pathologic changes. In the DISC Study, prevention came in the form of reducing elevated low-density lipoprotein cholesterol (LDL-C) levels through a low-fat diet. As with the Bogalusa Study, after years of follow-up, children participating in the intervention showed no significant differences in dietary intake over the control group.

The Stoplight Diet takes a different approach to that of the others in that it uses a combination of diet and an exercise program to influence weight loss in obese children. In addition, the Stoplight Diet and the DISC Study also included intensive family participation. Long-term results showed children in both the study and control groups gained a significant amount of weight. Weight gain seemed to be common among participants in all three interventions. Moreover, compliance also was a significant issue. Research has shown over the years that long-term adherence to diet, weight loss programs, and exercise programs is difficult. Once children mature, parental influence on weight and eating behaviors is minimized.

A significant limitation of clinical interventions is self-reported data. Most often, study data such as dietary recall is self-reported, and this can directionally influence study results. Self-reported data is subject to error because children (and adults) tend to under- or over-report critical values (IOM, 2005). Despite this fact, food frequency questionnaires are one of the widely accepted ways to assess dietary intake and recall among children and adolescents. Measuring dietary intakes of children can be challenging. These challenges include recall and accuracy. Children have difficulty quantifying foods consumed, frequency of consumption, as well as estimating portion size (Berkey et al., 2000; IOM, 2005). This factor also could result in under- or over -reporting of food consumption.

To alleviate problems such as recall, particularly with younger children, dietary data can be obtained through interviewer-administered 24-hour recall by using a multiple-pass technique to reduce under-reporting (Bowman et al., 2004). Use of the 24-hour recall method is common; however, the need to consistently collect information for multiple days to determine typical intake of foods or nutrients makes it a time and labor intensive process. Furthermore, the energy requirements for children vary, depending on the timing of growth and developmental spurts, and may be highly individualized (IOM, 2005).

Several dietary interventions have incorporated food frequency questionnaires into the study design to measure total energy intake in children and adolescents with some degree of success. Studies such as the Bogalusa Heart Study utilized food diaries based on 24-hour recall (Nicklas et al, 2001b). In the NGHS Study, girls recorded their dietary intake that was measured using three, consecutive-day food records (NHLBI, 2004). The FRESH (Food Re-Education for

Elementary School Health) Study used 24-hour diet food logs recorded by preadolescent children in grades 2 through 5 to measure total energy (Stewart et al., 1997).

Alternative methods can be used to capture and record food frequency in children. Although this data is not self-reported by the children, the potential for recall bias still exists. In a study by Francis (1999), of pre-pubertal, non-obese children, mothers compiled seven-day food diaries. Dennison et al. (1997), used food frequency questionnaires consisting of seven consecutive days of written dietary records to assess the association between dietary fat intake and measures of adiposity in a study of 168 preschool children. Other studies have used these instruments to recall dietary history, confirm portion sizes, and for follow-up. Children, particularly young children, often complete these questionnaires with parental assistance.

The development of questionnaires and evaluation among questionnaires for various ethnic groups requires attention, as does the function of questionnaires across different educational levels within ethnic groups (Willett, 1994). For these individuals, and younger children unable to report for themselves, proxy interviews can be conducted (Bowman et al., 2004). This is yet another challenge to using food frequency questionnaires. In spite of this, by 10 years of age, most children are able to give accurate dietary information, and are well aware of the foods they have eaten. Food frequency questionnaires provide enough accuracy in studies of adolescents to permit individual diets to be related to subsequent health outcomes (Berkey et al., 2000).

A significant limitation of epidemiologic surveys, such as these discussed above, in examining the role of diet and eating patterns in obesity, is the highly interrelated nature of dietary exposures. Thus, it often is difficult to distinguish the independent effects of nutrients, foods, or even specific eating patterns on weight status. The focus on dietary intake of specific nutrients, foods, or even specific eating patterns must be evaluated through its effects on total energy as it relates to energy balance (Nicklas et al., 2001a).

Additionally, most studies are based on cross-sectional associations; and not those that are longitudinal; sample sizes are relatively small; and limited to specific populations; and many studies have not been replicated. Further studies are needed to better understand how specific environmental factors, either singularly or in combination, affect total energy intake. Moreover, cross-sectional approaches must be utilized in any endeavor seeking to analyze the associations between eating patterns, dietary quality and obesity (Nicklas et al., 2001a).

Despite these limitations, clinical interventions provide a solid foundation for translating clinical practice into solutions that can be used to prevent childhood obesity. Future studies building upon the foundation of these interventions can address many of these limitations to generate more successful outcomes.

2.6 SCHOOL-BASED APPROACHES

Schools are one of the primary environments for reaching school-age children and youth. In 2002, 55 million students were enrolled in public and private elementary and secondary schools in the United States. Between 2002 and 2014, a further increase of 4% is expected with increases projected in both public and private schools (Hussar, 2005). This anticipated increase provides schools with opportunities to improve the health and well-being of their students now and in the immediate future.

The school environment has the potential to affect national obesity prevention efforts because of the population reach and the amount of time students spend in school each day.

Children obtain about one-third of their daily energy requirement from the school lunch, and should expend approximately 50% of their daily energy expenditure while at school, depending on the length of the school day (USDA, 2004). Given that schools offer numerous and diverse opportunities for young people to learn about energy balance and to make decisions about food and physical activity behaviors, it is important that the school environment be structured to promote healthful eating and physical activity behaviors (IOM, 2005). Therefore, the goal of various interventions in school settings should be to aim to maintain or achieve a healthy weight through a combination of nutrition, physical activity, and other behavioral interventions (Katz et al., 2005).

Increasingly, schools and school districts across the country are implementing innovative programs focused on improving student nutrition and increasing their physical activity levels. Parents, students, teachers, school administrators, and others play important roles in initiating these changes; and it is important to evaluate those efforts to determine whether they should be expanded, refined, or replaced and whether they should be further replicated and disseminated (IOM, 2005). When planning future interventions aimed at weight-control outcomes, considering interventions that produced modest but positive changes in weight-related measures might be useful. These interventions include allotting additional time to physical activity during the school day, including noncompetitive sports, and reducing sedentary activities, especially television viewing (Katz et al., 2005).

Evaluating effectiveness of school-based healthy eating and physical activity programs is critical to the evidenced-based health policy, and to justify broader implementation of successful programs. However, because only a limited number of studies have been conducted, the results have varied and the effectiveness of these programs is not well established (IOM, 2005). For example, a systematic review by Campbell et al. (2002) found only seven studies on the prevention of childhood obesity; four of which revealed programs that were effective, and three of which detailed programs that were not.

To evaluate effectiveness of school-based approaches, comparing students who attend schools with prevention programs to students from schools without a program provides an alternative to intervention studies with regard to evaluating effectiveness. Intervention studies rely on pre-intervention and post-intervention comparisons, and thus have better inferential potential. Schools that implement intensive and multifaceted programs that encompass CDC guidelines are demonstrated to be effective in preventing childhood obesity (Veugelers & Fitzgerald, 2005).

School-based approaches have targeted total fat, saturated fat, or fruit and vegetable intake. In addition, they have addressed other weight-related behaviors such as physical activity or television viewing. Most large-scale, controlled intervention studies (such as the CATCH study), have examined weight status or BMI changes as outcome measures. A much larger literature exists on school-based approaches to change dietary behaviors of students (IOM, 2005).

Evaluation of the literature on school-based approaches to improve food choices and dietary quality is complicated because of the variety and the multi-component nature of study designs. Comparing results is difficult because classroom education/behavioral skills curricula, for example, typically have been embedded in a multi-component program. Therefore, the effectiveness of this intervention component is difficult to evaluate as an isolated strategy. In addition, differences exist across studies in the number and types of food-related behaviors and age groups targeted (IOM, 2005).

Studies based in elementary, middle, and high schools differ not only in the developmental stage of the students, but in the corresponding physical and social environments, which contrast dramatically, for example, in the availability of a la carte foods, fast foods, snack bars, and vending machines. High school students also are more likely than elementary or middle school students to leave campus during the lunch period. These variables may moderate the effects of interventions designed to influence food choices in the school setting (IOM, 2005).

Three multi-component, school-based approaches were identified for this study because of their demonstrated ability to significantly impact BMI, dietary intake, and physical activity in elementary school students; in addition to their importance to public health. Moreover, two of the three interventions have been replicated and adopted by school districts throughout the nation. These evidence-based interventions: the Child and Adolescent Trial for Cardiovascular Health (CATCH), Planet Health, and Sports, Active Recreation and Play for Kids (SPARK) combine school curricula such as math, English, and science to teach students the importance of healthy eating. These programs also have been effective in targeting dietary and behavioral changes (IOM, 2005). In addition, SPARK is an integral component of Fun to Be Fit, which has been adopted as the new PE curriculum for Pittsburgh Public Schools.

There are several other notable school-based obesity prevention programs currently being implemented, such as the Stanford S.M.A.R.T. Program, Pathways, and the Stanford Adolescent Heart Health Program. These interventions show the feasibility of making positive changes in the school food and PE environments, but also the challenges still to be faced in designing primary prevention in schools. Overall, school-based approaches, both multi-component and single component, have produced healthful food choices among students (IOM, 2005).

However, even the best physical education programs offered five days per week cannot provide all of the physical activity that children need to maintain healthy lifestyles. Modes of delivery for physical education must be identified and assessed to determine the most effective manner to promote physical activity in children. Research also has proven that both dietary modification combined with physical activity is necessary to reduce childhood overweight and obesity. Any program put into practice should meet the needs of the students and communities involved (Sallis & Patrick, 1994).

2.6.1 CHILD AND ADOLESCENT TRIAL FOR CARDIOVASCULAR HEALTH (CATCH)

CATCH is the largest, most comprehensive school-based approach yet undertaken. This study was designed as a health behavior intervention for the primary prevention of cardiovascular disease, with BMI being the primary outcome study variable, and diet and physical activity targeted as secondary outcome variables. CATCH was evaluated in a randomized field trial in 96 (56 intervention and 40 control) elementary schools in California, Louisiana, Minnesota, and Texas. Twenty-eight (28) schools participated in a third grade through fifth grade intervention including school food service modifications, enhanced physical education (PE), and classroom health curricula. Twenty-eight (28) additional schools received these components, plus family education (Leupker et al., 1999).

In intervention school lunches, the percentage of energy intake from fat fell significantly more (38% to 31.9%) than in control lunches (38.9% to 36.2%; $p<.001$). The intensity of physical activity in PE classes during the CATCH intervention increased significantly in the intervention schools compared to the control schools ($p<.02$). Self-reported daily energy intake from fat among students in the intervention schools was significantly reduced (from 32.7% to 30.3%), compared to that among students in the control schools (from 32.6% to 32.2%; $p<.001$). Intervention students reported significantly more daily vigorous activity than controls (58.6 minutes versus 45.4 minutes; $p<.003$). The CATCH intervention was able to modify the fat content of school lunches, and to increase moderate-to-vigorous physical activity in children during three school years (Leupker et al., 1996). Like many of the other multiple-risk factor intervention trials for school children, the CATCH showed feasibility of delivering classroom-based environmental changes to PE curriculums and cafeteria modifications within a school setting (Schmitz & Jeffrey, 2002).

2.6.2 PLANET HEALTH

Planet Health is a curriculum-based health approach designed to evaluate the impact of a school-health behavior intervention on obesity in grades six through eight in Massachusetts public schools. This was a randomized controlled field trial with five intervention and five control schools. Outcomes were assessed using pre-intervention and follow-up measures, including prevalence, incidence, and remission of obesity. Students participated in Planet Health over two school years. Over the two-year study period, students received messages to make behavior changes relative to health. Control schools received no intervention. Planet Health promotion sessions were included within existing curricula using classroom teachers in five major subjects: math, language arts, social studies, science and physical education. Sessions focused on decreasing television viewing, decreasing consumption of high-fat foods, increasing fruit and vegetable intake, and increasing moderate and vigorous physical activity. The primary outcome was obesity remission and the secondary outcomes were changes in four behavioral targets (Gortmaker et al., 1999).

This intervention study showed significant effects on body weight outcomes. The Planet Health intervention decreased obesity among female students over two school years, indicating a promising school-based approach to reducing obesity among youth. At the end of the two-year period, obesity had declined from 23.6 % to 20.3% among girls in the intervention schools (odds ratio [OR] = .47, p=.03), however girls in the control group showed an increase of obesity from 21.5% to 23.7%. There was a lack of intervention effect among boys. There were no significant between-group differences for boys (OR=0.85, p=.48). Between-group differences for decreases in television viewing time were 0.58 hours (p=.001) and 0.40 hours (p=.0003) per day in girls and boys, respectively (Gortmaker et al., 1999).

However, girls in the intervention group also improved in fruit and vegetable intake by 0.32 more servings than the control group (p=.003), decreased total daily caloric intake more than the control group by 575.5 kilocalories (p=.05), and marginally decreased percentage of calories from fat more than the control group by 0.67% (p=.07). By contrast, comparisons of between-group changes in these dietary factors in boys were not close to statistical significance. These eating behavior change results most likely explain why the obesity-related outcomes were significant in girls only (Gortmaker et al., 1999).

It is particularly interesting that the Planet Health intervention produced significant changes in an obesity index with decreases in television viewing time, but no accompanying significant change in the amount of time spent in moderate to vigorous physical activity in boys or girls (Gortmaker et al., 1999).

2.6.3 SPORTS, PLAY AND ACTIVE RECREATION FOR KIDS (SPARK)

SPARK is a comprehensive health-related, elementary school-based physical education program designed to improve the quality and quantity of physical activity, fitness, and movement skills of children in grades three through six during physical education. The curriculum calls for classes to be taught a minimum of three days per week for 30 minutes throughout the school year. The yearly plan is divided into instructional units that typically are four weeks (12 lessons in length) (Sallis et al., 1997).

A standard 30-minute lesson has two components: Type 1 activities that focus on developing health-related fitness and locomotor skills, and Type 2 activities that focus on developing generalizable motor skills. It is a product of a five-year National Institutes of Health grant, and has been evaluated in a controlled trial. Current results show that students in the SPARK program made significant improvements in cardiorespiratory fitness, muscular strength, endurance measures, and sport skills. SPARK's effectiveness was evidenced by the increased frequency and length of health classes, PE classes, fitness activities, skill drills, and the minutes children were engaged in moderate to vigorous physical activity. In addition, teachers implementing SPARK also demonstrated significant improvement in the quantity and quality of physical education. Outcomes assessed included changes in student BMI and physical activity levels (U.S. Department of Education, 1995; Sallis et al., 1997; IOM, 2005).

In a study of 955 children in grades 4-5 in seven elementary schools, students were assigned to three treatment conditions in a two-school-year, quasi-experimental design. The study evaluated a health-related program designed to increase physical activity during physical education classes and outside of school. Health-related physical education was taught by physical education specialists or trained classroom teachers. There were two treatment arms –

I(s): SPARK led by a specialist; and I(t): SPARK led by a classroom teacher. In the control schools, existing physical education class were led by an untrained teacher. Students participating in the treatment were compared to control students. This trial resulted in students spending more minutes per week being physically active in the I(s): SPARK led by a specialist (40 minutes) and I(t): SPARK led by a classroom teacher (33 minutes) than students in the control classes (18 minutes); ($p<.001$). After two years, girls in the I(s): SPARK led by specialist condition were superior to girls in the control condition on abdominal strength and endurance ($p<.001$) and cardiorespiratory endurance ($p<.001$). There were no effects on physical activity outside of school (Sallis et al., 1997). The implications are that fitness activities accompanied by a health-related curriculum can provide students with substantially more physical activity during physical education classes. Improved physical education classes can potentially benefit 97% of elementary school students (Sallis et al., 1997).

Planet Health and SPARK continue to be among the most widely replicated school-based childhood obesity interventions still in existence (IOM, 2005).

Limitations of School-Based Approaches

In the literature search for the review of school-based approaches, an insufficient number of studies (according to the Task Force on Preventive Services Community Guide) were identified that had methodological quality on which to base recommendations for options for weight control. Literature used included studies initiated before the age- and sex-adjusted BMI standards for children (currently the gold standard) were established in the late 1990s. In addition, in these qualifying studies, varying outcome measures were used. Therefore, comparisons across studies were hampered (Katz et al., 2005).

Research findings support the effectiveness of behavior-oriented curricula as an option for weight control based on self-monitoring, goal setting, feedback about behavior change efforts, incentives, and reinforcement methods in promoting healthful food choices and physical activity. However, there is still much to learn about the elements of nutrition and physical activity education programs that are critical to changing behaviors and, subsequently, body weight (IOM, 2005).

A recent review of 16 school-based cardiovascular risk prevention intervention studies found that interventions were most effective in changing cognitive variables, such as self-efficacy and outcome expectations, and were least effective in changing physiological variables such as body fatness. However, these studies are difficult to compare because of the diversity of their multi-intervention components and the primary outcomes targeted. Some interventions were based on classroom curricula, while others include changes in the school food environment or PE classes (Resnicow & Robinson, 1997).

Intensive, school-based approaches have had success in altering the determinants of overweight, but only moderate success in reducing weight which, for the majority of interventions, was the primary goal. CATCH increased physical education, school nutrition modifications, and family education. It also increased students' physical activity levels and decreased fat content in school lunches, but had no effect on weight. Similarly, Planet Health used educational strategies for reducing television viewing and high fat intake, and increasing physical activity and consumption of fruits and vegetables. Results showed that girls, not boys, received the greatest benefit from the intervention. Both of these interventions addressed multiple determinants of obesity, yet their effects on weight were modest (Luepker et al., 1996; Forrest & Riley, 2004). Results from SPARK support these findings. Sallis et al (1997) also found few effects on body weight, although physical activity increased and no effects were found on physical activity outside of school. These findings demonstrate the difficulty in addressing childhood obesity, and the possibility that, for greater return on investment, efforts need to begin even before children enter elementary school.

Other factors for consideration are developmental. Children mature at different rates, and girls more often are concerned with weight than are boys. Preferences in physical activities among girls and boys also are different, as are skill levels. In addition, multi-year studies increase the risk of threat to maturation. As children mature, their knowledge base broadens as do environmental effects. Therefore, by participating in a multi-year trial, students gain knowledge regarding making healthy food choices, reducing sedentary behavior, increasing physical activity, and changing eating behaviors over time; which could influence the outcomes of the study (IOM, 2005).

Similar to the dietary interventions identified to address childhood overweight and obesity, further research is needed to evaluate the extent to which changes from school-based approaches persist over a longer period. Despite limitations of school-based approaches, at present, these interventions are particularly important due to the increasing number of students that have been identified as at risk for overweight and/or obesity (IOM, 2005).

3.0 THEORETICAL FRAMEWORK

3.1 OVERVIEW OF CHILDHOOD OBESITY

The Social Cognitive Theory (SCT) evolved from research on the Social Learning Theory (SLT) which asserts that people learn not only from their experiences, but by observing their actions and benefits of those actions. SCT is a behavioral prediction theory that represents a clinical approach to health behavior change (Rimer & Glanz, 2005). This theory has been widely applied to health behavior with respect to prevention, health promotion, and modification of unhealthy lifestyles for many different risk behaviors. According to SCT, an individual's behavior is uniquely determined by each of these three factors (Redding et al., 2000).

The interaction between the person and behavior involves the influences of a person's thoughts and actions. The interaction between the person and the environment involves human beliefs and cognitive competencies that are developed and modified by social influences and structures within the environment. The third interaction, between the environment and behavior, involves a person's behavior determining the aspects of his or her environment and, in turn, their behavior is modified by that environment (Figure 3-1). The theory identifies human behavior as a triadic reciprocity interaction of personal factors, behavior, and the environment (Bandura, 1986).

According to SCT, three main factors affect the likelihood that a person will change a health behavior: (1) self-efficacy, (2) goals, and (3) outcome expectations. If individuals have a sense of personal agency or self-efficacy, they can change a behavior even when faced with obstacles. If they do not feel that they can exercise control over their health behavior, they are not motivated to act, or to persist through challenges. As a person adopts new behaviors, this causes changes in both the environment and in the person (Rimer & Glanz, 2005).

The usefulness of the theory in public health is that SCT has been used successfully as the underlying theory for behavior change to study a wide range of health problems; from dietary change to medical theory compliance, alcohol abuse, immunizations, and pain control. A number of SCT techniques such as modeling, skill training, self-monitoring, and contracting currently are used in interventions (Rimer & Glanz, 2005; Brown, 1999). SCT also is helpful for understanding and predicting both individual and group behavior and identifying methods in which behavior can be modified or changed (Bandura, 1986).

The main limitations of the theory are that its comprehensiveness and complexity make it difficult to operationalize; and many applications of the SCT focus on one or two constructs, such as self-efficacy, while ignoring the others (Rimer & Glanz, 2005; Brown, 1999).

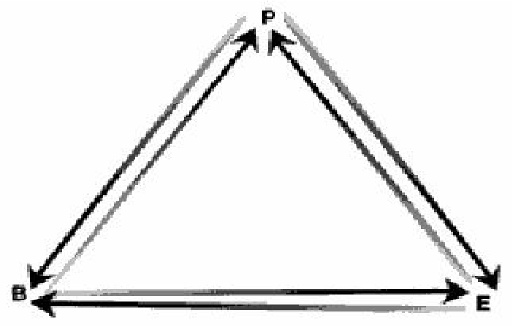

Figure 3-1. Design/Schematic Social Cognitive Theory

B represents behavior; P represents personal factors in the form of cognitive, affective, and biological events; and E represents the external environment.
(Source: Bandura, 1986)

3.2 CONCEPTUAL FRAMEWORK

SCT integrates concepts and processes from cognitive, behaviorist, and emotional models of behavior change; so it includes many constructs (Bandura, 1986; Rimer & Glanz, 2005). Bandura considers self-efficacy the most important personal factor in behavior change, and it is a nearly ubiquitous construct in health behavior theories. In addition to the concept of self-efficacy, behavior change also is determined by outcome expectancies. Outcome expectancies are the results an individual anticipates from taking action. Strategies for increasing self-efficacy (e.g., exercising for 10 minutes each day) include behavioral contracting and monitoring, and reinforcement (Rimer & Glanz, 2005). Figure 3-2 illustrates how self-efficacy, environmental, and individual factors impact behavior.

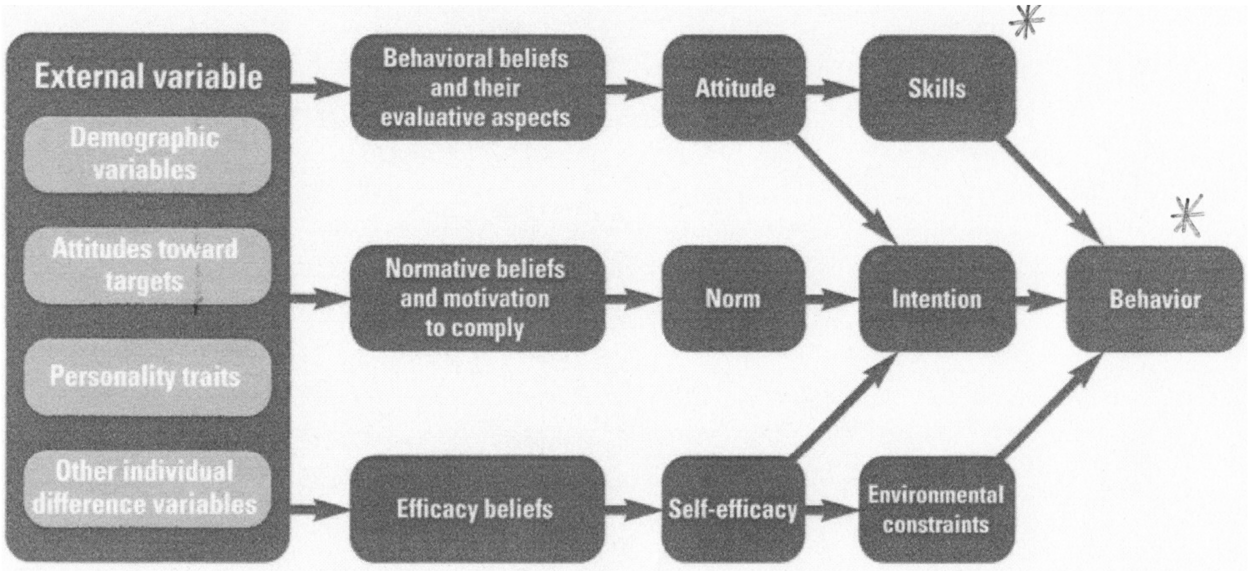

Figure 3-2. SCT Integrative Model of Self-Efficacy, Environmental and Individual Factors

(Source: Rimer & Glanz, 2005)

Social cognitive theory also is the most commonly used theoretical framework for developing behavior-based school interventions (IOM, 2005). Because literature has shown that SCT is most widely used in designing interventions to elicit individual behavior change, it would have been appropriate for this study. However, this study is not testing the SCT model. Therefore, it was not designed around the theory.

Two components of the SCT model are applicable to this study: skills and behavior (indicated by asterisks). In this study, students are provided with opportunities to gain knowledge and skills through participation in Fun to Be Fit to perform a given behavior. The behaviors include developing healthy eating habits, increasing nutrition knowledge, and improving physical fitness levels. Each of these behaviors contributes to the adoption of healthy lifestyles.

Potential change strategies consider ways to promote behavior change, including making adjustments to the school environment by offering alternatives to unhealthy foods in the school cafeteria or in influencing personal attitudes toward nutrition and physical activity. Students adopt new behaviors resulting in changes in the school environment, home environment, and in the students themselves.

Future research regarding Fun to Be Fit could be designed to incorporate additional components of the model, thereby utilizing strategies to increase self-efficacy; reduce frequency of consumption of foods high in fat, sodium, and sugar; increase frequency of consumption of heart healthy foods; increase nutrition knowledge; and increase physical activity levels from pre-test to post-test. If, as a result of the intervention and appropriate environmental conditions, students believe in their ability to eat healthy and increase levels of physical activity, behavior changes will be successful.

4.0 METHODOLOGY

4.1 OVERVIEW OF CHILDHOOD OBESITY

The rationale for selecting Fun to Be Fit for the current study is that much research has shown coordinated, school-based physical education programs that incorporate healthy eating can help exhibit significantly lower rates of overweight and obesity; eat healthier diets; and participate in more physical activity. The primary interest of the study is to determine whether Fun to Be Fit is more effective for the experimental group than the control group in improving frequency of food consumption, nutrition knowledge, and increasing physical activity levels.

4.1.1 FUN TO BE FIT

With $750,000 ($500,000 in direct funding and $250,000 in in-kind contributions) from Highmark, Inc., the Pittsburgh Public School District piloted and subsequently adopted an innovative, school-based health education program that integrates nutrition and physical education (PE). The program represents the first significant, comprehensive upgrade to the PE curriculum in three decades, and replaces the traditional PE and health format.

Fun to Be Fit blends two programs: FRESH (Food Re-Education for Elementary School Health) and SPARK (Sports, Play and Active Recreation for Kids), that have demonstrated effectiveness in achieving significant clinical outcomes. The Fun to Be Fit curriculum provided students with two 50-minute periods of physical education each week, 10 minutes devoted to FRESH concepts and skill-building activities, and the remaining 40 minutes to physical activity incorporating the SPARK curriculum.

FRESH, a nutrition-focused, school-based heart health program developed by researchers at Johns Hopkins Bayview Medical Center is designed to reduce the risk of future heart disease through nutrition education. FRESH teaches children about the effects of cholesterol and the foods that contain it. It also provides interactive lessons on heart health, the relationship between exercise and nutrition, healthy food choices, meal planning, shopping, and food preparation (Stewart et al., 1997). The FRESH component (nutrition education) was assessed using the two-part FRESH survey.

In this study, actual eating behavior or food consumption was not measured. Students were not required to maintain food diaries; rather frequency of food consumption was evaluated only by students' self-reported responses to Part II of the FRESH survey. Similarly, nutrition knowledge was measured by students' self-reported responses to Part I of the FRESH survey. Both treatment and control schools were evaluated for frequency of food consumption, nutrition knowledge, and physical activity levels at the beginning and end of the school year.

SPARK comprises the fitness portion of the curriculum. Developed at San Diego State University through a grant from the National Heart Lung and Blood Institute of the National Institutes of Health, it is the most researched and published physical education program in the world. SPARK eliminates the competitive sports emphasis prevalent in most physical education curricula, and instead fosters a child's personal best and enjoyment while achieving recommended skill development standards. In addition, SPARK encourages children to be active away from class, and to regard exercise as fun as well as beneficial. In the SPARK program, children nearly double the amount of time spent being active. Their satisfaction with the PE experience also is greater than children in traditional PE classes. In trials, even though SPARK children sacrificed academic hours for PE, their academic outcomes were as good as or better than children with more hours in the classroom (Sallis et al., 1997).

Although students engaged in SPARK activities, for the purpose of this study, a fitness assessment consisting of three activities was incorporated into Fun to Be Fit. The reason for adding activities was the need to obtain quantifiable outcomes from the physical activity component of the intervention that could not be attained from SPARK activities. SPARK was designed to encourage children to enjoy movement; it was not meant to be competitive. SPARK activities are not included in measurement in this study. Therefore, activities utilized to evaluate fitness in the current study were selected and modified from the President's Challenge, President's Council on Physical Fitness and Sports. The President's Challenge is a national program that encourages all Americans to make being active part of their everyday lives. This program is used in schools nationwide to help to educators encourage students to stay active, specifically in the Physical Fitness and Health Fitness programs.

The 50th percentile (based on the 1985 School Population Fitness Survey) was selected for Fun to Be Fit because it was determined that the majority of students could achieve the age-appropriate scores similar to those reported in the President's Challenge normative data. The activities consisted of push-ups, curl-ups, and a one-half mile endurance run/walk. Students participating in the study were only required to complete one-half of the number of push-ups and curl-ups and one-half mile endurance run/walk rather than the one-mile endurance run/walk required by the President's Challenge. For example, the President's Challenge requires students to complete push-ups and curl-ups in 60 seconds, while students participating in Fun to Be Fit were required to complete these same activities in 30 seconds. In addition, the number of each fitness activity (push-ups and curl-ups) varied according to grade level and gender.

To differentiate the curriculum from the assessment, the intervention in this study is Fun to Be Fit. The physical fitness component is evaluated by three fitness activities, and the nutrition education component (FRESH) is assessed by the FRESH survey

4.1.1.1 TEACHER TRAINING

Throughout the school year, certified health/PE teachers (PE teachers) in the treatment schools utilized lesson plans to teach nutrition concepts from the FRESH portion of the curriculum, and received training and coaching designed to obtain significant outcomes from the treatment group compared to the control group. Treatment and control PE teachers also were provided with test administration materials, survey booklets, written instructions for administering (pre-test) and follow-up (post-test) FRESH surveys and an answer key. A program evaluator from Highmark conducted training sessions with teachers from both the treatment and control schools on how to administer the FRESH survey. Although teachers were provided with an answer key, it was to enable them to become familiar with the answers to the survey. The survey booklets were scanned electronically and scored by the Highmark program analyst to minimize the potential for scoring errors.

Each PE teacher participating in Fun to Be Fit attended training sessions. However, training for teachers assigned to treatment schools differed from training for teachers assigned to control schools. Training was conducted on an ongoing basis throughout the 2001-2002 school year.

Training for Treatment School PE Teachers

There were at least two full school building in-service days, eight hours each of training with SPARK activities, one-day training with a research assistant, monthly meetings with the District program officer and two district-wide in-service (8 hour) training sessions conducted in August 2001 and January 2002. The Health, Safety, and Physical Education Program Officer (program officer) from the District also worked with physical education teachers from treatment schools by training them in the proper methods of delivering the physical fitness activities (push-ups, curl-ups, and endurance run/walk), timing, scoring, and demonstrating proper form, and providing reinforcement (such as telephone support and/or one-on-one instruction, if necessary). Training also covered administration of the FRESH survey as well as additional training in FRESH concepts.

Training for Control School PE Teachers

The in-service training for the control school teachers focused solely on the SPARK curriculum. The focus of the monthly training sessions was instruction regarding implementation of SPARK activities and the administration of the FRESH survey. Teachers in the control schools did not receive support (coaching or reinforcement) other than what was mandated by the District: two in-service days covering various topics related to their respective schools. PE teachers in the control schools were not trained in conducting the fitness assessments (push-ups, curl-ups, and endurance run/walk).

What differentiates the treatment and control groups in this study is PE teachers from control schools did not receive additional training, reinforcement, or coaching on the fitness assessments. These teachers did not receive additional training in concepts from the FRESH curriculum or teaching strategies. Therefore, students in the control schools did not benefit from supplementary activities to reinforce nutrition concepts from the FRESH component of the curriculum. In addition, PE teachers from control schools only received printed materials from the President's Council on Sports and Physical Fitness Website describing how to perform the physical fitness assessments (push-ups, curl-ups, or the one-half mile endurance run/walk) rather than actual demonstrations.

4.2 ASSUMPTIONS

Nutrition data used in this study was self-reported by the students, and physical activity data was recorded by the physical education teacher. It was assumed that students answered all survey questions based on knowledge and familiarity without teacher involvement.

4.3 SOURCE OF DATA

This research used secondary data to study the efficacy of a school-based approach to childhood obesity by means of reducing frequency of consumption of foods high in fat, sodium and sugar, increasing consumption of healthy foods and increasing physical activity and nutrition knowledge in a sample of 576 third and fourth grade Pittsburgh Public school students from September 2001 through June 2002.

Although 10 elementary schools (5 treatment and 5 controls) were selected to participate in the pilot study, analyses were actually conducted using data from 9 schools (five treatment and four controls). Scores from the control school removed from the study are not included in the data analyses. The reason for excluding those scores is that students from the school were provided with the correct answers to questions on the FRESH post-test, which could possibly bias and/or or contaminate the results.

4.4 STUDY DESIGN

The study utilized a matched pre-test and post-test design. The analysis is based on nine schools, five treatment (n=332) and four controls (n=244). This was a sample of convenience assigned to one of two conditions: treatment and control.

The treatment and control schools were matched using specific criteria such as school demographics (geographic location in the District, student population, racial mix, and teaching ability). For example, each treatment school selected was matched with a control school with similar characteristics. Treatment schools also were chosen to reflect teachers who were more receptive to teaching the Fun to Be Fit curriculum.

In the current study, the most appropriate units of analyses are the school and the students affected by participation in Fun to Be Fit. The relationship of food frequency consumption and nutrition knowledge to physical activity was analyzed anticipating a positive correlation between participation in Fun to Be Fit and an increase in physical activity, nutrition knowledge, and consumption of heart healthy foods; while decreasing frequency of consumption of high fat, high sodium, and high sugar foods.

The target outcome measures include continuous (fitness scores, nutrition knowledge, and food frequency variables. With 576 students, the design should be able to detect an effect size of .16 or larger with 80% power and a significance level of .05 or less.

The objective of this study is to examine the effect of Fun to Be Fit on frequency of consumption of foods high in fat, sodium, and sugar and heart healthy foods; while improving nutrition knowledge and increasing physical activity in a sample of third and fourth grade elementary school students. This study was approved as “exempt” through the University of Pittsburgh Institutional Review Board as IRB #0502106 (Appendix A).

4.5 STUDY POPULATION

The study population consists of 576 third and fourth grade students enrolled in one of nine elementary schools located in the Pittsburgh Public School District. More than one-half of students enrolled and attending District schools are minorities. The Pittsburgh Public School District is located in Pittsburgh, Pennsylvania. Pittsburgh is one of two larger metropolitan cities in the Commonwealth of Pennsylvania, with a population of approximately 2,269,806 residents. The majority of Pittsburgh residents are Caucasian (90%vs. 8% African-American). Other races (2%) comprise the remainder of the population (United States Census Bureau, 2003 American Community Survey).

The mission of the Pittsburgh Public Schools is to improve social and academic achievement, which will enable all students to be successful school and community citizens who grow into contributing adults. This urban school district is comprised of 86 schools: 53 elementary, 17 middle, 10 high, 2 alternative, and 4 special education schools. Total enrollment during the 2001-2002 school-year (pilot year for Fun to Be Fit study) was approximately 34,000 students. Total enrollment in 2005 was approximately 31,000. Average class size ranged from 20.3 to 27.2 students per class. The racial balance of Pittsburgh Public School District is predominantly African-American (60% vs. 40%). Approximately 72% of graduating seniors were enrolled in higher education. The 3,000 teachers provide a ratio of (1:10) one teacher for every 10 students (Pittsburgh Public Schools, 2005).

Every school district residence is assigned to a school attendance area within one of three geographic areas. Students are assigned to schools as close to their homes as possible, with respect for space and maintaining diversity in student enrollment. Magnet schools and programs provide opportunities to achieve racial balance through voluntary enrollment. Admission to magnets is based on the availability of space and racial balance, as well as the individual needs and interests of the students who apply. Through Limited Options enrollment, parents may choose to enroll their child in a different school in their geographic area, provided space is available, there are no additional transportation costs to the District, and the transfer will not have a negative impact on the racial balance of the receiving or sending school (Pittsburgh Public Schools, 2005).

The District serves students residing in Pittsburgh communities and the borough of Mt. Oliver. An appointed superintendent and an elected, nine-member school board govern the school district. The Superintendent of Schools provides leadership for and monitors the development and implementation of all educational and business plans designed to facilitate achievement of the District’s goals and policies. Board members are elected to serve a four-year term. Each director serves without pay, and represents one of nine geographic areas within the

City of Pittsburgh and the borough of Mt. Oliver**.** The board also is the policy-making body for the school district (Pittsburgh Public Schools, 2005).

Table 4-1 provides baseline sociodemographics of the study population. Characteristics of Fun to Be Fit study participants for treatment and control group are as follows. There are a few more males than females participating in the study. There are more students in grade 4 than grade 3. The majority of third and fourth graders are from treatment schools. Of the treatment schools, Minadeo has the highest number of participating students (80, 24%). Of the control schools, Knoxville has the lowest (44, 18%). Ethnicity was not collected on the study population.

Table 4-1. Selected Demographic Characteristics (%) of Sample of Pittsburgh Public Elementary School Students in Pilot Study Fun to Be Fit 2001-2002*

Characteristics	Treatment Students (n=331)	% of Students	Control Students (n=245)	% of Students
Gender Male (n=274)	152	46%	122	50%
Female (n=302)	179	54%	123	50%
Grade Level Grade 3 (n=259)	154	46%	105	43%
Grade 4 (n=317)	177	53%	140	57%
	Treatment Schools* (n=5)		**Control Schools* (n=4)**	
	Fulton 80	24%	Colfax 61	25%
	Martin Luther King 52	16%	Fort Pitt 79	32%
	Minadeo 82	25%	Knoxville 44	18%
	Murray 54	16%	Manchester 60	25%
	Northview 64	19%		

*****The original sample contained 331 students in the treatment group and 245 students in the control group. Secondary data indicates one student was moved from the control group to the treatment group. Therefore, data analysis was performed on scores of 332 treatment and 244 control students.
(Source: Pittsburgh Public Schools, 2005)

Characteristics of Treatment and Control Schools

Table 4-2 provides descriptives and frequencies for the treatment (n=5) and control schools (n=4). A total of 2,667 students are enrolled in elementary schools selected as study. Of that total, 82% (n=2171) were identified as Non-Hispanic Black and 18% (n=496) were identified as Non-Hispanic White. Other races comprised less than 2%.

The study schools are largely neighborhood/community schools. The majority of students live within walking distance of these schools. The Pittsburgh Public School District assigns students to schools in one of three geographic areas: North/Central, East, and South/West; with the exception of Northview, which is a magnet school. Students living anywhere in the City of Pittsburgh and the Borough of Mt. Oliver are permitted to attend Northview. As reported in Table 4-1, the number of pilot study students in the five treatment schools is: Fulton (24%, n=80), Minadeo (25%, n=82), Murray (16%, n=54), Martin Luther King (16%, n=52), and Northview (19%, n=64). The number of pilot study students in the four control schools is: Colfax (25%, n=61), Knoxville (18%, n=44), Manchester (25%, n=60), and Fort Pitt (32%, n=79). Three schools serve North/Central: Northview, Manchester, and Martin Luther King. Four schools serve the East: Minadeo, Fulton, Fort Pitt, and Colfax; while the remaining two schools: Knoxville and Murray serve South/West communities.

Mean income levels of families residing in the study school neighborhoods vary from low-middle to high-middle. Minadeo, which is located in one of Pittsburgh's wealthier neighborhoods, has the highest mean family income $97,532; while Fort Pitt, located in a low- to middle-income neighborhood, has the lowest mean family income, $36,513. Both Minadeo and Fort Pitt also have the highest number of students participating in Fun to Be Fit.

Schools were selected in an attempt to balance the geographic location and racial mix of the treatment and control schools. For example, Knoxville (treatment) and Murray (control) are both located in the South/West communities. A majority of schools are located in the same geographic area. Although four of the nine schools are located in the East, two are treatment: Fulton and Minadeo, and two are control: Colfax and Fort Pitt. Martin Luther King (treatment) and Manchester (control) both serve North/Central communities.

Of the treatment schools, fewer White students (1.9%, n=5) attended Fulton than any of the pilot schools; however, more Whites attended Minadeo (54.2%, n=232) than any of the other pilot schools. The highest number African-American or Black students (97%, n=295) attended Northview, while the lowest number of African-American or Black students (36.2%, n=155) attended Minadeo. Of the treatment schools with the highest and lowest number of students participating in the pilot study, Minadeo was the highest with 82% (n=54) and Philip Murray the lowest with 9.4 % (n=14).

Of the control schools, the largest majority of African American or Black students (98%, n=328) and the smallest number of White students (2.1%, n=7) attended Fort Pitt. The highest number of White students (17.5%, n=51) and the least number of African-American or Black students (67%, n=195) attended Colfax. Other ethnicities comprised less than 2% of the study population. Of the control schools with the highest and lowest number of students participating in the pilot; Fort Pitt was highest 13.7%, n=79) and Knoxville lowest (7.6%, n=44).

Table 4-2. Demographic Characteristics: Fun to Be Fit Treatment and Control Schools

School	Study Type	Total Enrollment (n=2776)	School Ethnicity*	% Ethnicity	Communities Served
Colfax	Control	291	195 African-Americans 51 Whites	67% African American 17.5% White	East Hills/Point Breeze/ Homewood/ Squirrel Hill
Knoxville	Control	269	209 African-Americans 50 Whites	77.7% African American 18.6% White	Beltzhoover/ Knoxville
Manchester	Control	340	316 African-Americans 24 Whites	92% African American 7 % White	Manchester/Old Allegheny (North Side)
Fort Pitt	Control	335	328 African-Americans 7 Whites	98% African American 2.1% White	Bloomfield/ Garfield/ Lawerenceville/ Lincoln-Lemington
Fulton	Treatment	262	250 African-Americans 5 Whites	95.4% African American 1.9% White	East Liberty/ Highland Park
Martin Luther King	Treatment	252	237 African-Americans 3 Whites	94% African American 5.2% White	North Side (Lower)
Minadeo	Treatment	428	155 African-Americans 232 Whites	36.2% African American 54.2% White	Squirrel Hill/ Homewood/ Point Breeze
Philip Murray	Treatment	295	186 African-Americans 108 Whites	63.1% African American 36.6% White	Carrick/Mt. Oliver/St. Clair Village/ Arlington
Northview (magnet)	Treatment	304	295 African-Americans 6 Whites	97% African American 2.0% White	North Side (Upper) Northview Heights/Spring Hill/Perry Hilltop

***School enrollment may not total. Other minorities not reported in this table comprise less than 2% of school ethnicity.
(Source: Pittsburgh Public Schools, 2005)

Teacher Characteristics

Certified treatment and control health/PE teachers (n=13) were responsible for implementing the pilot study. Of these teachers, 62% (n=8) taught physical education to both third and fourth grade students, 23% (n=3) taught third grade only, while the remaining 15% (n=2) taught fourth grade only. Several were assigned to more than one school. Four teachers (30%) were assigned to Colfax, while two teachers (15%) were assigned to Fort Pitt. The remaining seven teachers (54%) were each assigned to one school only. Several teachers were assigned to more than one school; however, not to more than one treatment or control school. Teachers assigned to treatment schools did not teach in control schools, and teachers assigned to control schools did not teach in treatment schools. Treatment school teachers were selected on the basis of exemplary performance. Exemplary performance was determined by scores received from performance evaluations and classroom observations conducted by the Program Officer from the District. This individual has oversight for training, observing, and evaluating PE and health teachers throughout the district. Fun to Be Fit teachers were trained as physical education teachers (none of the Pittsburgh Public School PE teachers selected for the study were classroom teachers).

Recruitment

Participation in the study was restricted to students enrolled in one of the treatment or control schools in the Pittsburgh Public School District; and enrolled in grade levels three or four during the study period. No incentives were provided to students, schools, or teachers as a condition of participation. Aggregate data was used for analyses; therefore parental consent was not needed for student participation in the study.

4.6 STUDY VARIABLES

All variables for the current study were developed from the study, data analyses, or as a result of the literature review. In this section, the study variables are categorized as either independent (covariates) or dependent, and further defined in relation to the current study. Descriptive study variables were recoded for the purpose of data analyses. Pre-test and post-test variables are categorical/discrete (gender, group type and grade level) or continuous variables (baseline and follow-up nutrition and fitness scores). The measurement of independent and dependent variables are described in the next section.

4.6.1 OUTCOME VARIABLES

NUTRITION KNOWLEDGE

Nutrition knowledge was measured using Part I of the FRESH Nutrition Knowledge, Attitude, & Eating Behavior Survey (as described in Section 2.6).

FOOD FREQUENCY

Eating behavior was measured by self-reported frequency of consumption of foods high in fat, sugar and sodium, and was assessed by Part II of the FRESH Survey (as described in Section 2.6).

FAT

High fat foods were measured by nutrition knowledge and food frequency consumption. An example questionnaire item used was: “Which is a saturated fat.” The choices were: A=Butter, B=Corn oil, C=Nuts, or D=Don’t know.

SUGAR

Foods high in sugar were assessed by nutrition knowledge and food frequency consumption. The following questionnaire item was used to determine knowledge of foods high in sugar: “Which food provides you with calories, but few minerals and vitamins?” The choices were: A=Orange, B=Carrot sticks, C=Candy bar, and D=Don’t know.

SODIUM

High sodium foods were evaluated by nutrition knowledge and food frequency consumption by asking: “Which of the following food contains the most salt?” The choices were: A=Potato chips, B=Strawberries, C=Graham crackers and, D=Don’t know.

HEART HEALTHY FOODS

Heart healthy foods were measured by a questionnaire item such as, “A lunch that is healthy for the heart is:” A=Bologna sandwich, milk, potato chips, cookie; B=Peanut butter sandwich, cheese, ice cream , milk, apple; C=Low-fat yogurt with fruit, carrot sticks, non-fat milk, whole wheat roll; and D=Don’t know. Heart healthy foods were measured also by frequency of consumption.

Questions pertaining to exercise also are included in the FRESH Questionnaire. These questions evaluated knowledge of exercise relative to heart health. The following questionnaire items used to measure students' knowledge of heart healthy exercises included:"Which exercise is best for your heart?" A=Bowling, B=baseball, C=Aerobic dance, or D= Don't know; and "How long should you exercise to keep your heart healthy?" A=At least 5 minutes, B=At least 10 minutes, C= At least 20 minutes or D=Don't know.

Follow-up (post-test) food frequency consumption and nutrition knowledge were measured with the identical FRESH survey that was administered at pre-test. Post-test physical activities also were measured with push-ups, curl-ups, and one-half mile endurance run/walk.

4.6.2 COVARIATES

GRADE

Grade level was obtained from student rosters. Students were enrolled in either the third or fourth grade at the time of the study. This study variable was used to determine its effect on the fitness and nutrition (dependent) study variables. This categorical variable was recoded into a numeric value.

GENDER

Gender was obtained from student rosters. Gender was used in conjunction with other study variables (such as grade in school) to measure effect of program. This variable was recoded as a numeric variable.

4.6.3 FITNESS ASSESSMENTS

The three activities utilized to evaluate fitness in the current study are components of the President's Challenge, President's Council on Physical Fitness and Sports. The President's Challenge is a national program that encourages all Americans to make being active part of their everyday lives. This program is used in schools nationwide to help to educators encourage students to stay active; specifically the Physical Fitness and Health Fitness programs. These programs work in conjunction with the Active Lifestyle and Presidential Champions to bring out the best in students. The mission of the President's Council on Physical Fitness and Sports is to promote the benefits of fitness everywhere it can; from local communities all the way to the highest levels of government. That involves partnering with organizations across the country including schools, boys and girls clubs, corporations, and more.

These activities (push-ups, curl-ups, and one-half mile endurance run/walk) were selected as measures of physical fitness because of their noncompetitive nature; and scoring is made as simple as possible for schools. These activities also encouraged self-improvement while eliminating competition between students. The fitness activities measure upper body strength; abdominal strength, and heart/lung endurance.

PUSH-UPS

This variable is defined by the President's Council on Physical Fitness and Sports as a measure of upper body strength and endurance. This study variable was measured by the number of push-ups performed correctly in 30 seconds according to gender and grade level.

The student lies face down on the mat in push-up position with hands under shoulders, fingers straight, and legs straight, parallel, and slightly apart, with the toes supporting the feet.

The student straightens the arms, keeping the back and knees straight, then lowers the body until there is a 90-degree angle at the elbows, with the upper arms parallel to the floor. A partner holds her/his hand at the point of the 90-degree angle so that the student being tested goes down only until her or his shoulder touches the partner's hand, then back up. The push-ups are done to a metronome (or audio tape, clapping, drums) with one complete push-up every three seconds, and are continued until the student can do no more in rhythm (has not done the last three in rhythm) or has reached the target number specified. Right-angle push-ups are a better indicator of the range of upper body strength and endurance found in students.

CURL-UPS

This variable is defined by the President's Council on Physical Fitness and Sports as a measure of abdominal strength and endurance. This study variable was measured by the number of curl-ups performed correctly (in good form) in 30 seconds according to specified criteria. There was no limit to the number of repetitions that could be performed. Curl-ups test: Students lie on cushioned, clean surface with knees flexed and feet about 12 inches from buttocks. Feet are not held or anchored. Arms are extended forward with fingers resting on the legs and pointing toward the knees. The student's partner is behind the head with hands cupped under the student's head.

The student being tested curls up slowly, sliding the fingers up the legs until the fingertips touch the knees, then back down until the head touches the partner's hands. The curl-ups are done to a metronome (or audio tape, clapping, drums) with one complete curl-up every three seconds, and are continued until the student can do no more in rhythm (has not done the last three in rhythm) or has reached the target number for the test. Students were permitted to have helpers (to count the number performed). The event was scored by recording those curl-ups done with proper form and rhythm (not "bouncing" off the floor"). The rationale for performing curl-ups is done slowly with knees bent and feet not held: the partial curl up is a better indicator of abdominal strength than timed curl-ups.

ONE-HALF MILE ENDURANCE RUN/WALK

This variable is defined by the President's Council on Physical Fitness and Sports as a measure of speed, quickness, and agility. Scores are recorded to the nearest tenth of a second. For this study, the variable was evaluated by the number of laps students either ran or walked. Students were instructed on proper techniques such as pacing. If school gymnasiums were used for this event rather than an outdoor track, teachers were required to convert the measurement into miles. This event was scored by the number of laps run/walked in one-half mile. No more than 4 laps were required. Times were recorded in seconds.

4.7 MEASUREMENT

Instrument

The FRESH curriculum was designed to help establish good lifelong nutrition and exercise habits in children. Research has demonstrated that heart healthy nutrition education may improve knowledge and food selection, and may lower cholesterol and blood pressure. The FRESH curriculum provides nutrition education for children and evaluates its effect on heart healthy knowledge and attitudes, food intake, and cardiovascular risk factors. The prevailing themes of FRESH are: (1) to educate children so that they can favorably influence their health through proper food choices at school, and (2) to motivate their parents and teachers to provide a supportive heart healthy environment (Stewart et al., 1997).

The FRESH Survey is used to evaluate baseline and follow-up food frequency and nutrition comprehension (Appendix B). FRESH is based on the “Know Your Body” program, an inclusive school health promotion program designed to reduce cardiovascular risk factors in elementary school students (Stewart et al., 1997).

This multiple choice survey is composed of two parts. Students completed Part 1; a 20-item multiple choice test that assesses knowledge of nutrition (15 items) and physical fitness (5 items). Each question showed a picture of a food item or physical activity, with students marking their responses according to their knowledge of foods which were high fat, high sodium, high sugar, and heart healthy. Teachers were not permitted to give direct assistance with survey questions, but were permitted to give general help.

The FRESH Survey was group-administered to treatment and control students as a pre-test in September/October 2001, and as a post-test in May/June 2002, to obtain two scores for each food classification. All pre-tests were completed by mid-October and post-tests by the end of the school year.

Part I was scored by awarding one point for each correct answer. There are four options: A, B, C, and D (Don’t know). The number of correct items were then summed and divided by 20 (the total number of items) to obtain the percent correct. (See Appendix C for scoring key for knowledge and food frequency questions).

Part II, a 51-item food frequency survey, assessed food frequency consumption (eating behaviors). Students marked frequency of food consumption or how often each food was eaten by filling in the bubble in the columns opposite of the picture of the food item. A Likert-type scale was used to measure frequency. Responses were assigned as follows: Almost never=0 points, Sometimes=1 point and Almost always=2 points. Foods were classified on four scales: high sugar (7 items), high sodium (3 items), high fat (15 items), or heart healthy (28 items). Two items (hot dogs and potato chips) were classified in more than one category (high fat and high sodium). Average scores for each scale were calculated by summing the values for each item selected and dividing by the total number of items. Higher score indicates food eaten more often: lower score indicates food eaten less often. Scores are not percentages, but straight addition of scores. Classroom averages were calculated by adding the values within each category (fat, sodium, and sugar) by classroom. The classroom average is determined separately for pre-test and post-scores.

Teachers were instructed to read or paraphrase instructions to the students for Part I, including the purpose of the survey. Teachers were to read every question to the students holding the questionnaire up in front of the class, pointing to each choice as the questions were read. Teachers were permitted to answer simple questions, but were not to define or explain words or concepts (such as saturated fat). Students were encouraged to answer each question based on the best of their ability including the option, “Don’t know,” if they did not understand a word. Students completed Part II (food frequency questionnaire) independently. Students were encouraged to answer all questions and check responses prior to turning in survey booklets to the teacher. The survey in total required approximately 30-40 minutes to complete. A Highmark program analyst staff person scored Parts I and II of the survey. Scoring protocols were obtained from the FRESH program and used in this analysis.

In scientific trials of FRESH, for both groups, traditional learning and social learning, the use of high-sodium foods decreased by 12% ($p < .01$), the use of high-sugar foods decreased by

15% (p< .01), and the use of heart healthy foods did not change. The children in intervention group reported up to 23% decrease in intake of high-fat foods. Total cholesterol was higher (p< .05) in the traditional group at baseline. Cholesterol fell in both groups (p<. 01). However, the decrease in cholesterol was greater in the traditional group than in the social learning group (4.0% vs. 1%; p<. 05) (Stewart et al., 1997). Similar to the field trials of the Know Your Body program, the size of the effect was small. Know Your Body has been pilot tested extensively in clinical trials of diverse populations of school children in the United States and abroad (Resnicow et al., 1993).

Potential Instrument Bias

Part II of the FRESH survey is self-report. Self-reporting can lead to potential underreporting and biased results. Because children often are not reliable, it is difficult to accurately measure food frequency recall in young children less than 10 years of age (Berkey, 2000). Children may report food items are eaten less often when, in fact, they are eaten more often. Because of exposure to healthy eating through mediums such as health education classes in school and television, most students are acutely aware of healthy and unhealthy foods. Therefore, they may over-report or underreport frequency of food items consumed, particularly those that are considered to be unhealthy.

Second, survey administration limited strength of the outcomes. There were disparities in how the survey was administered. In one of the control schools, students were provided with the correct answers to the FRESH survey. Subsequently, scores for that school were discarded, and excluded from the pilot study. These inconsistencies also resulted in analyses performed on fewer cases. Teachers scored and recorded baseline and follow-up scores from the fitness assessments. Inconsistency in scoring between teacher and schools could result in inaccurate values for the fitness activities.

The survey includes 71 total items. Children are encouraged to complete the entire survey with limited teacher assistance. Therefore, considering the length of the survey, inappropriate guessing cannot be eliminated as an explanation for incorrect answers, particularly if students are slow to comprehend. Teachers also resisted administering the survey because of the amount of time required from explanation to completion.

Third, preference for certain foods also may lead to inaccuracy in reporting. For example, a student may not eat a certain food prepared as a low-fat food because of a preference for food prepared in a certain manner (frying versus baked or broiled). Eating fried food in moderation does not constitute unhealthy eating behavior or lack of nutrition knowledge. Having knowledge that fried foods are considered to be “unhealthy,” a student may incorrectly report these foods are almost never eaten.

Fourth, children are not responsible for the types of food served. Therefore, children typically consume foods that are purchased by parents and those that are served during the school day. Food consumption can be regulated during school meals however; food consumption behavior outside of the school environment is not likely to be. Food consumption outside of school could potentially minimize the effects of Fun to Be Fit.

Finally, the food frequency questionnaire includes foods that are favorites for most children, which often are served as a part of the school lunch and in the home. However, food items are not further differentiated to represent healthy alternatives such as low sodium or low fat. Therefore, a student indicating that a certain food is eaten “sometimes,” e.g., hot dogs could receive a lower score.

Follow-up

Approximately eight months after the pilot study began (September, 2001), students were assessed at follow-up (May/June), which was the conclusion of the 2001-2002 school year. Each treatment and control group student was reassessed at post-test with the FRESH survey. Students were also reassessed at post-test with the fitness assessments (push-ups, curl-ups, and one-half mile run/walk). If students were absent on the day of the pre-test and or post-test, their data was excluded from the study.

4.8 DATA ANALYSIS

The statistical procedures used in the current study are discussed in the following section. All analyses were performed using Statistical Program for the Social Sciences (SPSS version 13.0 for Windows). Question 1 ANCOVA differentiates treatment and control groups. An independent samples t-test was used also to answer Question 1. ANCOVA analysis used for Question 2 and Question 3 is identical to the treatment/control ANCOVA analysis used to answer Question 1. The analysis for Question 2 further differentiates boys and girls while that of Question 3 is further differentiated by third and fourth grade students. A median split analysis used to answer Question 4, examines the direction and variability of scores in treatment and control low and high groups using median split analysis.

4.8.1 ANALYSES FOR ADDRESSING RESEARCH QUESTIONS

Several statistical tests were conducted to address the research questions. Descriptive statistics were used to describe: characteristics of the sample, frequency distributions, means, standard deviations, and medians. Descriptive statistics also were generated to: observe the distribution of the sample, detect the presence of outliers, test the validity or accuracy of the data, and summarize study variables. Only cases with valid values for all variables are included in the analyses. Means, standard deviations, t, and p-values are reported. Categorical variables (such as grade level, gender, and group type) were recoded as dummy variables.

Graphic illustrations: figures and tables are presented to show visual results of the statistical analyses conducted for every research question. First, raw/unadjusted data for pre-test and post-test outcome variables is presented in each figure; and second, ANCOVA results tables showing group differences follow. Group means, standard deviations, F test results, and p-values are reported in each table.

An independent samples t-test was used to compare means between two samples. Each group, treatment and control, was measured at pre-test (Kleinbaum et al., 1998). In this study, the independent samples t-test was used compare pre-test means of food frequency, nutrition knowledge, and fitness activities, in order to examine the differences between the two groups. The reason for using this test to answer Research Question 1 was also to conclude whether the groups were unrelated and/or significantly different at pre-test. Group means, standard deviations, t-test results, and p-values are reported in each table. This test was used only in the analysis of Research Question 1.

A multivariable method, analysis of covariance (ANCOVA), was selected to compare treatment and control groups by taking into account pre-test scores so that any differences found in post-test scores could not be attributed solely to differing levels of ability or knowledge between the two groups at the beginning of the study (Kleinbaum et al., 1998). ANCOVA was used to examine treatment and control group differences at post-test in food frequency consumption, nutrition, and physical activity scores, while statistically controlling for gender and grade level.

Median split analysis was conducted to determine whether Fun to Be Fit was more effective in low students (students with low scores initially), and to determine if high students (students scoring higher at pretest), already were performing at a higher level. Pre-test scores for each outcome variable was split on the median to form two groups; groups that were more healthy and less healthy at the beginning; and to examine group differences.

Median split was computed by obtaining the median value for each variable and assigning each group a code, 1 (Control Low, Treatment Low) or 2 (Control High, Treatment High). The sample was then compared on dependent variables (post high fat, high sodium, high sugar, heart healthy foods, nutrition knowledge, and physical fitness activities). With regard to fitness variables, the two groups were further differentiated into Control and Treatment Low Fit (low fitness scores) group; and Control and Treatment High Fit group (already having high fitness scores) at pre-test. ANCOVA analyses subsequently were performed on group type (treatment and control) and median split to test if treatment and control groups were significantly above or below the median for each variable.

The significance level was set at .05, indicating the error or probability that is willing to be tolerated for rejecting the null hypotheses (H_o). Alpha at .05 is a higher, less stringent value. P-values less than .05 were used as the cut-point for the level of statistical significance (Kleinbaum et al., 1998). The smaller the level of p, the more convincing is the rejection of the null hypotheses: there is no difference in mean scores between the Fun to Be Fit (treatment) group and the control group; or Fun to Be Fit has no effect on either group.

5.0 RESULTS

In this chapter, results obtained from the analyses will be used to address the research questions. This chapter explains the results of the study. Included are figures and tables to support the research hypotheses, and to answer research questions. Descriptive statistics, univariate analyses, and multivariable methods are presented and discussed. Data points for each variable are represented in graphs.

5.1 DIFFERENCES IN FREQUENCY OF FOOD CONSUMPTION, NUTRITION KNOWLEDGE, AND PHYSICAL ACTIVITY

Question 1: To what degree does participation in the Fun to Be Fit Program reduce frequency of consumption of high fat, high sodium and high sugar foods, increase consumption of healthy foods, increase nutrition knowledge, and increase physical activity levels in students in the treatment group in comparison to students in the control group over the course of the school year?

Independent Samples T-test

The independent samples t-test tables report mean treatment and control group differences in food frequency consumption (Table 5-1), nutrition knowledge (Table 5-2), and physical activity levels (Table 5-3) at pre-test. Possible scores for push-ups are curl-ups are 0 (lowest) to 20 (highest).

Table 5-1. Independent Samples T-test Results of Pre-test Food Frequency Consumption in Treatment and Control Schools

	Treatment		Control		t	p
	N	PRE	N	PRE		
High Fat Foods	309	1.18 (.34)	207	1.12 (.34)	-1.837	(ns) p=.067
High Sodium Foods	324	1.32 (.50)	225	1.23 (.48)	-2.207	**p=.028***
High Sugar Foods	319	1.01 (.34)	218	.95 (.34)	-1.928	(ns) p=.054
Heart Healthy Foods	297	1.00 (.33)	201	.98 (.33)	-.746	(ns) p=.456

*=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations

Table 5-2. Independent Samples T-Test Results of Pre-test Nutrition Knowledge in Treatment and Control Schools

	Treatment		Control		t	p
	N	PRE	N	PRE		
Knowledge	331	11.88 (3.17)	244	11.56 (3.65)	-1.137	(ns) p=.256

ns=not significant; values are mean scores; numbers in parentheses are standard deviations

Table 5-3 Independent Samples T-test Results of Pre-test Physical Activity Scores in Treatment and Control Schools

	Treatment		Control		t	p
	N	PRE	N	PRE		
Push-ups	325	13.46 (7.24)	72	11.57 (7.74)	-1.973	**p=.049***
Curl-ups	318	15.79 (5.43)	51	16.86 (6.89)	1.262	(ns) p=.208
Endurance run/walk	212	335.63 (88.31)	128	316.54 (70.20)	-2.080	**p=.038***

*=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations

With regard to food frequency consumption, results from the independent samples t-test showed at pre-test, the means of the two groups were different on only frequency of consumption of high sodium foods (two sided t-test, t (547)=-2.207, p=.028). The control group appears already to consume foods that are not high in sodium, prior to participating in Fun to Be Fit. In this case, the null hypothesis would be rejected in favor of the alternative: there is a difference between the means of the two groups.

There were no significant differences in the means of the treatment and control groups on frequency of consumption of high fat (two sided t-test, t (514)=-1.837, p=.067), high sugar (two sided t-test, t(535)=-1.928, p=.054) or heart healthy foods (two sided t-test, t(496)=-.746, p=.456). The results for nutrition knowledge were similar (two sided t-test, t (573)=-1.137, p=.256).

Outcomes for the fitness assessments showed differences in the means for two activities at pre-test: push-ups and the endurance run/walk. The group means are different on push-ups (two sided t-test, t (395)=-1.141, p=.049 and the endurance run/walk (two sided t-test, t (338)=-2.080, p=.038). The mean number of push-ups was smaller for the control group; students in the treatment group performed more push-ups than students in the control group. However, the control group performed the endurance run/walk in less time than the treatment group. There was no significant difference in means for curl-ups in the two groups (two sided t-test t (367)=1.262, p=.208). Results from this independent samples t-test indicate it is likely that this sample is from a population with similar mean values. Significant differences in the groups at post-test will be accounted with ANCOVA. Discussion of those results is presented at the end of this section.

Frequency of Food Consumption

Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 show raw/unadjusted data for pre-test and post-test treatment and control group differences on frequency of consumption of foods high in fat, sodium, sugar and heart healthy foods.

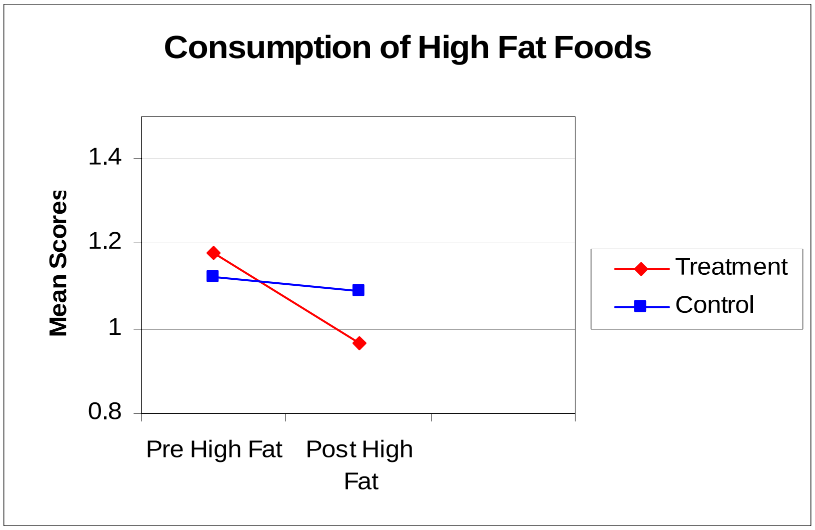

Figure 5-1. Differences in Frequency of Consumption of High Fat Foods

The treatment group shows a significant decrease in the frequency of consumption of high fat foods. The control group showed a small decrease at pre-test and post-test.

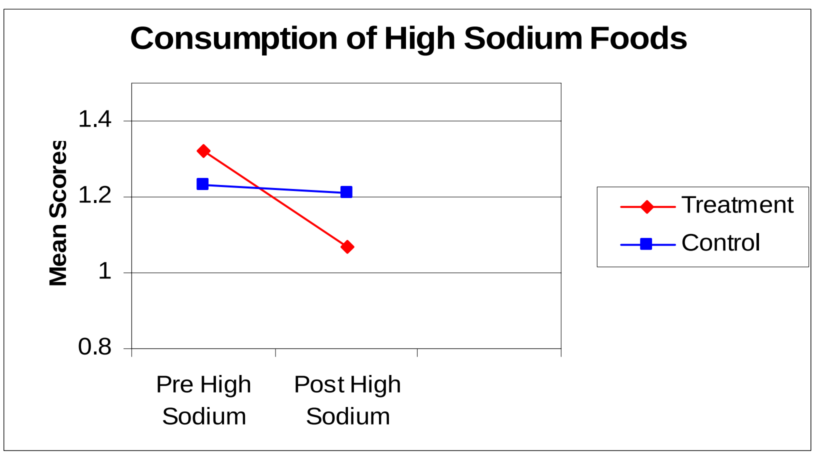

Figure 5-2. Differences in Frequency of Consumption of High Sodium Foods

The treatment group significantly decreased frequency of consumption of high sodium foods. The control group showed no significant change in the frequency of consumption of high sodium foods from pre-test to post-test.

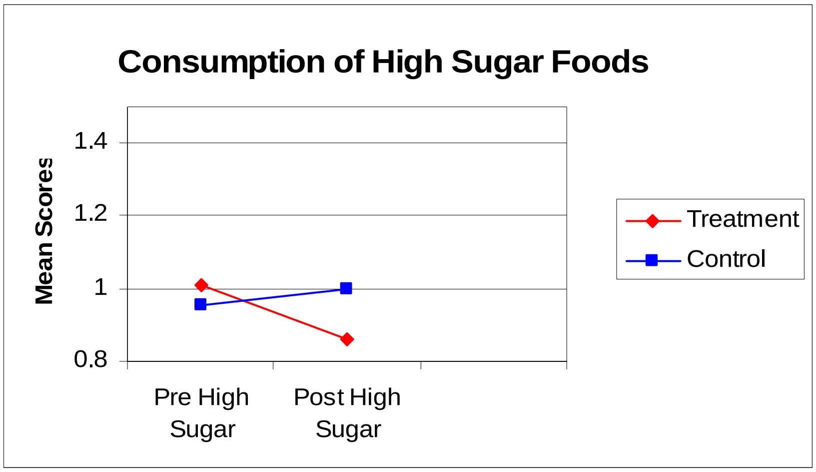

Figure 5-3. Differences in Frequency of Consumption of High Sugar Foods

The treatment group shows more positive change indicating a significant decrease in the frequency of consumption of high sugar foods than the control group.

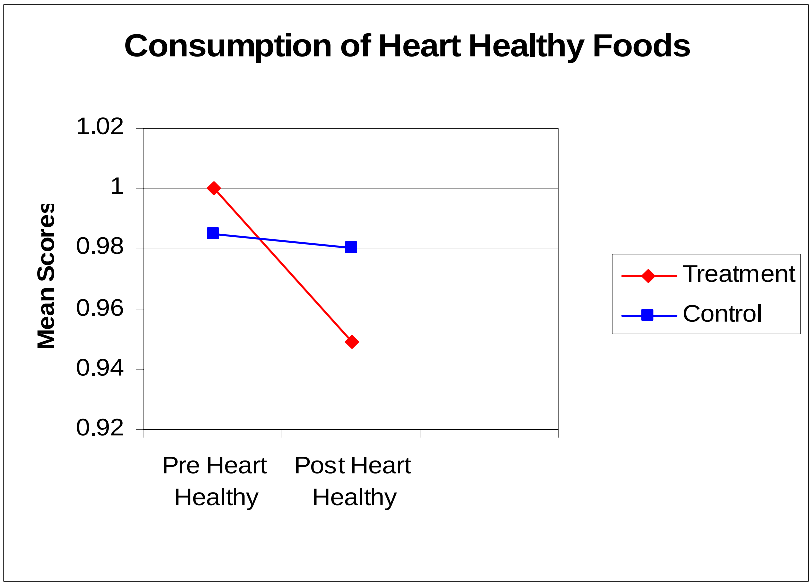

Figure 5-4. Differences in Frequency of Consumption of Heart Healthy Foods

The control group showed no increase in the frequency of consumption of heart healthy foods. Although the treatment group consumed less heart healthy foods at post-test, differences in the consumption of heart healthy foods were not significant in either group.

Nutrition Knowledge

Figure 5-5 represents raw data from pre-test and post-test means for nutrition knowledge. This figure shows the degree of change in the nutrition knowledge between the treatment and control groups.

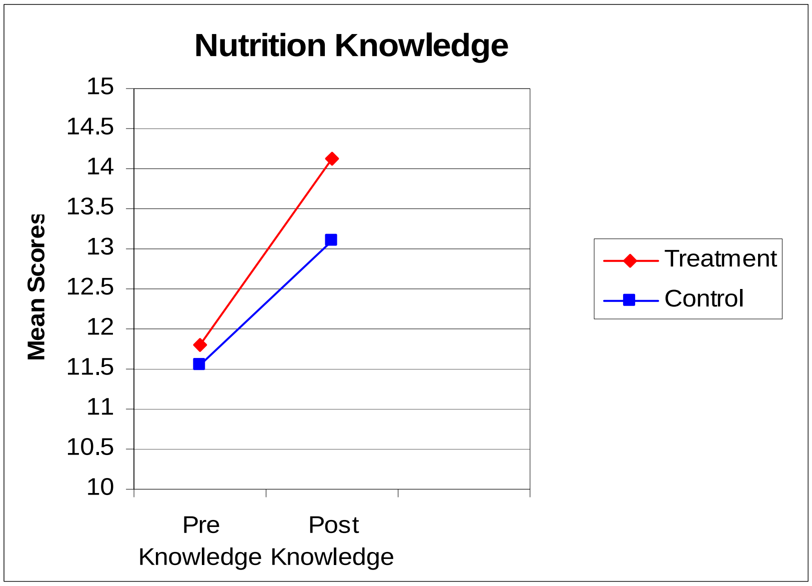

Figure 5-5. Differences in Nutrition Knowledge

The post-test difference between the groups is significant. The treatment group showed greater improvement in nutrition knowledge at post-test than the control group.

ANCOVA Results

ANCOVA results of adjusted mean pre-test and post-test food frequency scores for treatment and control groups are reported in Table 5-4. The table reports adjusted scores for frequency of consumption of high fat, high sodium, high sugar and heart healthy foods. Pre-test and post-test nutrition knowledge scores are reported in Table 5-5. Higher score indicates food eaten more often; lower score indicates food eaten less often. Range of possible scores is 0 (lowest) to 2 (highest). F test results and significant p-values are also reported.

Table 5-4. ANCOVA Comparison of Treatment and Control Groups on Food Frequency Consumption

	Treatment			Control			F	p
	N	**PRE**	**POST**	**N**	**PRE**	**POST**		
High Fat Foods	309	1.18 (.34)	.96 (.35)	207	1.12 (.34)	1.09 (.34)	30.48	**p=.000***
High Sodium Foods	324	1.32 (.50)	1.07 (.52)	225	1.23 (.48)	1.21 (.47)	21.56	**p=.000***
High Sugar Foods	319	1.01 (.34)	.85 (.35)	218	.95 (.34)	.99 (.38)	30.08	**p=.000***
Heart Healthy Foods	297	1.00 (.33)	.94 (.36)	201	.98 (.33)	.98 (.31)	3.66	(ns) .056

*****=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Table 5-5. ANCOVA Comparison of Treatment and Control Groups on Nutrition Knowledge

	Treatment			Control			F	p
	N	**PRE**	**POST**	**N**	**PRE**	**POST**		
Knowledge	331	11.88 (3.17)	14.12 (3.47)	244	11.56 (3.65)	13.11 (4.26)	9.37	**p=.002***

*=significant at p<.05; values are mean scores; numbers in parentheses are standard deviations.

Physical Fitness Assessments

The following figures, Figure 5-6, Figure 5-7 and Figure 5-8 represent raw/unadjusted pre-test and post-test data from mean fitness assessment scores. These graphs demonstrate the degree of change in fitness assessment scores between the treatment and control groups.

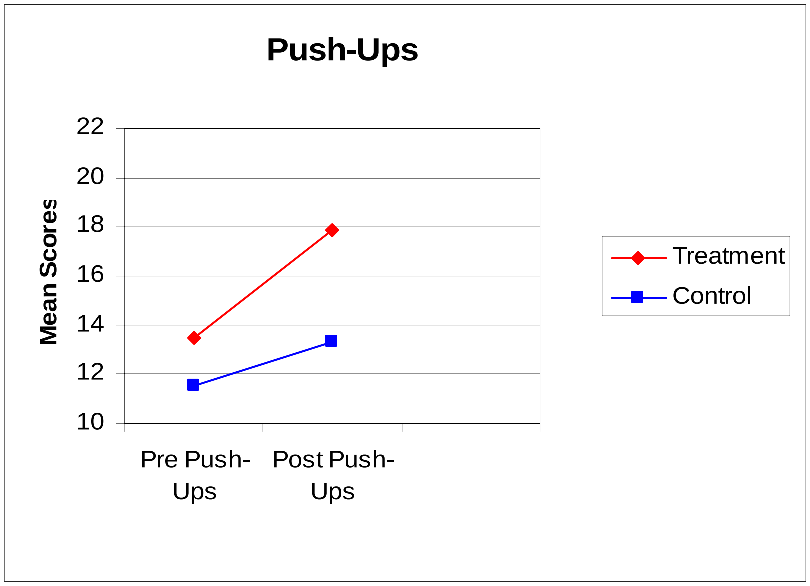

Figure 5-6. Differences in Number of Push-ups

Post-test differences between the two groups are significant. The treatment group scores are higher than those of the control group. The intercept for the treatment group is significantly higher than the intercept for the control group.

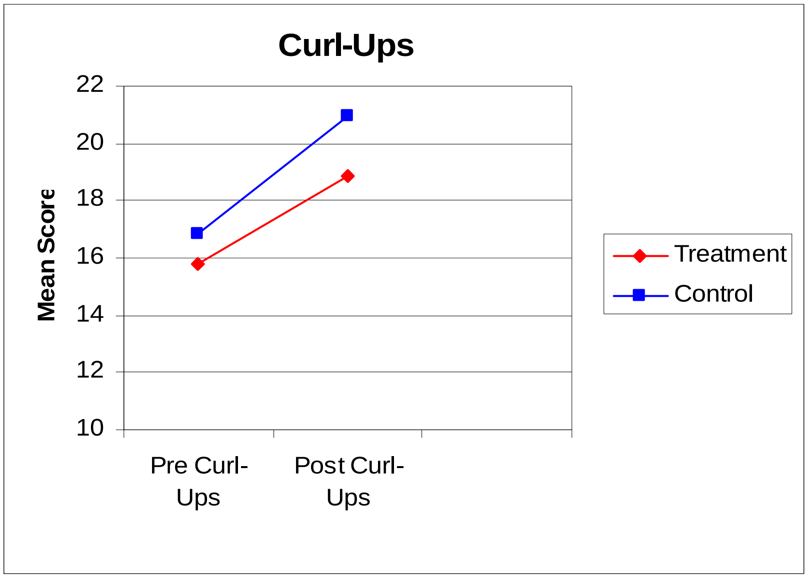

Figure 5-7. Differences in Number of Curl-ups

Both groups increased the number of curl-ups completed. The control group significantly increased the number of curl-ups than the treatment group at post-test.

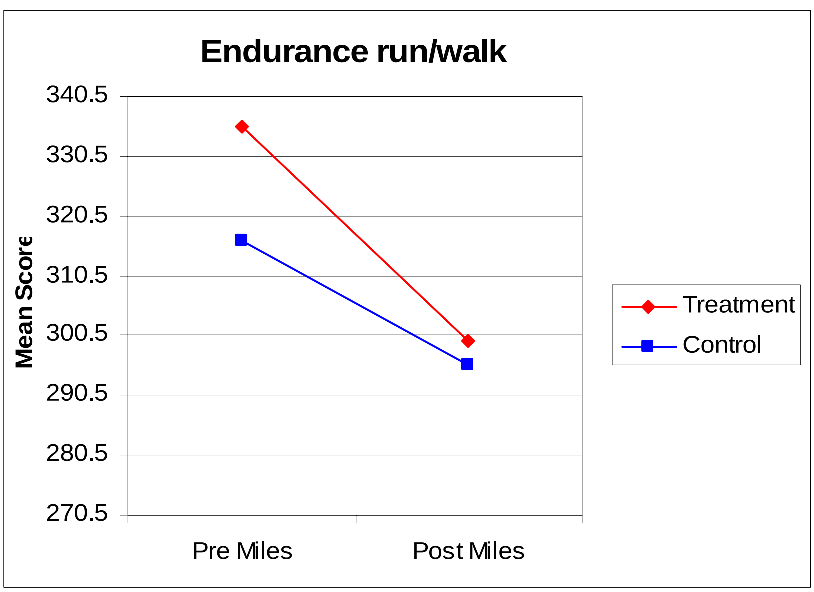

Figure 5-8. Differences in Times for Endurance run/walk

Both groups showed improved times (measured in seconds) for the endurance run/walk. However, differences in treatment group performance was not significant than that of the control group.

Table 5-6 represents ANCOVA analysis of adjusted fitness assessment scores comparing treatment and control groups. Higher score indicates greater number of push-ups and curl-ups completed. Endurance run/walk measured in seconds; without time limits.

Table 5-6. ANCOVA Comparison of Treatment and Control Groups on Fitness Activities

	Treatment			**Control**			**F**	**p**
	N	**PRE**	**POST**	**N**	**PRE**	**POST**		
Push-ups	325	13.46 (7.24)	17.83 (8.06)	72	11.57 (7.74)	13.31 (8.31)	12.78	**p=.000***
Curl-ups	318	15.79 (5.43)	18.83 (5.61)	51	16.86 (6.89)	20.98 (5.57)	4.59	**p=.003***
Endurance run/walk	212	335.63 (88.31)	299.56 (59.28)	128	316.54 (70.20)	295.51 (77.03)	.441	(ns) .507

***=**significant at p< .05; ns=non-significant; values are mean scores; numbers in parentheses are standard deviations.

Research Question 1 addresses the effect of Fun to Be Fit on reducing food frequency consumption of unhealthy foods; increasing consumption of heart healthy foods; improving nutrition and physical activity levels in treatment students compared to control group students during the course of the school year.

Unpublished outcomes reported from preliminary analysis conducted by Highmark indicated that Fun to Be Fit showed significant improvements in the treatment schools than the control schools on of consumption of high fat, sugar sodium and heart healthy foods. The treatment group showed greater reductions in the frequency of consumption of foods high in fat, sugar, and sodium; while increasing frequency of consumption of heart healthy foods than the control group. Treatment group showed greater improvement in nutrition knowledge at post-test than control schools. Although the treatment group appeared to show a slight decrease in healthy food consumption, this was not statistically significant. Data from fitness assessments were not analyzed by Highmark because of limitations concerning the data and the small number of control groups with useable data. However, based on the fact that Fun to Be Fit devotes more classroom time to fitness activities than the existing curriculum, it would not be unreasonable to assume that fitness measures, had they been analyzed; would have shown improvements over the traditional curriculum (Pearson, 2003).

Further in-depth analysis of the data using ANCOVA statistical technique in this study measured the effects of Fun to Be Fit. At post-test, with the level of significance set to .05, the data showed significantly greater reductions in frequency of consumption of high fat foods (F (1, 516)=30.48, p=.000; high sodium foods (F (1, 549)=21.56, p=.000; and high sugar foods (F (1, 537)=30.08, p=.000; compared to the control students. There were no significant changes in either group in the frequency consumption of heart healthy foods F (1, 498)=3.66, p=.056. Although the treatment students appeared to show a slight decrease in frequency of consumption of heart healthy foods, this was not statistically significant. The treatment group showed higher knowledge of nutrition at pre-test and post-test (F (1,575=9.37, p=.002) compared to the control group.

Although fitness data was analyzed using a smaller number of controls in this study, similar assumptions made by Highmark relative to the effectiveness of Fun to Be Fit over the traditional PE curriculum also are appropriate for this study. Fitness scores also showed a significantly greater increase in the number of push-ups (F (1, 397)=12.784, p=.000 for Fun to Be Fit students compared to control students. However, curl-ups were significantly greater for control students at post-test (F (1, 369)=4.59, p=.003; and differences in the results for the endurance run/walk were not significant (F (1, 340)=.441, p=.507. Although the increases or improvement may be significant, due to the small sample size of the control group with regard to physical activity measures, it is important to examine the rate of increase between the two groups.

ANCOVA results indicate that participation in Fun to Be Fit improved frequency of healthy food consumption and nutrition knowledge in the treatment group than that of the control group. However, participation in Fun to Be Fit was not conclusive with regard to increasing and or improving physical activity levels in treatment or control group students.

Question 2: Are similar effects from the Fun to Be Fit program observed on frequency of food consumption, nutrition knowledge, and physical activity levels for both boys and girls?

Frequency of Food Consumption

The following figures represent raw/unadjusted data from pre-test and post-test means for frequency of consumption of high fat, high sodium, high sugar and heart healthy foods, controlling for grade. The figures show the effect of the program on treatment and control group males and females.

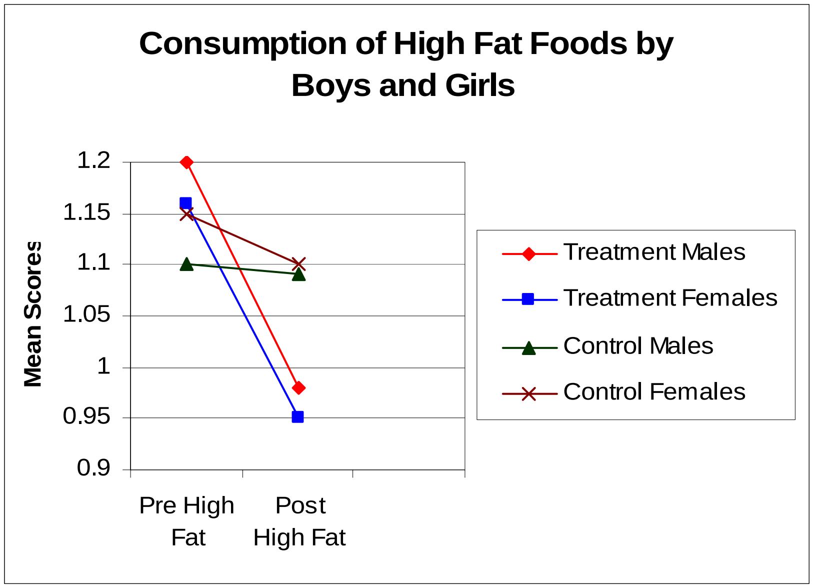

Figure 5-9. Effect of Fun to Be Fit on Frequency of Consumption of High Fat Foods by Boys and Girls

The effect of the program is the same on boys and girls in reducing frequency of fat consumption.

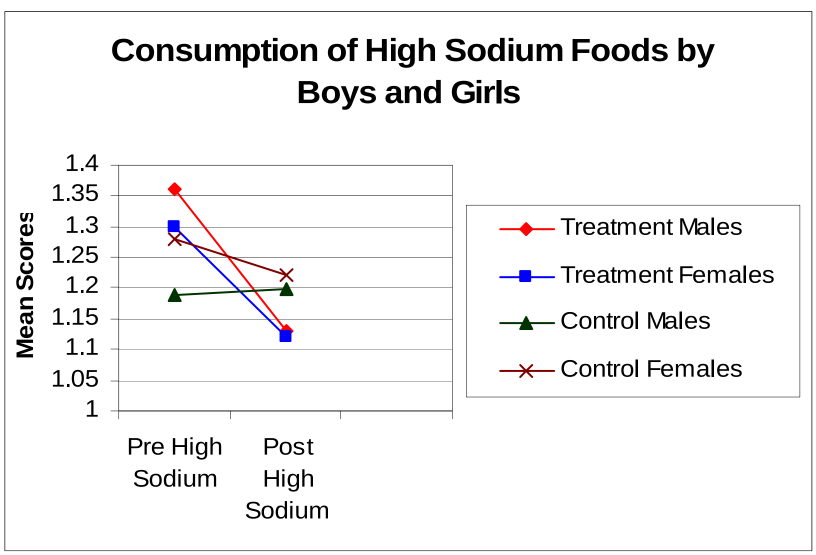

Figure 5-10. Effect of Fun to Be Fit on Frequency of Consumption of High Sodium Foods by Boys and Girls

The effect of the program is the same on boys and girls in reducing sodium consumption. Control group males actually increased frequency of sodium consumption from pre-test to post-test.

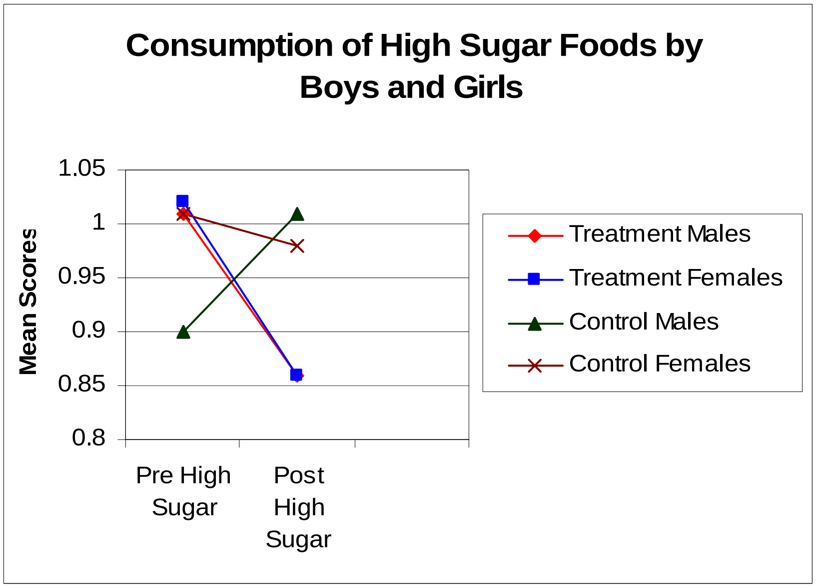

Figure 5-11. Effect of Fun to Be Fit on Frequency of Consumption of High Sugar Foods by Boys and Girls

There is no difference in post-test scores in treatment boys and girls. The regression lines overlap each other, and the intercepts of the two regression lines are equal. Although boys in the control group increased consumption of high sugar foods from pre-test to post-test, Results show no difference of Fun to Be Fit on consumption of high sugar foods in boys and girls.

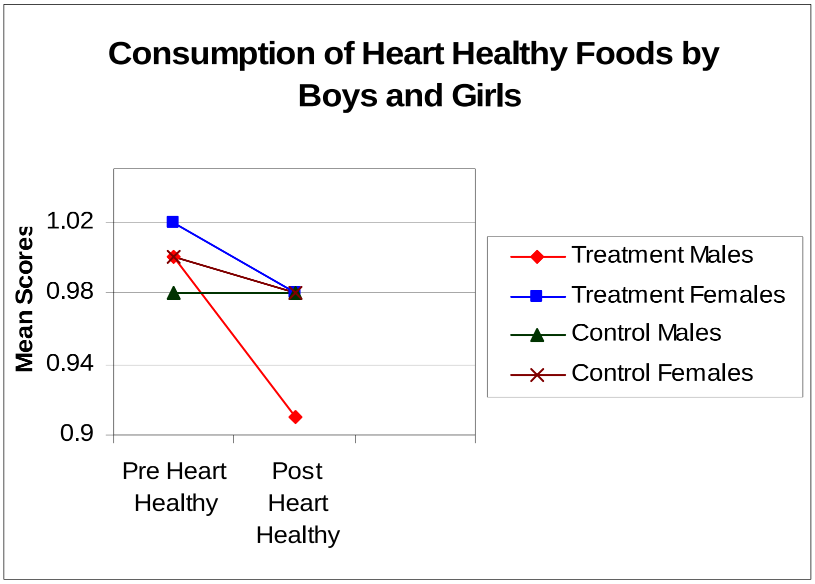

Figure 5-12. Effect of Fun to Be Fit on Frequency of Consumption of Heart Healthy Foods by Boys and Girls

Parallel lines indicate no significant interaction. Fun to Be Fit showed no difference on frequency of consumption of heart healthy foods by boys and girls. The program has the same effect on boys as girls.

The following tables report ANCOVA results of adjusted mean scores for treatment and control groups controlling for grade level at pre-test and post-test. To test whether differences are significant, the F test of significance is used. Significant p-values also are reported.

Table 5-7 shows ANCOVA results of adjusted scores for treatment and control groups on frequency of consumption of high fat, high sodium, high sugar and heart healthy foods. Results from this ANCOVA analysis are used to conclude whether Fun to Be Fit was more effective for boys than girls. Higher score indicates food eaten more often: lower score indicates food eaten less often. Thus, lower scores at post-test indicate improvement in frequency of food consumption, indicating a treatment effect. Range of possible scores is 0 (lowest) to 2 (highest).

Table 5-7. ANCOVA Comparison of Food Frequency Consumption Scores in Treatment and Control Group Boys and Girls

	Treatment		Control			
	Males (n)	Females (n)	Males (n)	Females (n)	F	p
Pre High Fat	1.20 (.35) N=142	1.16 (.34) N=167	1.10 (.34) N=105	1.15 (.33) N=102		
Post High Fat	.98 (.36) N=142	.95 (.33) N=167	1.08 (.35) N=105	1.10 (.33) N=102	.269	(ns) .604
Pre High Sodium	1.35 (.50) N=148	1.29 (.49) N=176	1.18 (.48) N=114	1.27 (.47) N=111		
Post High Sodium	1.06 (.54) N=148	1.07 (.50) N=176	1.19 (.51) N=114	1.22 (.41) N=111	.969	(ns) .325
Pre High Sugar	1.00 (.35) N=147	1.01 (.33) N=172	.90 (.33) N=109	1.00 (.34) N=109		
Post High Sugar	.86 (.35) N=147	.85 (.34) N=172	1.01 (.38) N=109	.98 (.38) N=109	1.616	(ns) .204
Pre Heart Healthy	.99 (.36) N=134	1.01 (.31) N=163	.97 (.34) N=101	.99 (.33) N=100		
Post Heart Healthy	.90 .(36) N=134	.98 (.36) N=163	.97 (.33) N=101	.98 (.29) N=100	2.412	(ns) .121

ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Figure 5-13 represents raw/unadjusted data from pre-test and post-test means for nutrition knowledge, controlling for grade level in treatment and control group males and females. This figure shows the degree of change in nutrition knowledge relative to gender.

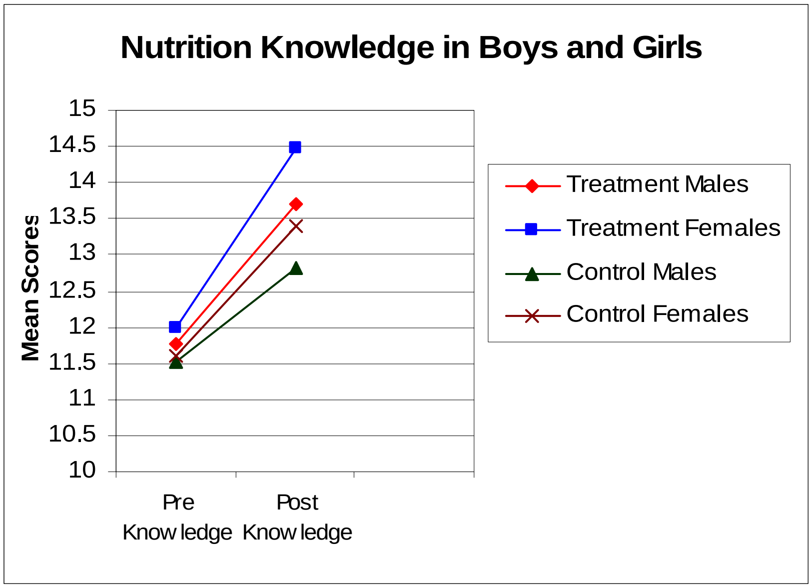

Figure 5-13. Effect of Fun to Be Fit on Nutrition Knowledge in Boys and Girls

The regression lines for girls and boys are parallel showing no significant interaction. No difference in nutrition knowledge was observed. Fun to Be Fit had the same effect on nutrition knowledge in boys and girls.

Table 5-8 shows ANCOVA results of adjusted difference scores, controlling for grade level among treatment and control group boys and girls on nutrition knowledge. Higher score indicates greater knowledge of nutrition. Range of possible scores is 0 (lowest) to 20 (highest).

Table 5-8. ANCOVA Comparison of Nutrition Knowledge Scores in Treatment and Control Group Boys and Girls

	Treatment		**Control**		**F**	**p**
	Males (n)	**Females (n)**	**Males (n)**	**Females (n)**		
Pre Knowledge	11.76 (3.22) N=152	11.98 (3.13) N=179	11.53 (3.84) N=121	11.59 (3.46) N=123		
Post Knowledge	13.69 (3.43) N=152	14.48 (3.47) N=179	12.83 (4.36) N=121	13.39 (4.16) N=123	.000	(ns) .989

ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Physical Fitness Assessments

The following figures: Figure 5-14, Figure 5-15, and Figure 5-16 represent raw/unadjusted pre-test and post-test data from fitness assessment scores, controlling for grade. Presence and/or absence of parallel lines signifies treatment or no treatment effect on number of push-ups, curl-ups completed, and the endurance run/walk shown for males and females in treatment and control groups.

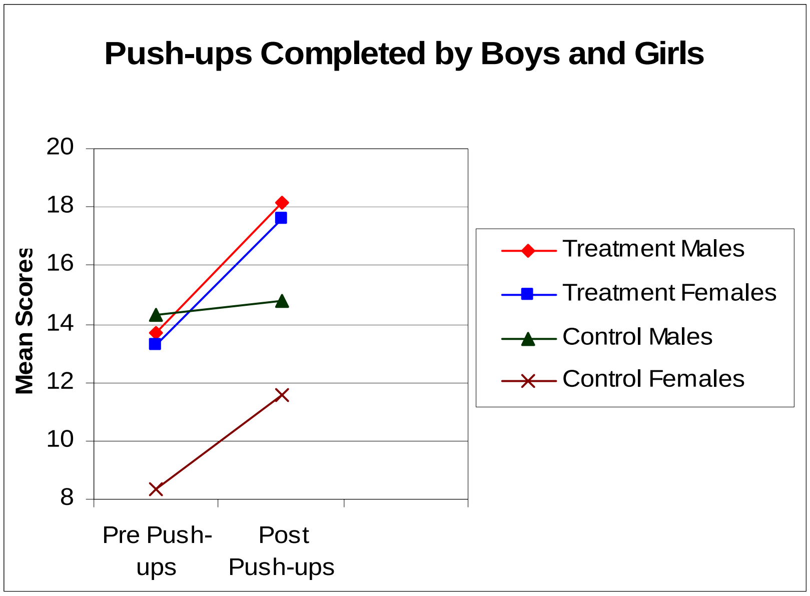

Figure 5-14. Effect of Fun to Be Fit on Number of Push-ups Completed by Boys and Girls

No significant effect in treatment males and females. Control males showed no significant increase in the number of push-ups completed at post test. Control females showed some small treatment effect, although not statistically significant**.**

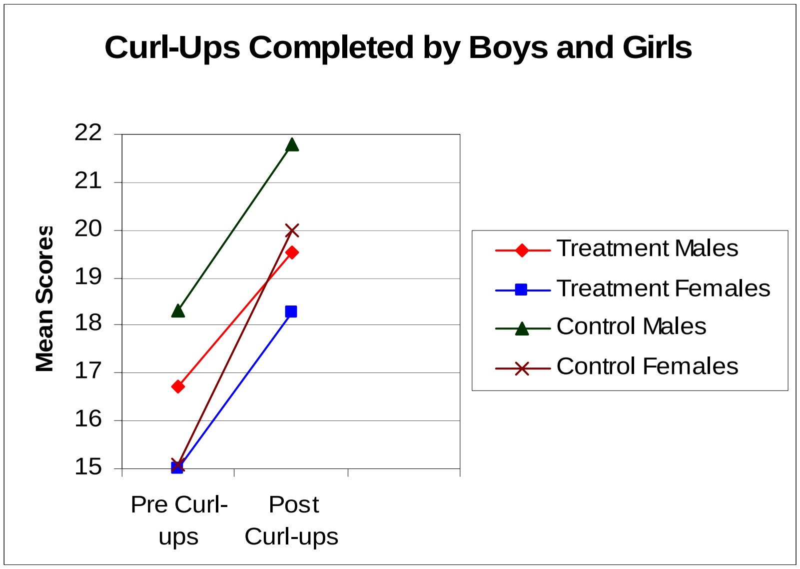

Figure 5-15. Effect of Fun to Be Fit on Number of Curl-ups Completed by Boys and Girls

Parallel lines indicate no significant difference in the number of curl-ups completed by both boys and girls. A comparable number of curl-ups were completed by boys and girls in both groups at post-test.

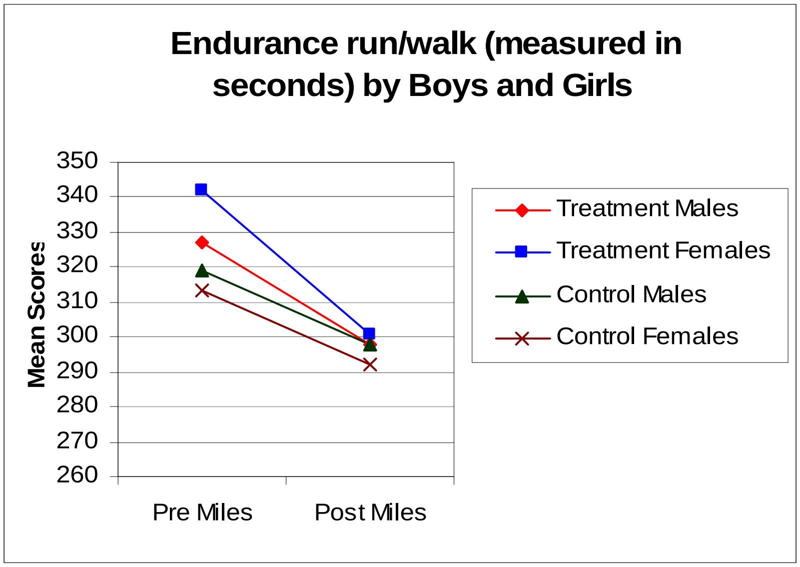

Figure 5-16. Effect of Fun to Be Fit on Endurance run/walk

No significant difference in post-test scores between girls and boys. Parallel lines show no effect from the Fun to Be Fit program was observed.

Table 5-9 reports adjusted mean difference scores from ANCOVA analysis. Higher scores for push-ups and curl-ups indicate greater number of fitness activities completed in 30 seconds while lower scores indicate fewer activities completed. The range of possible scores for push-ups and curl-ups are 0 (lowest) to 20 (highest). The endurance run/walk should be completed in less time at post-test than at pre-test. Grade and variation in pre-test scores were statistically controlled. ANCOVA analysis shows no treatment effect of Fun to Be Fit on physical activity levels.

Table 5-9. ANCOVA Comparison of Physical Activity Levels in Treatment and Control Group Boys and Girls

	Treatment		Control			
	Males (n)	**Females (n)**	**Males (n)**	**Females (n)**	**F**	**p**
Pre Push-ups	13.67 (7.69) N=150	13.27 (6.86) N=175	14.28 (7.90) N=39	8.36 (6.25) N=33		
Post Push-ups	18.13 (8.81) N=150	17.58 (7.35) N=175	14.77 (8.65) N=39	11.58 (7.66) N=33	.154	(ns) .695
Pre Curl-ups	16.70 (4.89) N=146	15.01 (5.75) N=172	18.32 (6.21) N=28	15.09 (7.39) N=23		
Post Curl-ups	19.51 (5.79) N=146	18.26 (5.40) N=172	21.79 (5.70) N=28	20.00 (5.36) N=23	.050	(ns) .823
Pre-Endurance run/walk	327.23 (76.21) N=92	342.07 (96.85) N=120	318.78 (71.61) N=74	313.46 (68.69) N=54		
Post-Endurance run/walk	297.92 (58.59) N=92	300.81 (60.03) N=120	297.97 (63.07) N=74	292.13 (93.80) N=54	.024	(ns) .877

ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Research Question 2 addresses whether participation in Fun to Be Fit had an effect on frequency of food consumption, nutrition knowledge, and physical activity levels for both boys and girls in treatment and control groups. To answer the question, ANCOVA was performed on difference scores to obtain an F value. Covariates were controlled to eliminate interactive effect.

No significant interaction of Fun to Be Fit was observed on frequency of food consumption, nutrition knowledge, or physical activity levels in boys and girls. Controlling for grade level and pre-test scores, Table 5-7 and Figures 5-9 through 5-12 show no significant statistical evidence of program domination on frequency of consumption of: high fat foods, (F (1, 526)=.269, p=.604; high sodium foods (F (1, 549)=.969, p=.325; high sugar foods (F (1, 537)=1.616, p=.204; and heart healthy foods, (F (1, 498)=2.412 p=.121 in girls and boys.

The mean frequency of food consumption difference scores for girls in the treatment group is consistent with those of the control group. This also is evident for boys in both the treatment and control groups.

In assessing nutrition knowledge, the lines for treatment and control group boys and girls appear to be parallel (Figure 5-13), indicating there is probably no statistically significant interaction. Data from Table 5-8 demonstrates that lack of significance can be confirmed by the F test (F (1,575)=.000, p=.989. The slopes are parallel for both groups, further confirming absence of an interaction in this condition.

ANCOVA was used to assess the effects of Fun to Be Fit as a predictor of increased physical activity levels (push-ups, curl-ups, and one-half mile endurance run/walk), controlling for grade and pre-test scores. Results from the ANCOVA F test reported in Table 5-9 and illustrated in Figure 5-14, Figure 5-15, and Figure 5-16 demonstrate the lack of significant effect of Fun to Be Fit on post physical activity variables: push-ups (F (1, 397)=.154, p=.695; Curl-ups (F (1, 369)=.050, p=.823; and one-half mile endurance run/walk (F (1, 340)=.024, p=.877). Figure 5-16 shows the lines are almost parallel which further confirms there is no statistically significant interaction of the program on the one-half mile endurance run/walk. The slope of the straight lines relating Fun to Be Fit and group type do not statistically significantly differ for boys and girls. Lack of a significant effect probably can be attributed to the extremely small sample size in the control group. The findings showed grade level did not make a significant difference in frequency of food consumption, improving nutrition knowledge, or increasing physical activity levels.

Question 3: Are similar effects from the Fun to Be Fit program observed on frequency of food consumption, nutrition knowledge, and physical activity levels for third and fourth grade students?

Frequency of Food Consumption

The figures below illustrate the effects of change in scores on frequency of food consumption, nutrition knowledge, and fitness assessments of the treatment and control third and fourth grade students. These figures represent raw/unadjusted data from pre-test and post-test means of food consumption and nutrition knowledge. Slope of the line also indicates the presence or absence of significant treatment effect.

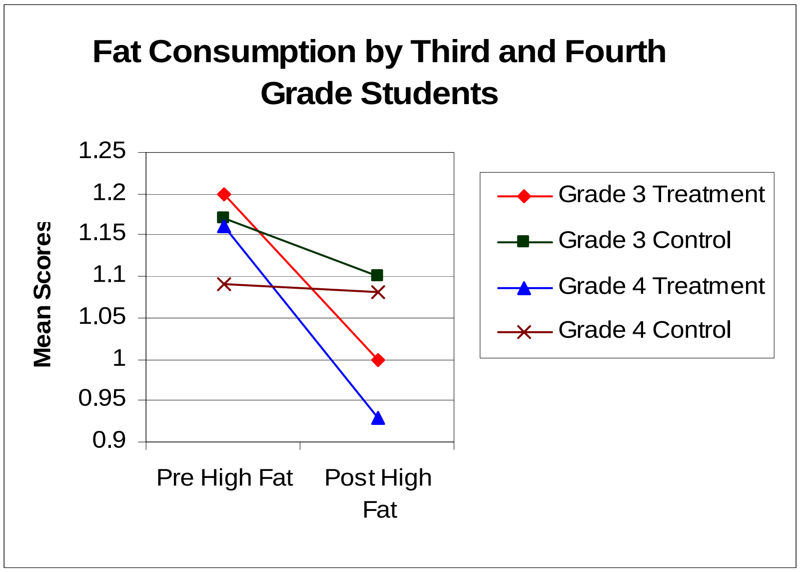

Figure 5-17. Effects of Fun to Be Fit on Consumption of High Fat Foods by Third and Fourth Grade Students

Post-test means of the treatment groups are not significantly different than that of the control groups. No effect of Fun to Be Fit was observed on frequency of fat consumption in either group. Grade 4 control group showed practically no improvement in consumption of high fat foods from pre-test to post-test.

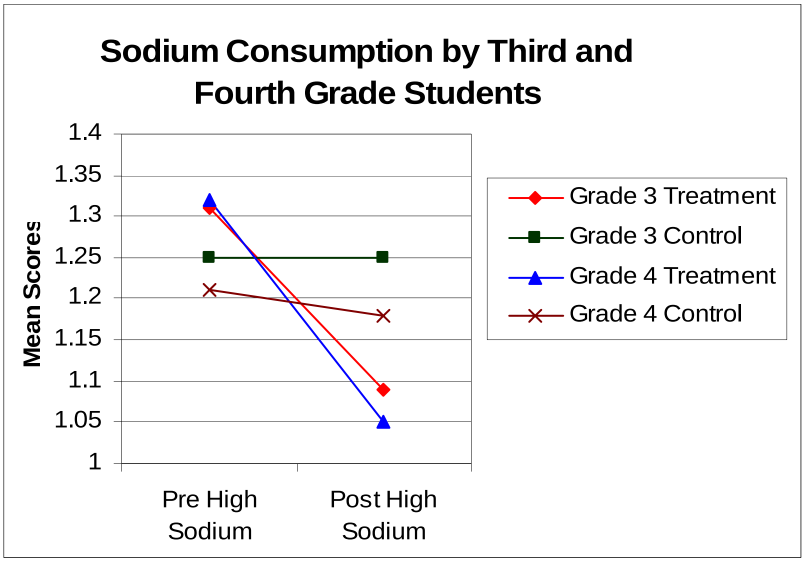

Figure 5-18. Effect of Fun to Be Fit on Consumption of High Sodium Foods by Third and Fourth Grade Students

No effect of Fun to Be Fit was observed on frequency of sodium consumption in third and fourth grade students. Students in Grade 3 control group showed no improvement in consumption of high sodium foods from pre-test to post-test.

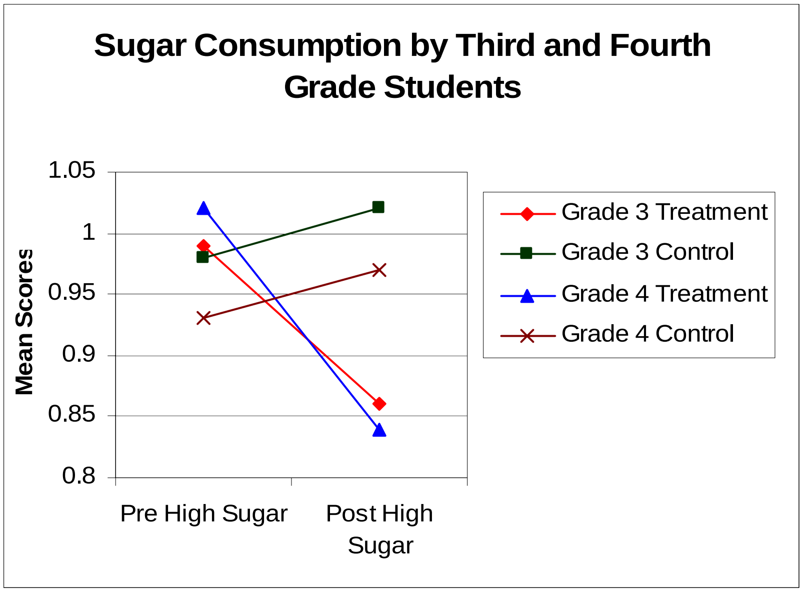

Figure 5-19. Effect of Fun to Be Fit on Consumption of High Sugar Foods in Third and Fourth Grade Students

Students in Grade 3 and Grade 4 control groups increased frequency of consumption of high sugar foods at post-test. Therefore, no significant effects of Fun to Be Fit are observed on either group.

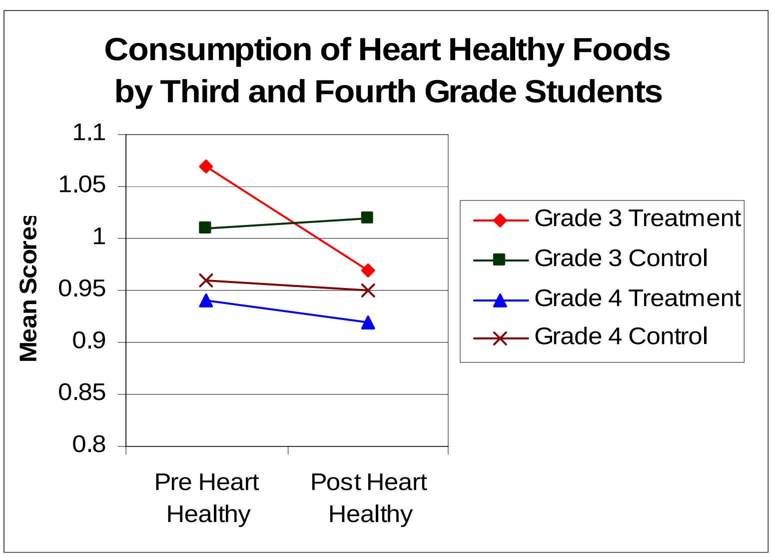

Figure 5-20. Effect of Fun to Be Fit on Consumption of Heart Healthy Foods by Third and Fourth Grade Students

No significant effects of Fun to Be Fit on frequency of consumption of heart healthy foods in Grade 4 treatment and control students. No significant difference in post-test means in Grade 3 and Grade 4 treatment and control group students.

Table 5-10 represents adjusted mean scores for third and fourth grade students. ANCOVA results show Fun to Be Fit has no significant effect on frequency of consumption of high fat, high sodium and high sugar foods in the sample of third and fourth grade students. Higher score indicates food eaten more often: lower score indicates foods eaten less often. Mean scores for third and fourth grade control group students showed an increase in consumption of high sugar foods from pre-test to post-test.

Table 5-10. ANCOVA Analysis of Frequency of Food Consumption in Third and Fourth Grade Students

	Treatment		Control			
	Grade 3	Grade 4	Grade 3	Grade 4	F	p
Pre High Fat	1.20 (.37) N=141	1.16 (.31) N=168	1.17 (.34) N=83	1.09 (.33) N=124		
Post High Fat	1.00 (.36) N=141	.93 (.33) N=168	1.10 (.34) N=83	1.08 (.34) N=124	1.54	(ns) .214
Pre High Sodium	1.31 (.43) N=152	1.32 (.46) N=172	1.25 (.50) N=88	1.21 (.46) N=137		
Post High Sodium	1.09 (.54) N=152	1.05 (.50) N=172	1.25 (.49) N=88	1.18 (.45) N=137	.000	(ns) .984
Pre High Sugar	.99 (.35) N=148	1.02 (.33) N=171	.98 (.34) N=84	.93 (.34) N=134		
Post High Sugar	.86 (.37) N=148	.84 (.32) N=171	1.02 (.37) N=84	.97 (.39) N=134	.001	(ns) .971
Pre Heart Healthy	1.07 (.33) N=78	.94 (.33) N=160	1.01 (.37) N=78	.96 (.31) N=123		
Post Heart Healthy	.97 (.37) N=78	.92 (.35) N=160	1.02 (.32) N=78	.95 (.30) N=123	1.54	(ns) .215

ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Figure 5-21 represents raw/unadjusted data from pre-test and post-test means for nutrition knowledge, controlling for gender. This figure shows the effects of change in scores on nutrition knowledge of the treatment and control third and fourth grade students.

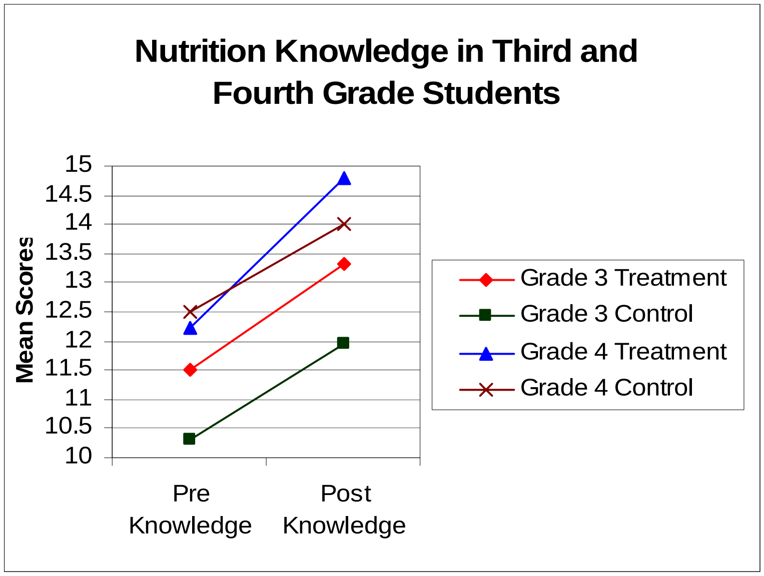

Figure 5-21. Effects of Fun to Be Fit on Nutrition Knowledge in Third and Fourth Grade Students

No significant post-test differences in nutrition knowledge between students in Grade 3 and Grade 4 treatment and control groups. Parallel lines show no significant effect from the Fun to Be Fit program was observed on nutrition knowledge.

Table 5-11 contains adjusted mean scores for nutrition knowledge for third and fourth grade treatment and control students, controlling for gender. Results from the ANCOVA analysis show no observed significant effects of Fun to be Fit program on nutrition knowledge in third and fourth grade students.

Table 5-11. ANCOVA Analysis of Nutrition Knowledge in Third and Fourth Grade Students

	Pre Knowledge		Post Knowledge		F	p
	Treatment	Control	Treatment	Control		
Grade 3	11.49 (3.40) N=154	10.32 (3.26) N=105	13.33 (3.52) N=154	11.94 (4.22) N=105		
Grade 4	12.23 (2.93) N=177	12.49 (3.66) N=139	14.80 (3.28) N=177	13.99 (4.09) N=139	.022	(ns) .882

ns=not significant, values are mean scores, numbers in parentheses are standard deviations

Physical Fitness Assessments

The following figures represent raw/unadjusted pre-test and post-test data from fitness assessment scores controlling for gender. Results showed no treatment effect was observed on number of push-ups or curl-ups completed. However, a treatment effect was observed in third and fourth grade students in both the treatment and control groups on the endurance run/walk. Slower times indicate the one-half endurance run/walk was performed in less amount of time at post-test than pre-test, which is the desired outcome.

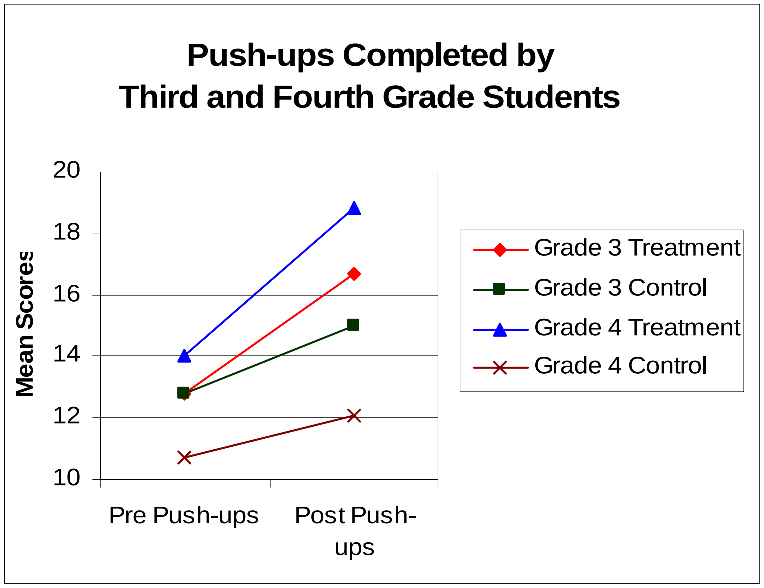

Figure 5-22. Effect of Fun to Be Fit on Number of Push-ups Completed by Third and Fourth Grade Students

Parallel lines show no effect from the Fun to Be Fit program observed on number of push-ups completed. No significant differences in groups were observed. Fun to Be Fit had no effect on the number of push ups completed by third or fourth grade students.

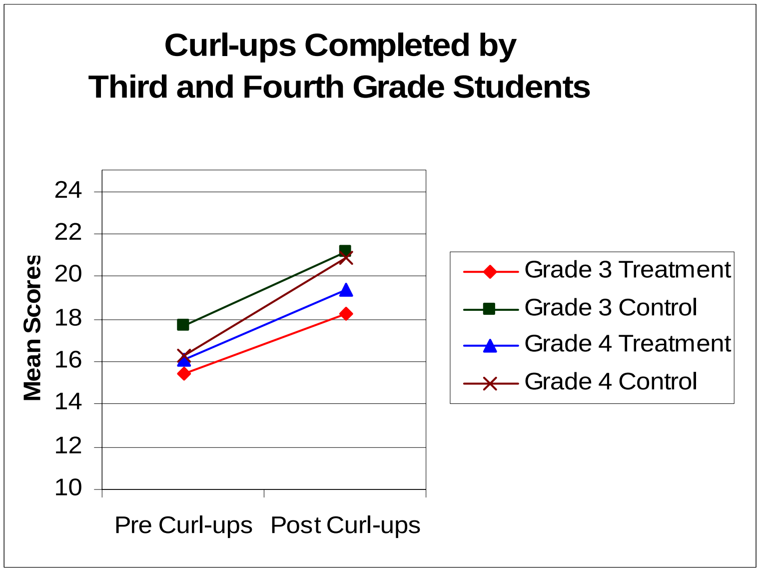

Figure 5-23. Effect of Fun to Be Fit on Number of Curl-ups Completed by Third and Fourth Grade Students

The post-test mean for curl-ups of Grade 3 and Grade 4 treatment groups is not significantly different from that of the Grade 3 and Grade 4 control group. No significant differences were observed between the groups at pre-test or post-test.

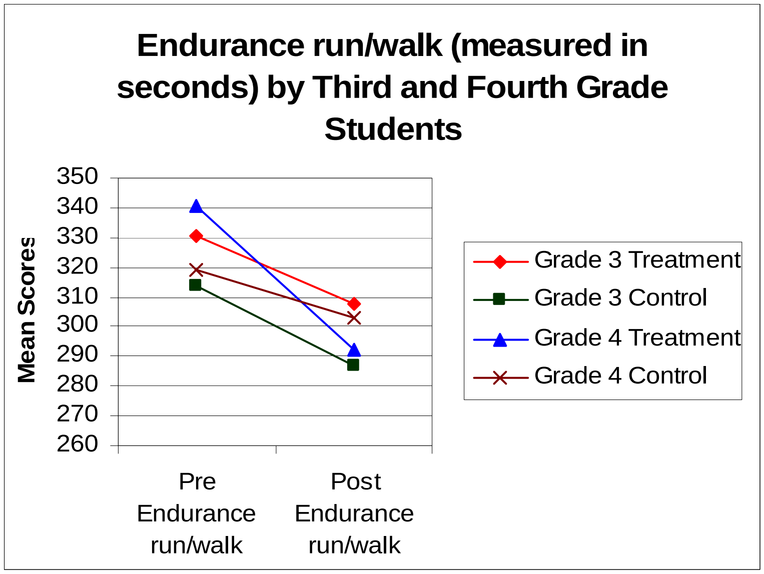

Figure 5-24. Effects of Fun to Be Fit on Endurance run/walk in Third and Fourth Grade Students

ANCOVA indicates the post-test differences between the two groups are significant. A treatment effect was detected in treatment group students in Grade 4.

Table 5-12 shows adjusted mean scores for physical activities for third and fourth grade students. ANCOVA results show participation in Fun to Be Fit had no effect on the number of push-ups and curl-ups completed. Higher score indicates greater number performed. Means for both groups were not significantly different. However, effects from Fun to Be Fit were observed on scores from the one-half mile endurance run/walk in Grade 4 treatment students.

Table 5-12. ANCOVA Analysis of Physical Activity Levels in Third and Fourth Grade Students

	Treatment		Control			
	Grade 3	**Grade 4**	**Grade 3**	**Grade 4**	**F**	**p**
Pre Push-ups	12.78 (6.74) N=153	14.05 (7.63) N=172	12.77 (8.84) N=30	10.71 (6.83) N=42		
Post Push-ups	16.70 (7.59) N=153	18.84 (8.35) N=153	15.00 (8.98) N=30	12.10 (7.67) N=42	2.713	(ns) .100
Pre Curl-ups	15.40 (7.59) N=150	16.13 (5.38) N=168	17.68 (5.92) N=22	16.24 (7.60) N=29		
Post Curl-ups	18.27 (5.60) N=150	19.33 (5.58) N=168	21.14 (5.75) N=22	20.86 (5.66) N=29	.000	(ns) .984
Pre-Endurance run/walk	330.50 (64.08) N=101	340.30 (105.73) N=111	313.63 (75.34) N=60	319.10 (65.80) N=68		
Post Endurance run/walk	307.90 (57.74) N=101	291.96 (59.09) N=111	286.95 (74.25) N=60	303.06 (79.18) N=68	8.412	**p=.004***

*significant at p< .05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Physical Fitness Assessments

The fitness assessment component of Fun to Be Fit reported in Table 5-12 is modified from the 50th percentile of the President's Challenge fitness activities based on the 1985 School Population Fitness Survey reported in Table 5-13. Table 5-13 reports normative data for boys and girls of comparable grade level (Grade 3 and Grade 4) to the treatment and control group students participating in the Fun to Be Fit pilot program.

These mean scores are reported as the number of push-ups and curl-ups completed in 60 seconds rather than Fun to Be Fit's requirement of 30 seconds. The President's Challenge measured activities based on percentile scores based on age/test in number of curl-ups in 60 seconds, number of push-ups completed every 3 seconds, and percentile scores based on age/test scores in number of laps run/walked in minutes and seconds. Third and fourth grade students participating in Fun to Be Fit performed more push-ups in 30 seconds at pre-test and post-test (Table 5-12) than the normative data reported from the President's Challenge.

Table 5-13. The President's Challenge Normative Data Based on the 1985 School Population Fitness Survey

	Grade 3		Grade 4	
	Males	**Females**	**Males**	**Females**
Push-ups	9	9	12	12
Curl-ups	31	29	32	30
Endurance run/walk**	4:22	4:56	4:14	4:50

**Endurance run/walk already modified to one-half mile run/walk and reported in minutes and seconds.

Research Question 3 examines whether the observed effect of Fun to Be Fit on frequency of food consumption, nutrition knowledge, and physical activity is similar for third and fourth grade students. As a result of participation in the Fun to Be Fit program, the aim was to observe a treatment effect in third and fourth grade students while reducing frequency of consumption of foods high in fat, sugar, and sodium, increasing consumption of heart healthy foods, nutrition knowledge, and increasing physical activity. To answer the question, ANCOVA was performed on difference scores to obtain an F value. Covariates: gender and pre-test scores were controlled to eliminate the interactive effect. Results from Table 5-10 show no statistical evidence of program domination on frequency of consumption of: high fat foods, (F (1, 516)=1.54, p=.214; high sodium foods (F (1, 549=.000); p=.984; high sugar foods (F(1. 573)=.001, p=.971; and heart healthy foods, (F(1, 498)=1.54, p=.215 in third and fourth grade students. Parallel lines show no significant interactions between Fun to Be Fit and the independent variables (GRADE x EXPGROUP) were observed.

ANCOVA results from Table 5-11 show no significant change in nutrition knowledge in third and fourth grade students. None of the groups showed improvement from pre-test to post-test. Neither the size of the effect nor the results were significant (F (1, 575)=.022, p=.882.

No significant effects from the Fun to Be Fit program were observed on push-ups (F (1,397)=2.713, p=.100 or curl-ups (F (1,369)=.000, p=.984. Moreover, the sample size for push-ups for treatment groups Grade 3 (n=153) and Grade 4 (n=172) is more than four times the size of the control groups: Grade 3 (n=30) and Grade 4 (n=42). While not statistically significant, within groups, students in Grade 4 treatment group showed the most improvement in push ups from pre-test (M=14.05, SD=7.63) to post-test (M=18.84, SD=8.35).

Results reported in Table 5-12 show a treatment effect of the Fun to Be Fit program on the one-half mile endurance run/walk (F (1, 340)=8.412, p=.004 in the Grade 4 treatment group Significant differences in mean scores were observed at pre-test (M=340.30, SD=105.73) and at post-test (M=291.96, SD=59.09). Although students in the Grade 3 treatment group, and students in the Grade 3 and Grade 4 control groups decreased the time in which the endurance run/walk was performed, the Grade 4 treatment group showed the largest decrease overall in the time taken to complete the one-half mile run/walk from pre-test to post-test.

It appears that Fun to Be Fit was more effective on certain physical fitness activities for fourth grade students in the treatment group, specifically the endurance run/walk than any other group. Table 5-12 shows that Fun to Be Fit does not appear to significantly improve physical activity levels in third and fourth grade students.

Question 4: How effective is Fun to Be Fit in students with high food frequency, low nutrition knowledge and physical activity levels at pre-test in comparison to students with high nutrition knowledge, and physical activity levels at pre-test?

Frequency of Food Consumption

The figures below show raw unadjusted scores from a median split analysis. These figures represent pre-test and post-test means for food consumption and nutrition knowledge controlling for gender and grade in the control high and low group; and the treatment high and low group.

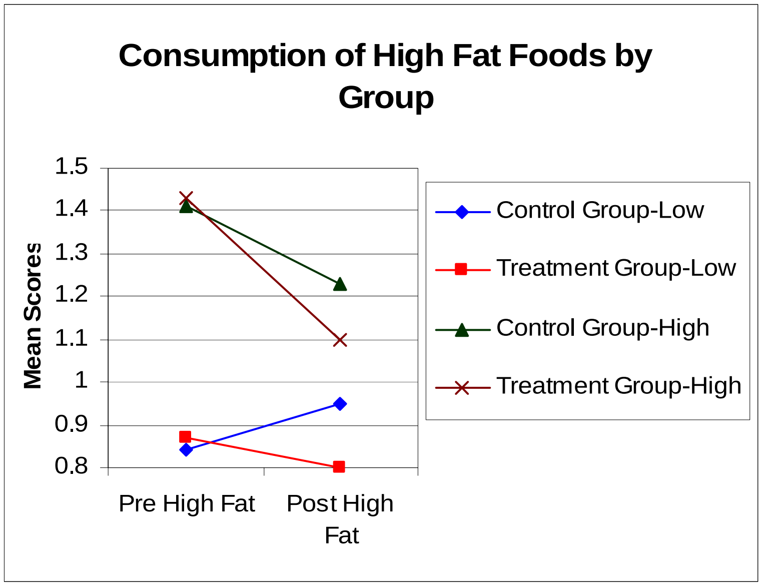

Figure 5-25. Frequency of High Fat Foods Consumption by Group

Fun to Be Fit is more effective for students in the treatment and control high group than the treatment and control low group.

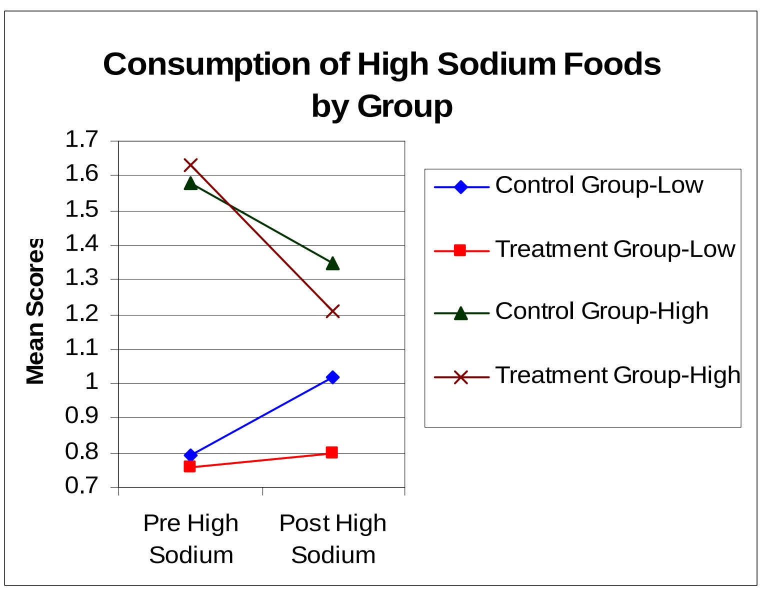

Figure 5-26. Frequency of High Sodium Foods Consumption by Group

The control and treatment high group had lower frequency of consumption of foods high in sodium than the control and treatment low group. Although Fun to Be Fit was effective in both groups, the control and treatment high group appears to have received more benefit from Fun to Be Fit.

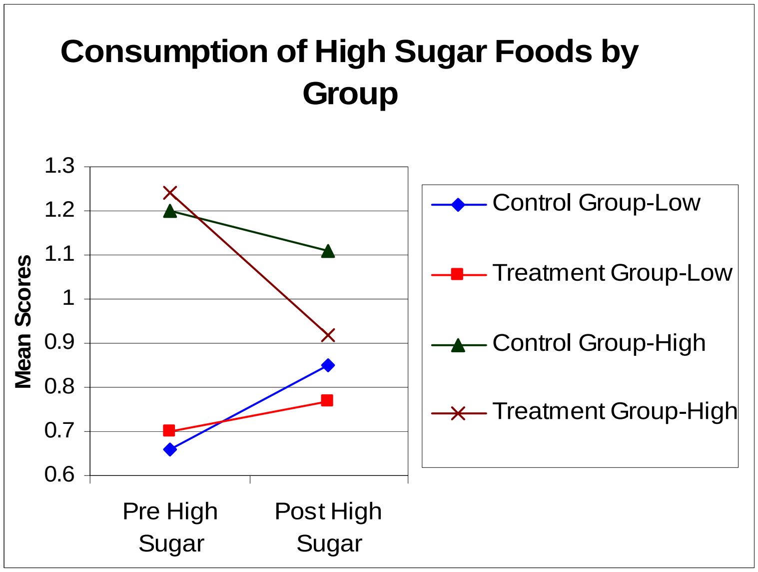

Figure 5-27. Frequency of High Sugar Foods Consumption by Group

The control and treatment high group received the most benefit from the effect of Fun to Be Fit in decreasing consumption of foods high in sugar.

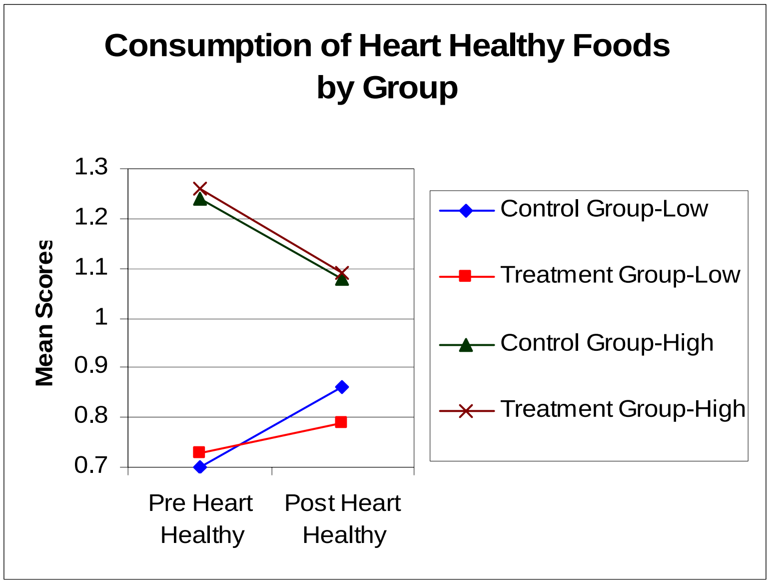

Figure 5-28. Frequency of Heart Healthy Foods Consumption by Group

The effect of Fun to Be Fit was more significant in the control low and treatment low group. No significant difference in the post-test means between the control high and treatment high group. The regression lines overlap and the intercepts of the two regression lines for this group are equal.

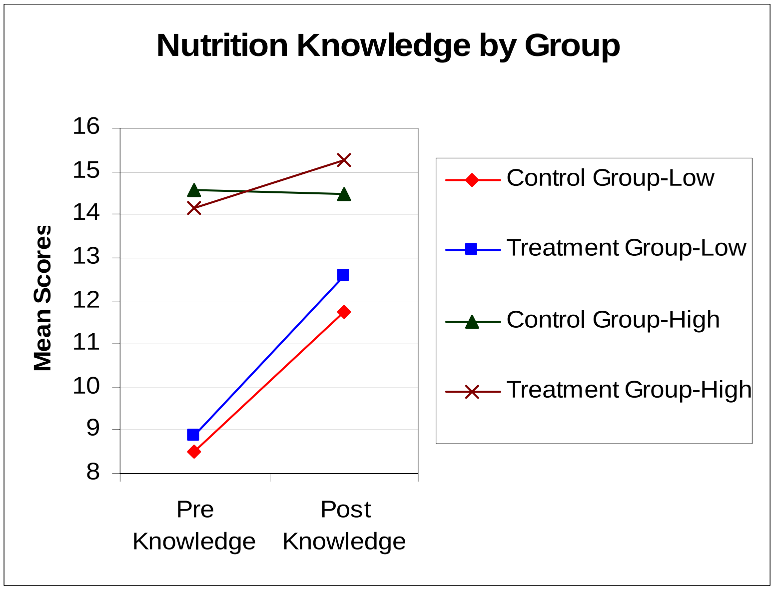

Figure 5-29. Nutrition Knowledge by Group

Fun to Be Fit was more effective in the control high and treatment high group than the low group. Parallel lines indicate no significant interaction of Fun to Be Fit on nutrition knowledge in the control low and treatment low group.

Frequency of Food Consumption

The following tables, Table 5-14, Table 5-15, Table 5-16, Table 5-17, and Table 5-18 show results of median split analysis on frequency of consumption of high fat, high sodium, high sugar, heart healthy foods and nutrition knowledge. The results were significant by group on consumption of high fat and high sodium foods, indicating significant treatment effects were observed on both the treatment and control low and high groups.

Table 5-14. Median Split Analysis Consumption of High Fat Foods by Group

MEDIAN SPLIT (M=1.200)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low**	106	.84 (.20)	.95 (.32)	17.270	**p=.000***
	Treatment Low	140	.87 (.21)	.80 (.28)		
GROUP 2	**Control High**	101	1.41 (.17)	1.23 (.30)	12.406	**p=.001***
	Treatment High	169	1.43 (.19)	1.10 (.34)		

*****=significant at p<.05; values are mean scores; numbers in parentheses are standard deviations.

Table 5-15. Median Split Analysis Consumption of High Sodium Foods by Group

MEDIAN SPLIT (M=1.330)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low**	101	.79 (.29)	1.02 (.45)	15.225	**p=.000***
	Treatment Low	117	.76 (.29)	.80 (.46)		
GROUP 2	**Control High**	124	1.58 (.25)	1.35 (.43)	9.018	**p=.003***
	Treatment High	207	1.63 (.26)	1.21 (.49)		

*****=significant at p<.05; values are mean scores; numbers in parentheses are standard deviations.

Table 5-16. Median Split Analysis Consumption of High Sugar Foods by Group

MEDIAN SPLIT (M=1.000)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low**	101	.66 (.20)	.85 (.35)		
	Treatment Low	137	.70 (.18)	.77 (.32)	5.442	**p=.021***
GROUP 2	**Control High**	117	1.20 (.21)	1.11 (.36)		
	Treatment High	182	1.24 (.23)	.92 (.35)	20.084	**p=.000***

*****=significant at p<.05; values are mean scores; numbers in parentheses are standard deviations.

Table 5-17. Median Split Analysis Consumption of Heart Healthy Foods by Group

MEDIAN SPLIT (M=1.000)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low**	96	.70 (.19)	.86 (.30)		
	Treatment Low	144	.73 (.17)	.79 (.31)	7.381	**p=.007***
GROUP 2	**Control High**	105	1.24 (.20)	1.08 (.28)		
	Treatment High	153	1.26 (.22)	1.09 (.34)	.211	(ns) p=.647

*****=significant at p<.05; ns=significant; values are mean scores; numbers in parentheses are standard deviations.

Table 5-18. Median Split Analysis of Nutrition Knowledge by Group

MEDIAN SPLIT (M=12.00)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low**	121	8.50 (2.02)	11.73 (4.21)		
	Treatment Low	142	8.89 (2.01)	12.60 (3.61)	1.599	(ns) .207
GROUP 2	**Control High**	123	14.56 (2.05)	14.47 (3.86)		
	Treatment High	189	14.13 (1.69)	15.26 (2.88)	10.147	**p=.002***

*****=significant at p<.05; ns=significant; values are mean scores; numbers in parentheses are standard deviations.

Physical Fitness Assessments

Figure 5-30, Figure 5-31, and Figure 5-32 below illustrate the results of median split analysis. Groups that had lower scores at pre-test and those with higher scores at pre-test observed some treatment effects, such as change in physical activity levels.

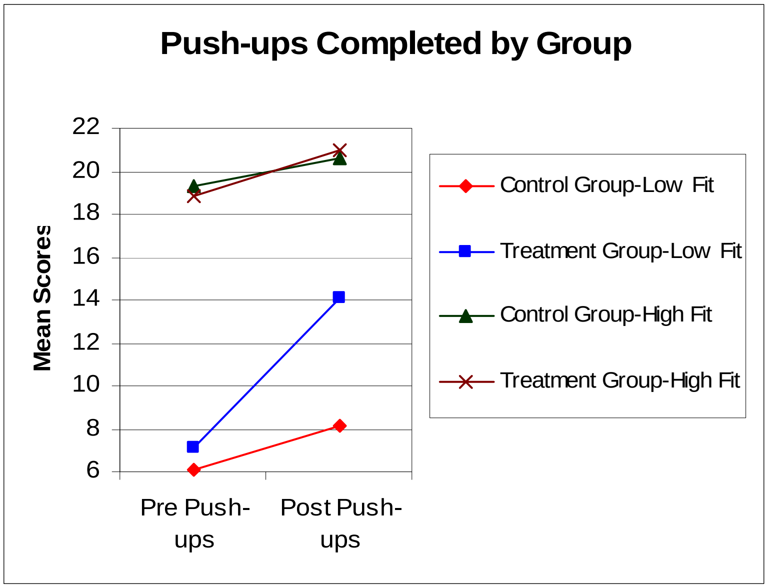

Figure 5-30. Push-ups Completed by Group

Fun to be Fit showed effectiveness for the control and treatment low fit group. No significant differences in the post-test scores between the control and treatment high fit group.

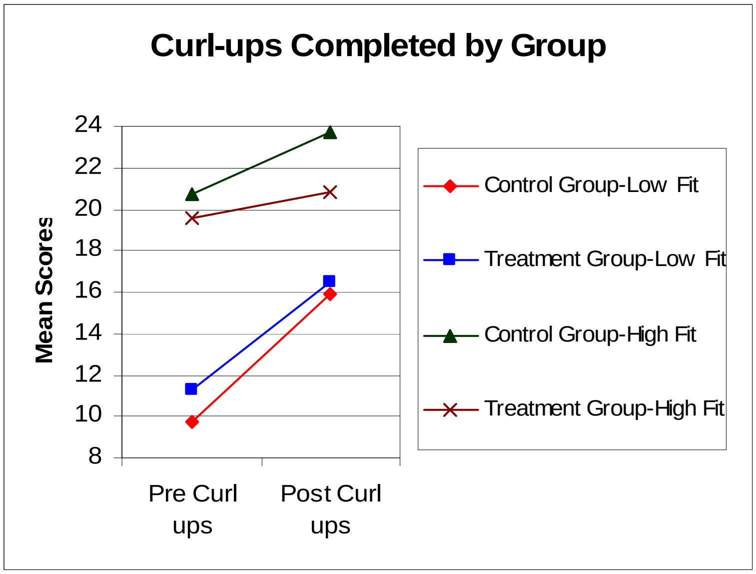

Figure 5-31. Curl-ups Completed by Group

Treatment effect of Fun to Be Fit is observed in the control and treatment high fit group. Parallel lines represent no significant treatment interaction in the low fit group.

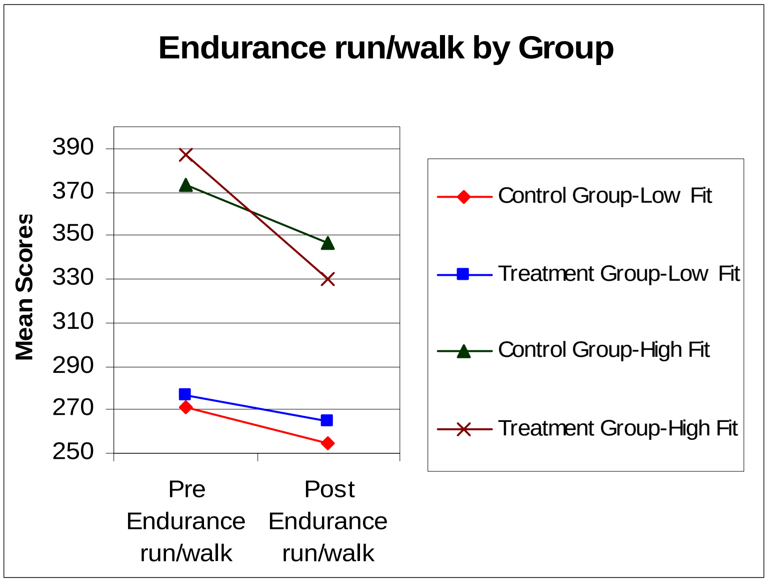

Figure 5-32. Differences in Times for Endurance run/walk

A significant treatment effect was detected in the control and treatment high fit group. No significant treatment effect was detected in the treatment and control low fit group.

Table 5-19, Table 5-20, and Table 5-21 report adjusted fitness scores for median split analysis for low fit and high fit treatment and control students at pre-test and post-test. Higher scores indicate greater number of fitness activities performed.

Table 5-19. Median Split Analysis Number of Push ups Completed by Group

MEDIAN (M=13.00)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low Fit**	42	6.07 (3.27)	8.10 (5.560)		
	Treatment Low Fit	149	7.13 (3.96)	14.09 (7.24)	11.764	**p=.001***
GROUP 2	**Control High Fit**	30	19.27 (5.13)	20.60 (5.51)		
	Treatment High Fit	176	18.81 (4.57)	20.94 (6.98)	.083	(ns) p=.773

*=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Table 5-20. Median Split Analysis Number of Curl ups Completed by Group

MEDIAN SPLIT (M=16.00)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low Fit**	18	9.78 (6.33)	15.94 (5.36)		
	Treatment Low Fit	145	11.23 (3.56)	16.45 (4.99)	.219	(ns) p=.641
GROUP 2	**Control High Fit**	33	20.73 (3.07)	23.73 (3.31)		
	Treatment High Fit	173	19.60 (3.31)	20.83 (5.32)	5.600	**p=.019***

*=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Table 5-21. Median Split Analysis One-half mile run/walk by Group

MEDIAN (M=314.0)	GROUP TYPE	N	PRE	POST	F	p
GROUP 1	**Control Low Fit**	71	270.97 (21.52)	254.34 (41.91)		
	Treatment Low Fit	99	277.11 (24.49)	264.52 (36.08)	2.227	(ns) p=.138
GROUP 2	**Control High Fit**	57	373.30 (68.46)	346.79 (80.22)		
	Treatment High Fit	113	386.89 (92.14)	335.80 (66.92)	5.017	**p=.026***

*=significant at p<.05; ns=not significant; values are mean scores; numbers in parentheses are standard deviations.

Median split analysis was performed for Question 4 to examine the effect of Fun to Be Fit on scores of low and high treatment, and low and high control groups. Pre-test scores for each outcome variable was split on the median to form two groups; a group that was more healthy and a group that was less healthy at the beginning. Group differences were also examined.

Group 1 consists of control and treatment low (less healthy at pre-test) students. Group 2 consists of students in the control and treatment high (more healthy at pre-test) group.

The median for each of the dependent (post-test) variables was obtained from descriptive statistics: high fat (1.200), high sodium (1.330), high sugar (1.000) and heart healthy foods (1.000), nutrition knowledge (12.00), push-ups (13.00), curl-ups (16.00) and one-half mile endurance run/walk (314.0 seconds).

Further inspection of the pre-test and post-test food frequency consumption, nutrition, and physical activity scores in some instances shows possible regression to the mean. This is particularly evident in both frequency of food consumption and fitness post-test scores, where groups with high pre-test scores have low post-test scores, and groups with low pre-test scores have high post-test scores. Regression to the mean potentially could have reduced the effectiveness of Fun to Be Fit. Because of regression to the mean; it is difficult to conclude that Fun to Be Fit actually had a treatment effect. The FRESH Survey, fitness assessments, or the groups themselves could contribute to regression to the mean. Although some increases and/or decreases from pre-test to post-test are indeed real, some could have occurred by chance.

Results of the split median analysis for each variable are presented in Tables 5-14 through 5-21.

Results for frequency of consumption of high fat foods by group are reported in Table 5-14. Fun to Be Fit had a treatment effect on both the control and treatment groups, although there was a more significant result in Group 1 (F (1, 246)=17.270, p=.000 than Group 2 (F (1, 270)=12.406, p=.001.

Median split results for frequency of consumption of high sodium foods reported in Table 5-15 indicate significant program effect in Group 1 (F (1, 218)=15.225, p=.000. Although Group 2 showed a small treatment effect (F (1, 331)=9.018, p=.003; the effect was more significant in Group 1. Fun to Be Fit was more effective in decreasing frequency of consumption of high sodium foods in Group 1.

Table 5-16 shows Fun to Be Fit was more effective in Group 2 (F (1, 299)=28.084, p=.000 in decreasing frequency of consumption of high sugar foods than Group 1 (F (1, 238)=5.442, p=.021. Slope of the line for Group 2 (Figure 5-27) showed more positive change.

Table 5-17 shows Fun to Be Fit had more of a treatment effect Group 1 (F (1, 240)=7.381, p=.007 than Group 2 (F (1, 258)=.211, p=.647. The parallel lines in Figure 5-28 indicate no significant interaction between Fun to Be Fit and increased frequency of consumption of heart healthy foods in Group 2. As evidenced by post-test scores, Group 2 consumed significantly less heart healthy foods at post-test.

Fun to Be Fit was more effective in the high group in increasing nutrition knowledge in Group 2. Results from Table 5-18 ($F(1, 312)=10.147$, $p=.002$ show treatment effect was more significant in Group 2 than that of Group 1 ($F(1, 263)=1.599$, $p=.207$. The parallel lines shown for Group 1 in Figure 5-29, suggest no significant interaction.

Similar effects of Fun to Be Fit were shown on physical activity variables. Additionally, the control groups contained less than half the students as the treatment groups. This factor could potentially affect treatment effect, size of the effect, results, and conclusions to be drawn from the data. With regard to physical activity variables, Groups 1 and 2 are further differentiated into Control and Treatment Low Fit: Group 1 (low fitness scores); and Control and Treatment High Fit: Group 2 (already having high fitness scores at pre-test).

Table 5-19 reports the effect of Fun to Be Fit on number of push-ups completed by the treatment and control groups. Results from the median split analysis indicate a treatment effect in Group 1 ($F(1, 191)=11.764$, $p=.001$ than Group 2. Figure 5-30 illustrates Group 2 showed no significant increases in post-test scores ($F(1, 206)=.083$, $p=.773$.

Table 5-20 reports that Fun to Be Fit was more effective in students in Group 2 ($F(1, 206)=5.60$, $p=.019$ than Group 1($F(1, 163)=.219$, $p=.641$ on the number of curl-ups. Group 2 significantly increased the number of curl-ups completed at post-test. Parallel lines in Figure 5-31 indicate no significant interaction of Fun to Be Fit on Group 1.

There appears to be somewhat of a treatment effect of Fun to Be Fit on the endurance run/walk scores in Group 2 as reported in Table 5-21 ($F(1, 170)=5.017$, $p=.026$; and illustrated by Figure 5-32; suggesting that these students could be at a higher fitness level prior to Fun to Be

Fit. Parallel lines in Figure 5-32 indicate no significant interaction of the program in Group 1 (F (1, 170)=2.227, p=.138. Lesser times indicate not as much time to complete the one-half mile endurance run/walk, which is the expected outcome at post-test.

The median split analysis, data tables, and figures, show that Fun to Be Fit was more effective for Group 2 (high fit) than Group 1 (low fit) on physical activity levels. Fun to Be Fit appeared to be more effective for Group 1 only on push-ups.

Fun to Be Fit had an effect on both Group 1 and Group 2 with regard to frequency of consumption of high fat, high sodium, high sugar and heart healthy foods,. The exception was frequency of consumption of heart healthy foods and nutrition knowledge. Students in Group 2 reported lower consumption of heart healthy foods. Students in Group 1 did not increase nutrition knowledge as a result of participation in Fun to Be Fit.

From the results presented for each of the research questions, it can be concluded that Fun to Be Fit could be an effective school-based approach in addressing childhood overweight and obesity in elementary school-age students.

6.0 DISCUSSION

6.1 OVERVIEW OF THE STUDY

This chapter examines the results of this study, and discusses the findings presented in previous chapters. Study limitations, policy implications for public health practice, and future childhood obesity research initiatives also will be discussed.

Study Overview

This study began with discussion of literature, methodology and results which confirm the effects of SPARK and FRESH on childhood overweight and obesity in a sample of third and fourth grade elementary school students.

In recent years, many multifaceted, school-based interventions (such as Planet Health, SPARK, and CATCH) have been designed to address childhood obesity. However, research has shown that certain variables within these interventions may moderate the effects designed to influence food-related behaviors and physical activity. Several of the large-scale, controlled intervention studies have examined variables such as weight loss and BMI changes as outcome measures (IOM, 2005). Although these variables were not included in Fun to Be Fit, school districts are now required to collect, record, and report BMI for each student at the beginning and conclusion of the school year. Moreover, schools also are beginning to make significant changes in the school food environment and in physical education curricula. These actions further support the need for programs such as Fun to Be Fit. Programs of this type have demonstrated effectiveness in addressing childhood overweight and obesity from a public health perspective.

This study revealed that participation in Fun to Be Fit showed reductions in consumption of high fat, sodium and sugar foods, and improved nutrition knowledge among the treatment group compared to the control group. However, it is noteworthy that the effects of the program did not differ regardless of grade level or gender. Although the sample chosen may not be representative of the entire population of Pittsburgh Public School students, the severity of childhood overweight and obesity necessitates further exploration of the program.

This study also is significant given that school-based approaches are necessary to understanding knowledge, attitudes, and beliefs regarding dietary intake and physical activity among elementary school students. It provides further evidence that school-based nutrition and physical activity interventions may be effective in addressing childhood overweight and obesity. Moreover, this study has public health relevance since it is a first step in addressing consequences relevant to childhood overweight and obesity in the Pittsburgh Public School District.

6.1.1 FREQUENCY OF FOOD CONSUMPTION

The findings suggested that both treatment and control groups showed improvement in food consumption of foods high in fat, sodium and sugar from pre-test to post-test. The study revealed that, in the overall sample, Fun to Be Fit appeared to show greater effect for the treatment group compared to those in the control group. Students in the treatment group significantly reduced frequency of consumption of foods high in fat, sodium, and sugar; indicating improved food behavior. The fact that these students significantly had improved scores from pre-test to post-test suggests the program was effective for these students. This is an important finding because it suggests that the program was effective for the group for which it was designed.

The findings showed that neither gender nor grade level make a difference in frequency of food consumption or improve nutrition knowledge. No additional information was available to explain the consistent lack of program effect on gender or grade level. Racial differences and the urban setting were not controlled in this study.

Findings from the median split analysis showed that Fun to Be Fit was effective for both control and treatment low, and control and treatment high groups on food frequency consumption and the consumption of heart healthy foods. The program appears to reduce the self-reported frequency of consumption of high fat, sodium, and sugar foods; and increase reported consumption of heart healthy foods in both groups. Participation in Fun to Be Fit did not improve the consumption of heart healthy foods at post-test in students in the control and treatment high groups. However, this group had higher nutrition knowledge scores.

Additionally, findings from the independent samples t-test revealed the means of the two groups were not significantly different. It is likely the groups are from a population with similar mean values.

As research findings have shown, despite tremendous commitments of resources and expertise, intervention effects were significant for some reported behavioral changes, but not for others (Luepker et al., 1996). Therefore, without knowledge of other issues, no assumptions can be made regarding program effect on frequency of food consumption (or eating behavior) among girls and boys and grade level.

Because students are completing the survey during the school day, they might not distinguish between foods consumed at home after school and those consumed during the school day. The questions ask how often certain foods are eaten; not when the foods are eaten. Therefore, questions of food frequency could be subject to bias. Students could distort the questionnaire with inaccurate reporting and/or recall.

A contributing factor to the increase or decrease in frequency of food consumption in this study is whether student meals are prepared on school premises, prepared at another location and delivered to the school building; or prepared and brought from home. Several of the Pittsburgh Public School buildings have no cafeteria where meals are prepared. Therefore students either purchase limited food items that are brought to the school during the lunch period, or bring food from home. Manchester Elementary School (control school) is one such school building (Pittsburgh Public Schools, 2005).

The results of this study regarding food frequency consumption are similar to the published researched findings using the FRESH survey. In a study conducted by researchers at Johns Hopkins Bayview Medical Center (Stewart et al., 1997) that compared two different styles of teaching the same school-based cardiovascular health promotion program, the authors found that both programs resulted in decreases in frequency of consumption of high fat, high sodium and high sugar foods. There was no change in the frequency of consumption of heart healthy foods. Pre-test scores from the Johns Hopkins study were similar to pre-test scores for the treatment group in this study, except the children in the Hopkins study consumed slightly fewer high fat foods and slightly more high sugar foods at pre-test. The changes over time in the treatment group were quite similar to the changes over time for the Johns Hopkins treatment groups.

The Hopkins study found that grade level made no difference in frequency of food consumption in either group. The Hopkins study did not examine program effects on gender because the physical characteristics are similar in preadolescent boys and girls, and because this age precedes puberty for most children (Stewart et al., 1997).

6.1.2 NUTRITION KNOWLEDGE

This study found the treatment group showed significant improvement in nutrition knowledge in comparison to the control group. These study findings contrast those reported in the Hopkins study. In the Hopkins study, nutrition knowledge increased by 27% in the overall sample. However, there was no difference in the treatment and control groups at baseline (pre-test) or the end of the school year (post-test). The control group showed greater nutrition knowledge both at pre-test and post-test than the treatment group (Stewart et al., 1997).

Findings from the median split analysis showed students in the control high and treatment high groups demonstrated an increase in nutrition knowledge in comparison with students in the control low and treatment low group. The independent samples t-test revealed no significant difference; no improvement in nutrition knowledge in the two groups.

Improved nutrition knowledge, particularly at post-test, is an expected outcome of any program designed to address overweight and obesity. However, nutrition knowledge alone will not improve eating behaviors or result in increases or decreases in overweight or obesity. Some interventions designed to target nutrition behaviors are difficult to measure because of their diversity. Some interventions (such as Planet Health and CATCH) were only based on classroom curricula; while others include changes in the school food environment or PE classes (IOM, 2005). Similar to Planet Health and CATCH, nutrition behaviors in Fun to Be Fit were also based on nutrition knowledge and assessed by classroom curricula.

Although, nutrition knowledge is important in adopting healthy eating behaviors, a survey of school districts found an average total of only five hours only per year spent on topics related to nutritional and dietary behavior (IOM, 2005). Fun to Be Fit appears to be more advanced than some large-scale, school-based interventions. Fun to Be Fit students in the treatment group received 10 minutes of FRESH instruction each week.

6.1.3 PHYSICAL ACTIVITY

The findings revealed that participation in Fun to Be Fit did not significantly increase or improve physical activity levels in treatment or control groups, by gender, or grade level. The program demonstrated some benefit for the control group, suggesting these students may have been more motivated than the treatment group; or the teachers were more effective. In addition, control and treatment high fit students could have been held back because activities were designed for lower fit students (50th percentile of the President's Council on Sports and Physical Fitness). In addition, higher fit students are those who are more likely to be interested and engage in physical activity both inside and outside of the school environment. Low fit students could possibly feel self-conscious performing the fitness assessment before classmates.

The independent samples t-test revealed a difference in means for the treatment group and the control group for two of the three physical activity variables. At pre-test, there was a difference in the groups. Moreover, the control group on which the analysis was conducted was much smaller compared to the treatment group.

Moreover, no assumption could be made regarding a positive or negative relationship between food consumption and physical activity. A number of reasons for this may include ineffective demonstration and instruction; inconsistent scoring among teachers within school buildings, inconsistent student performance; or the fitness assessment. Additionally, without BMI, food diaries, and measuring physical activity outside of school, it would be difficult to make a correlation between physical activity, food frequency consumption, and nutrition knowledge in this study.

Children's gender and age also are important factors to consider in examining physical activity. Boys generally are more involved in moderate to vigorous physical activity than are girls. Explanations may include differential development of motor skills, body composition differences during growth, variations in socialization regarding sports and physical activity, and other social and environmental factors (IOM, 2005). At the age of the children in this study (ages 8 and 9), boys are more physically active than are girls.

Although young children are the most active segment of the population, physical activity levels begin to decline as children approach adolescence (DHHS, 2000). As children get older, they generally are less physically active; although this may be truer for girls than boys (IOM, 2005). Preference in physical activities of boys and girls at this age also could be a contributing factor on low levels of physical activity in this study. Boys in the third and fourth grade are more interested in team sports (i.e., baseball, football, and basketball), and are beginning to play Little League sports; whereas there are fewer opportunities to engage girls in physical activity outside of the school environment (DHHS, 2000).

The physical fitness component of Fun to Be Fit could be effective in addressing childhood obesity however, the design of the study precluded program effect in other groups (boys and girls, third and fourth grade students). Therefore, it may not be able to state with confidence that the fitness assessments are effective in addressing childhood overweight and obesity. Due to small sample sizes of the control groups, the findings presented suggest the results may not be generalizable to other students or schools in the district. However, Fun to Be Fit provides more physical activity than the traditional PE curriculum.

6.2 NEW DEVELOPMENTS/SIGNIFICANT IMPLICATIONS

Most recently, there have been new developments in the efforts to prevent childhood overweight and obesity with significant implications. Such developments include evaluating the nutritional contents of vending machines in schools rather than removal of vending machines; changes to cafeteria offerings in schools, media campaigns, revisions to school food policies, and enactment of new federal legislation (IOM, 2005).

The Child Nutrition and WIC Reauthorization Act of 2004 (Public Law 108-265, 108th Congress, represents one of the largest changes to school nutrition. Any school (public or private) participating in the National School Lunch or National School Breakfast programs must comply with this legislation. The Act promotes nutrition education and physical activity at the state and local levels to prevent childhood obesity; and requires local wellness policies designed and implemented at the local level. The Act also authorizes the Department of Agriculture to provide technical assistance, if requested by the school or school district, in implementing healthy school environments. The content of local wellness policies would be decided by local parents, teachers, administrators, school food service, school boards, and the public. Wellness policies are to be created and implemented no later than July 1, 2006 (Child Nutrition and WIC Reauthorization Act, www.gop.gov).

Another new development is the Growth Screening Program (Public School Code, Article XIV) which requires height/weight measurements for each child to establish a pattern of growth. The Department of Health is responsible for prescribing the content of the school health program. The screening procedure involves measuring of height and weight, determining BMI, graphing BMI on 2000 CDC growth charts, and providing information to parents. The program is to be fully implemented in school districts (Grades K-12) by the 2007-2008 school year (PANA, 2005).

Each of these developments has significant implication for childhood overweight and obesity. One implication is that schools now have resources with additional funding to effectively address childhood overweight and obesity in their students; and support is forthcoming from the larger community, school boards and students. With commitment from the federal government, school districts can create wellness policies, and develop and implement programs with involvement from the school board, parents, and other community-based organizations. This is a welcome change from past practice, when schools functioned with minimal input from the larger community.

In thinking about how Fun to Be Fit could have been implemented differently, there are several items of note: (1) interventions created to address childhood obesity can be implemented using low-tech programs with high pay-off options. Not every district will receive funding to support an overhaul of its entire PE curriculum. Therefore, school districts should use available resources to assist with new programs and/or curriculum including engaging PE teachers to develop new curriculum. Make teachers feel that they are part of the process. Their input is vital;

(2) include parents in all phases of curriculum development. A child's strongest ally is his/her parent. Support from parents encourages children to be physically active and adopt healthy eating behaviors; (3) use after-school programs to reinforce physical activity outside of school. After-school physical activity can translate into larger gains. Students naturally will incorporate physical activity and nutrition into their daily lives.

6.3 STUDY LIMITATIONS

This study has several limitations. The first is a weak study design that lends itself to threats to validity, specifically limitations of non-randomization and selection bias. Other design characteristics include a sample size too small, particularly with regard to the fitness assessments, to make meaningful conclusions regarding the program's true effectiveness. In addition, self-reported data could threaten the validity of the study.

The sample was one of convenience; therefore no third or fourth grade student in either of the treatment or control schools was excluded from the study. Schools were not randomly selected, but assigned to treatment and control groups. The five treatment schools were selected on the basis of performance of PE teachers, and their ability to comply with study requirements. Without random assignment, schools in the treatment groups are likely to show treatment effect; that Fun to Be Fit was effective in reducing frequency of consumption of foods high in fat, sodium, and sugar; and increasing physical activity and nutrition knowledge. Selection bias also distorts the estimate of the effect.

Second, physical activity scores for the control group were largely missing from the data set as a result of scoring issues. Physical activity scores were not available for two control schools (Knoxville and Fort Pitt). The remaining control schools (Colfax and Manchester) report a lower number of physical activity scores compared to treatment schools, making it difficult to determine whether outcomes can be correctly attributed to participation in Fun to Be Fit. This also limits the ability of the study to infer results from the sample to the population of third and fourth grade elementary school students.

Third, the use of secondary data to address research questions presents challenges, such as making sure the data are appropriate to answer study hypotheses. Because the study is limited to data previously collected and compiled, these data may not represent the variables of interest. For example, BMI, an appropriate variable for the current study, was not collected during initial data collection. Inclusion of BMI measurement would have made the current study more comprehensive, and afforded the opportunity to predict an association between it and other study variables or differences between treatment and control groups. Without BMI, it is difficult to determine the strength of the association between obesity, physical activity, knowledge, and behavior; or establish causality regarding childhood obesity. In addition, student ethnicity was not collected. Inclusion of ethnicity into the study also would have provided additional information regarding the sample and could be used to draw further conclusions regarding childhood obesity and health disparities. Moreover, use of secondary data also limited the statistical technique selected; limited conclusions about relationships between variables; affected the analysis conducted; and caused findings to be insignificant.

Fourth, teacher training could affect the significance of the study results with regard to the fitness assessment. Teachers in control groups already could be working with children more than treatment teachers. These teachers could also feasibly be experienced (new teachers versus experienced teachers).

Fifth, the use of food frequency questionnaire (FRESH) was not the best method to evaluate food frequency consumption. The disadvantage of using this tool is that it is not an accurate measure of what the students eat. Food frequency questionnaires are best used with large population studies. A food diary or food record would be more appropriate, and more accurate. Students would be required to write in the diary two days during the week and one weekend day; recording food consumed, portion size, and time of consumption.

Finally, parental involvement was not an integral feature of this study. There were no materials for parents to utilize that could assist them in helping their children to engage in healthy behaviors and increase their physical activity. This presents a challenge to the study because children are largely under the influence of their parents.

6.4 CONCLUSION

Childhood obesity continues to be a leading public health concern. The incidence and prevalence of childhood obesity has continued to increase, with more children being at-risk for overweight, and overweight or obese, than in the past.

Schools have the potential to impact childhood obesity with school-based nutrition and physical education programs because children spend more time in school than in any other venue. Therefore, it is essential for school districts to continue to assist students in adopting healthy lifestyles through innovative programs that provide nutrition education and opportunities for physical activity. Innovative, school-based interventions and clinical-based studies designed to promote good health and physical activity habits are necessary.

The results of this investigation suggest that, overall, Fun to Be Fit could be an effective approach to addressing childhood obesity. The outcomes of this study could be applicable to other Pennsylvania school districts with modifications such as stronger study design, enhanced teacher training, and student involvement.

6.5 POLICY RECOMMENDATIONS

This study has demonstrated the need for more intensive screening for childhood overweight and obesity at all levels. Health insurers should reimburse providers for screening, monitoring, and follow-up for at-risk children. It appears that children who are at-risk will require more intense screening, monitoring and multi-faceted programs. This means that health care providers, namely pediatricians, will need to spend additional time during office visits with these children and their families developing treatment plans, discussing prevention techniques and educational strategies, making information available to parents and patients, and making referrals, for which reimbursement should be available and equitable. Providers are being asked to play a critical role in treating childhood obesity, often without adequate resources. Reimbursement would result in better receptivity of screening in the clinical setting. With adequate reimbursement, providers would be able to thoroughly and effectively assess all children in the practice. Through assessment, providers also will have the ability to study obesity trends among children in their practice, engage in discussion regarding prevention, and propose practical solutions.

In addition to this being a policy recommendation, diagnostic codes and national standards for assessing and treating childhood obesity should be developed and subsequently implemented, making the case for reimbursement justifiable. From this, a nationwide reduction in the incidence of childhood overweight and obesity possibly could be observed. Ultimately, providers would have opportunities to develop and implement policies and strategies to make children healthier.

6.6 FUTURE RESEARCH INITIATIVES

In summary, this study provides a theoretical base upon which to conduct further investigations concerning obesity, fitness and nutrition behaviors in youth and adolescents. Possible future studies include determining whether Fun to Be Fit is successful at other grade levels. Therefore, expand the study into higher grade levels.

First, in designing school-based programs, it is essential to understand the importance of how behavioral, social, and cognitive factors impact program outcomes.

Second, because there were limited outcomes of interest which were significant to the study, in future studies of this type, it is important to understand the relationship between study variables that can be used to address research hypotheses and questions of outcome and impact.

Third, future studies should address what really affects program performance including sociodemographic variables such as race, gender, and income; and differences in school achievement. Each of these variables potentially impact childhood obesity.

Fourth, design flaws show significant differences in outcomes. In the future, to eliminate bias resulting from these flaws, randomize rather than assign groups into the two conditions; treatment and control. This action could produce different results. Select a different assessment to measure physical fitness or separate higher fit students from lower fit students. Prepare operations manual and specific written guidelines for program administration. It also is important to ensure that students understand survey items; particularly what constitutes high fat, high sodium, high sugar and heart healthy foods. In the future, collect BMI at pre-test and post-test. BMI is one of the best measures of overweight and obesity, in addition to demonstrating the effectiveness of the study. Another way to show a more significant effect of Fun to Be Fit is to follow students over more than one school year.

Fifth, include a parent component. With appropriate information, parents can be instrumental in developing and reinforcing health behaviors and physical activity.

Sixth, ensure that teachers and schools have experience in implementing large-scale studies. Include a more structured teacher training component. Ensure that teachers understand the program. This will also result in improved outcomes.

Finally, on the basis of the outcomes reported above, if it is decided that further study is not necessary, the program should be implemented system-wide in a manner that allows an ongoing, rigorous evaluation of its success.

APPENDIX A

INSTITUITONAL REVIEW BOARD APPROVAL LETTERS

University of Pittsburgh
Institutional Review Board

Exempt and Expedited Reviews
Christopher M. Ryan, Ph.D., Vice Chair

3500 Fifth Avenue
Suite 105
Pittsburgh, PA 15213
Phone: 412.383.1480
Fax: 412.383.1508
e-mail: irbexempt@upmc.edu

TO: Christina Wilds

FROM: Christopher M. Ryan, Ph.D., Vice Chair Chri

DATE: March 2, 2005

PROTOCOL: Assessment of Fun to Be Fit: A School-Based Intervention to Address Childhood Obesity

IRB Number: 0502106

The above-referenced protocol has been reviewed by the University of Pittsburgh Institutional Review Board. Based on the information provided in the IRB protocol, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section 45 CFR 46.101(b)(4).

The regulations of the University of Pittsburgh IRB require that exempt protocols be re-reviewed every three years. If you wish to continue the research after that time, a new application must be submitted.

- If any modifications are made to this project, please submit an 'exempt modification' form to the IRB.
- Please advise the IRB when your project has been completed so that it may be officially terminated in the IRB database.
- This research study may be audited by the University of Pittsburgh Research Conduct and Compliance Office.

Approval Date: March 2, 2005
Renewal Date: March 2, 2008

University of Pittsburgh
Institutional Review Board

Exempt and Expedited Reviews

University of Pittsburgh FWA: 00006790
University of Pittsburgh Medical Center: FWA 00006735
Children's Hospital of Pittsburgh: FWA 00000600

3500 Fifth Avenue
Suite 100
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TO: Christina Wilds

FROM: Sue R. Beers, Ph.D., Vice Chair Sue R Beers

DATE: November 22, 2005

PROTOCOL: Assessment of Fun to Be Fit: A School-Based Approach to Childhood Obesity

IRB Number: 0502106

The Institutional Review Board reviewed the recent modifications to your exempt protocol and finds them acceptable for administrative review. These changes, noted in your submission of 11/10/2005, are approved. Based on the information provided in the IRB protocol, this project still meets all the necessary criteria for an exemption.

- Please advise the IRB when your project has been completed so that it may be officially terminated in the IRB database.
- This research study may be audited by the University of Pittsburgh Research Conduct and Compliance Office.

Original Approval Date: 03/02/05
Modification Approval Date: 11/22/05
Expiration Date: 03/02/08

SRB:ehg

APPENDIX B

FOOD RE-EDUCATION FOR ELEMENTARY SCHOOL HEALTH

FRESH

Food Re-Education for Elementary School Health

Nutrition Knowledge, Attitude, & Eating Behavior Survey

Name: ____________________

Grade: __________ Gender (circle one): Male Female

School: ____________________

Teacher: ____________________

Date: __________

Are you a vegetarian? (circle one): Yes No

Developed by Johns Hopkins Bayview Medical Center. Sponsored in the Pittsburgh Public Schools by Highmark Blue Cross Blue Shield (412) 544-4168.

FRESH

Food Re-Education for Elementary School Health

Part I: Nutrition & Knowledge Survey

Please draw a circle around your answer. If you don't know the answer, circle the words: "Don't Know".

1. Which is a saturated fat?

Butter	Corn Oil	Nuts	Don't Know

2. Which of the following breakfast foods is best for you?

Oatmeal	Frosted Flakes	Donut	Don't Know

3. Which of the following foods is in the meat group?

Beans	Apple	Rice	Don't Know

4. Which of these activities uses the least amount of energy?

Watching TV	Running	Riding a Bike	Don't Know

5. The healthiest after school snack would be:

Fruit	Candy	Soda	Don't Know

6. Which of the following foods contains the most salt?

Potato Chips	Strawberries	Graham Crackers	Don't Know

7. A lunch that is healthy for the heart is:

Bologna sandwich, milk, potato chips, cookies	Peanut butter sandwich cheese, ice cream, milk apple	Low-fat yogurt with fruit, carrot sticks, non-fat milk, whole wheat roll	Don't Know

8. Which exercise is the best for your heart?

Bowling	Baseball	Aerobic Dance	Don't Know

9. Which of these nutrients is needed to build and repair muscle?

Fat	Protein	Vitamins	Don't Know

10. Most people eat:

Too much salt	Not enough salt	The right amount of salt	Don't Know

11. Which is the least healthy way to cook chicken?

Bake	Broil	Fry	Don't Know

12. How long should you exercise to keep your heart healthy?

At least 5 minutes	At least 10 minutes	At least 20 minutes	Don't Know

13. Suppose you have a tuna sandwich, milk, and an orange for lunch. To make a complete meal, you should add:

A piece of cake	A tossed salad	Bread & butter	Don't Know

14. Which food provides you with calories, but few vitamins and minerals?

Orange	Carrot Sticks	Candy Bar	Don't Know

15. How many days a week should you do aerobic exercise to keep your heart healthy?

3 days a week	2 days a week	1 day a week	Don't Know

16. Which milk is the healthiest for your heart?

Whole milk	Chocolate Milk	Non-fat Milk	Don't Know

17. Too much cholesterol in the blood can cause:

The Flu	Heart Disease	Headaches	Don't Know

18. Which food group is the healthiest?

Pizza, soda, ice cream, & fruit	Beans, fruit, low-fat milk, & baked fish	Beef, cheese French fries, fried fish, & soda	Don't Know

19. Another name for salt is:

Fat	Sugar	Sodium	Don't Know

20. Aerobic exercise is healthy because:

It strengthens your heart & lungs	It makes your muscles bigger	You only have to do it once a month to make you healthy	Don't Know

Part II

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
1. Ice Cream	O	O	O
2. Chocolate Candy Bar	O	O	O
3. Cookies	O	O	O
4. Donut	O	O	O
5. Cake	O	O	O
6. Soda	O	O	O
7. Turkey	O	O	O

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
8. Fried Chicken	O	O	O
9. Broiled Chicken	O	O	O
10. Rice	O	O	O
11. French Fries	O	O	O
12. Baked Potato	O	O	O
13. Potato Chips	O	O	O
14. Nuts	O	O	O

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
15. Popcorn No Butter	O	O	O
16. White Bread	O	O	O
17. Whole Wheat Bread	O	O	O
18. Eggs	O	O	O
19. Hot Dogs	O	O	O
20. Hamburger	O	O	O
21. Steak	O	O	O

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
36. Macaroni & Cheese	O	O	O
37. Appple	O	O	O
38. Watermelon	O	O	O
39. Banana	O	O	O
40. Orange	O	O	O
41. Strawberries	O	O	O
42. Grapefruit	O	O	O

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
43. Peas	O	O	O
44. Broccoli	O	O	O
45. Tomato	O	O	O
46. Carrot	O	O	O
47. Celery	O	O	O
48. Lettuce	O	O	O
49. Peanut Butter	O	O	O

Mark how often you eat each food by filling in the bubble.

	Almost Never	Sometimes	Almost Always
50. Mixed Salad	O	O	O
51. Vegetable Soup	O	O	O

APPENDIX C

SCORING KEY AND INSTRUCTIONS FOR ADMINISTERING FRESH SURVEY

(PARTS I AND II)

Instructions for Administering the

“FRESH Part I” Survey

Items marked in bold face type should be read to the students or paraphrased. Please read or paraphrase the following introduction:

You are about to take the FRESH health survey, which asks you about nutrition and exercise. Before we begin, there are a few important things we would like you to remember as you answer these questions:

1. Answer each question honestly.
2. Answer each question to the best of your ability.

C.1 INSTRUCTIONS FOR PART I: NUTRITION AND KNOWLEDGE SURVEY

Please remember to read <u>every question</u> to the students. It is helpful to hold the questionnaire up in front of the class, pointing to each choice as you read the question.

Read or paraphrase the following:

Part I asks you questions about nutrition and exercise. You may not know the answers to some of these questions because we have not covered this material yet. That’s okay-do the best you can.

Look at the first question: “Which is a saturated fat?” There are three choices: butter, corn oil; and nuts. (Hold up and point to the choices). If you know the answer, circle it. If you don’t know the answer, circle the words in the last box: “Don’t know.” Please circle only <u>one</u> answer. If you want to change your answer, cross it out and circle a new answer.

Teachers may answer simple questions, but do not define or explain words or concepts such as “saturated fat.” Encourage children to answer to the best of their ability. If they don’t understand a word, they should mark “Don’t know.”

Miscellaneous Points for Teachers:

- Make sure students have their first and last names on survey booklets.
- Make sure all 20 questions have been answered.
- Each student should have a survey booklet and write answers in survey booklet.
- Do not substitute words when reading the survey.
- Allow students time to check over their responses at the end.

C.1.1 Scoring Key for Part I

FRESH Knowledge Test Questions

Attached is the key to the pre-post knowledge test. It is scored by awarding one point for each correct item, summing the number of correct items, and dividing by 20 (the total number of items) to get the percent correct.

Knowledge Questions:

Question Number	Correct Answer
1	1
2	1
3	1
4	1
5	1
6	1
7	3
8	3
9	2
10	1
11	3
12	3
13	2
14	3
15	1
16	3
17	2
18	2
19	3
20	1

C.1.2 Scoring Instructions for FRESH Part II Survey

Food Frequency Items

Assign responses as follows: **0=Never, 1=Sometimes, 2=Always**.

1. There are four scales: high fat, high sodium, high sugar, and heart healthy. Add the values for each item selected for the fat, sodium, sugar, and healthy categories. Items are assigned to these four categories as follows:

1-6.	high **sugar** food
7.	heart healthy
8.	high **fat**
9.	heart healthy
10.	heart healthy
11.	high **fat**
12.	heart healthy
13.	high **fat** high **sodium**
14.	high **fat**
15.	heart healthy
16.	heart healthy
17.	heart healthy
18.	high **fat**
19.	high **fat** high **sodium**
20.	high **fat**
21.	high **fat**
22.	heart healthy
23.	heart healthy
24.	high **sodium**
25.	high **fat**
26.	heart healthy
27.	high **fat**
28.	high **fat**
29.	heart healthy
30.	high **fat**
31.	heart healthy
32.	high **sugar**
33.	heart healthy
34.	high **fat**
35.	heart healthy
36.	high **fat**
37. – 48.	heart healthy
49.	high **fat**
50.	heart healthy
51.	heart healthy

3. Add values within each category (sugar, fat, sodium) by classroom and determine the classroom average separately for pre and post scores.
   Total Sugar items: 7 Total Fat items: 13 Total Sodium items 3

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