The Effects of a Nutrition Education and Physical Activity Intervention on Metabolic Syndrome on At-Risk Youth in an Appalachian Community

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Melissa K. Lustic

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This thesis titled

The Effects of a Nutrition Education and Physical Activity Intervention on Metabolic Syndrome on At-Risk Youth in an Appalachian Community

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ABSTRACT

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Obesity prevalence has increased significantly in our youth. Several health concerns arise in those who are overweight or obese, including metabolic syndrome, a loosely-defined cluster of clinical criteria that represent several cardiovascular risk factors. Appalachian youth have an increased probability of being overweight or obese. Coupled with economic issues that have long plagued this region, this indicates the need for a low-cost solution to this problem. An eight-week supervised dietary and physical activity intervention was administered to overweight and obese Appalachian youth and their parents to determine if the intervention could improve the metabolic syndrome characteristics in this group. Results indicate that no significant change occurred with this intervention in metabolic syndrome characteristics, including waist circumference, blood pressure, glucose, triglycerides, HDL cholesterol, or body mass index. Future research should consider increasing the overall length of intervention, enhancing the dietary education portion of the intervention, and addressing the barriers Appalachian citizens may face on a regular basis.

Approved: _____________________________________________________________

Darlene E. Berryman

Associate Professor of Human and Consumer Sciences
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CHAPTER 1: INTRODUCTION

Overview and Background

Metabolic syndrome has become a major health issue within the United States (Amemiya et al., 2007). Based on the 2000 NHANES III data, approximately 25% of adults in the United States have been diagnosed with metabolic syndrome (Ford, Giles, & Mokdad, 2004). As defined by the World Health Organization, metabolic syndrome in adults includes the presence of at least three of five of the following factors: a BMI greater than 30 kg/m²; high-density lipoprotein levels below 39 mg/dL in women and 35 mg/dL in men; fasting blood glucose levels over 110 mg/dL; resting blood pressure over 140/90 mmHg; waist-to-hip ratio greater than 0.90 in men and 0.85 in women; urinary albumin to creatinine ratio greater than 30 mg/g; and triglycerides greater than 150 mg/dL (Brietzke, 2007). The risk of developing metabolic syndrome significantly increases with obesity and with the presence of type 2 diabetes (Brietzke, 2007). The development of several comorbid characteristics, including artherosclerosis, cardiovascular disease, type 2 diabetes mellitus, hypertension, and dyslipidemia, have been correlated with presence of obesity and metabolic syndrome (Berenson, Srinivasan, & Nicklas, 1998; Strong, et al., 1999). Common characteristics present in overweight individuals such as high blood pressure, impaired fasting glucose, and increased waist circumference, have been found to be risk factors for the development of these diseases (Berenson et al., 1998).

Unhealthy excessive weight is the most common modifiable risk factor of metabolic syndrome. The prevalence of overweight and obesity in the United States has
been increasing exponentially over the past 50 years (Centers for Disease Control [CDC], 2007). Nearly 67% of all adults residing in the United States have been identified as having a BMI greater than 25.0 kg/m² (classified as overweight) so the importance of monitoring and treating this issue continues to increase (Amemiya et al., 2007; CDC, 2007). The most common measurement tool used to assess and classify weight is body mass index, or BMI. Adults who have a BMI of 25.0 kg/m² to 29.9 kg/m² are classified as overweight, while obese individuals have a BMI over 30 kg/m² (CDC, 2007).

The occurrence of adult overweight status has increased and children and adolescents have been affected by this trend. Youth are classified as at risk for overweight if their BMI is above the 85th percentile for their age group, and they are classified as overweight when their BMI is at or above the 95th percentile for their age group (CDC, 2007). In the last 40 years, the rates of childhood obesity have tripled (Guerdjikova, McElroy, Kotwal, & Stanford, 2007). Alarmingly, 50% of children and adolescents who have been classified as overweight or obese will remain so into their adult years (McCrone, Dennis, Tomoyasu, & Carroll, 2000). As the population of overweight youths matures, an increase in adult obesity will result (McCrone et al., 2000). Children’s risk of being overweight or obese increases when parents are overweight or obese (D. Thorne, Tickamyer, & M. Thorne, 2004). As a result, children at an unhealthy weight should be screened to determine their risk for several health issues, including high blood pressure, impaired fasting glucose, dyslipidemia, and type 2 diabetes. Although the prevalence of metabolic syndrome has been found to be somewhat low in children and adolescents when compared to the adult population, the occurrence
increases drastically with age according to ATP-III criteria (Ford, Giles, & Dietz, 2002). It was once thought that only 4% of children suffer from the syndrome, 6.7% of 20 to 29 year olds have been diagnosed, and an alarming 43.5% of 60 to 69 year olds have been diagnosed (Ford et al., 2002). While a specific cluster of metabolic syndrome factors has yet to be determined for youth, guidelines with age-adjusted measurements have been established for use in describing the young population (Brietzke, 2007). Children and adolescents under 18 years are defined by a system that measures the percentile rank by age of each of the five established criteria used to monitor adults. The ATP-III panel recognizes the following five measures as acceptable for determining metabolic syndrome in adolescents. Three or more must be present to qualify as metabolic syndrome: BMI above the 97th percentile for age, blood triglycerides above the 95th percentile for age, HDL cholesterol levels below the 5th percentile for age, systolic and diastolic blood pressure above the 95th percentile for age, and impaired glucose tolerance (Weiss, et al., 2004). However, the most recognized and uniform definition has been identified by the International Diabetes Federation, which includes modified ATP-III and WHO criteria (Zimmet, et al., 2007). The criteria for children ages 6 through 17 are similar to those established for adults. The only difference is the inclusion of impaired glucose tolerance when monitoring children and adolescents due to the low prevalence of fasting hyperglycemia in children (Ornstein & Jacobson, 2006). Metabolic syndrome has been found not only to be a contributing factor of type 2 diabetes, but also to be linked to obesity, dyslipidemia, impaired glucose tolerance, and hypertension, as well as a predisposing symptom of artherosclerotic cardiovascular disease (Ornstein & Jacobson,
Therefore, it is important that metabolic syndrome be considered a serious health condition that must be treated in order to prevent the development of additional health problems.

Early identification of children at risk, followed by prompt intervention, could have a profound preventive health impact. Children have an increased risk of developing one or more of the factors themselves when their parents are overweight, obese or have been diagnosed with metabolic syndrome (Pankow, Jacobs, Steinberger, Moran, & Sinaiko, 2004). Because the presence of overweight and obesity increases the risk of developing any of the cluster factors, studies have recommended that screening for metabolic syndrome should be performed if a child has at least one parent with the syndrome, or if the child has developed any of the risk factors themselves (Pankow et al., 2004; Weiss, et al., 2004). Pankow et al. (2004) state that not only do genetic factors play a role in the development of such symptoms, but also environmental factors such as family habits, physical activity levels, and diet. All of these factors should be considered when determining the risk faced by children and adolescents. According to a review of family physician practices within the Appalachian region, the prevalence of childhood obesity has increased at a faster rate than in the United States as a whole (Wu, Tudiver, Wilson, & Velasco, 2007).

The Appalachian region, which is comprised of 219 counties within 13 states and includes southeast Ohio, has long been a socioeconomically depressed region (Seufert & Carrozza, 2005). Although the historical causes of the poverty relate to the lack of industrialization in the region, other reasons for the current low-income levels exist.
Counties within the Appalachian region considered economically distressed have a 12% lower labor force participation rate than the national average indicating fewer qualified workers actually do work. Current economic reliance has shifted from the historical agricultural and mining industries to retail and service industries (Appalachian Regional Commission [ARC], 2007). Additionally, due to the mountainous landscape and environmental factors such as unpredictable weather, the majority of the rural areas can be unsuitable for development (Wood, 2005). Families who have been in poverty through generations have difficulty gaining economic status, mainly due to the lack of easy access to available education, realization of the world outside their region, and available funds to attempt to live a better life (Wood, 2005). A study conducted in rural West Virginia, known as the CARDIAC study, found that obesity rates have increased at a faster rate within Appalachian communities than anywhere else in the United States (Neal, et al., 2001). Likewise, the CARDIAC study showed that a higher prevalence of childhood obesity exists in rural Appalachia, placing rates among those children significantly higher than the national average. Issues are not only excessive weight, but also metabolic syndrome risk criteria. A 1997 study indicated that metabolic syndrome resulting from obesity has increased more rapidly in Appalachian communities relative to national rates (Heneghan & Malakoff, 1997).

Statement of the Problem

As the incidence of childhood obesity rises, so does the risk for developing metabolic syndrome. The need for an effective program to decrease the associated risk
factors becomes highly important. Several studies have shown positive effects of a combined physical activity and nutrition education intervention to decrease the severity of obesity in both adults and children (American Dietetic Association Position, 2006; Weiss, et al., 2004; Wu et al., 2007). With an unemployment rate upwards of 8.66% in distressed Appalachian counties, the cost of medications used in the treatment of the metabolic syndrome risk factors, such as hypertension and cholesterol medications, may be too expensive for economically disadvantaged individuals (Huttlinger, Schaller-Ayers, & Lawson, 2004; Seufert & Carrozza, 2005). Therefore, the need for the development of a healthy lifestyle intervention arises, so as to increase the manageable treatment options for rural Appalachian communities without creating a financial burden for the residents.

Research Questions

What affect will an 8-week physical activity and nutrition education intervention have on modified International Diabetes Federation metabolic syndrome risk factors in at-risk children in an Appalachian community (children and adolescent participants in the Take Action trial)? Specifically, the study will use pre- and post-test measurements to address the following:

1. How will the intervention affect obesity (measured as waist circumference) in the children?
2. How will the intervention affect triglycerides in the children?
3. How will the intervention affect fasting glucose levels in the children?
4. How will the intervention affect blood pressure in the children?
5. How will the intervention affect high-density lipoprotein levels in the children?

6. How will the intervention affect BMI percentile rankings in the children?

With the study powered to have 40 child and adolescent participants, the researchers expect to find the following changes in the variables:

1. A decrease in weight-for-age BMI percentiles within 25% of the participants;

2. A decrease in fasting triglycerides of 5%;

3. A decrease in fasting glucose of 5%;

4. A decrease in waist circumference of 2.54 cm;

5. A decrease in systolic blood pressure of 5% and diastolic blood pressure of 10%;

6. An increase in HDL cholesterol of 5%.

Significance of the Study

Weiss, et al. (2004) states that the prevalence and magnitude of childhood obesity continues to increase dramatically for all ethnicities and all economic levels. The importance of determining the prevalence specifically in the Appalachian region grows, because the financial situation of the region remains depressed and because residents have a high risk of developing metabolic syndrome. In order to determine whether non-pharmacologic methods of decreasing the metabolic syndrome risk factors will work, it is important to examine what type of intervention will be the most effective. As studies
have demonstrated, a combination of dietary adjustments and an increase in physical activity can decrease obesity; the evaluation of an intervention focusing on both will provide a potential program for the Appalachian region to combat the development of metabolic syndrome and its associated complications.

Delimitations and Limitations

The researcher did not allow the participation of any child who was not cleared by a physician for all physical activity and testing. The researcher used the modified International Diabetes Federation definition for metabolic syndrome in children from age 6 years through age 17 years, although the IDF criteria do not include those at 17 years of age. All participants were screened for metabolic syndrome according to the IDF criteria for 10-16 year olds. Because of the study design, the researcher chose not to include a control group; all groups received the intervention, and therefore all pre- and post-testing was compared to each participant, as opposed to a control.

The researcher was unable to control the following:

1. Economic status of the participants: therefore, monetary problems may have influenced participation;

2. Economic situation of the community during the research, which may have had an effect on the outcomes;

3. Reliability of the participants when monitoring physical activity required outside of the intervention, although activity was encouraged and tracked based upon self-recording by the participants;
4. Education level of all participants, and thus difficulties in various age groups arose with portraying certain messages requiring reading;

5. Mental development within the participant groups, which may or may not have had an affect on classroom learning;

6. Child development and height change throughout the intervention; therefore, weight may increase as a result of stature change;

7. Height change in the participants; BMI may have been affected.
CHAPTER 2: REVIEW OF LITERATURE

The presence of metabolic syndrome risk factors, regardless of which definition is used, has rapidly increased with the rise in nationwide obesity. While adults have been recognized as an affected population for a long time, child and adolescent obesity has become an important health issue in more recent years. There is a need to prevent and to treat the metabolic syndrome and its risk factors in a manner that promotes and teaches lifestyle change in at-risk populations, such as the Appalachian region.

Metabolic Syndrome in Adults

Metabolic syndrome has been increasing in prevalence in the last two decades (Amemiya et al, 2007; Brietzke, 2007; Groop, 2000; Ornstein & Jacobson, 2006). In 1988, Gerald Reaven M.D. and his colleagues gave the Banting Lecture at the annual International Diabetes Federation meeting as a means of bringing metabolic syndrome to the attention of medical professionals. The team described a condition linking hypertension, type 2 diabetes mellitus, and an increased susceptibility to atherosclerosis with insulin resistance. The lecture was the first to formally relate these health implications with one another and address them as one disorder. Before Dr. Reaven’s address, the aforementioned characteristics were associated with each in different ways and with different definitions and phrases: metabolic syndrome, syndrome X, and insulin resistance syndrome (Modan, et al., 1985; Weiss, et al., 2004). However, in the wake of the descriptive lecture, several researchers began to investigate the phenomenon of metabolic syndrome, attempting to describe and diagnose a definitive condition.
“Metabolic syndrome” became the widespread term to describe the cluster of clinical characteristics. Haffner (1997) examined the relationship of several metabolic risk factors and their relationship to cardiovascular disease. The study included hypertension, dyslipidemia, and type 2 diabetes (Haffner, 1997). The Bruneck study, conducted by Bonora, et al., (1998), assessed the insulin resistance of subjects who had been diagnosed with impaired glucose tolerance, dyslipidemia, hyperuricemia, type 2 diabetes, and hypertension in an attempt to investigate any relationship. The study concluded that the prevalence of metabolic disorders, such as those listed above, increased drastically in subjects who also had been diagnosed with insulin resistance (Bonora, et al., 1998). The study was one of the last conducted before a set of criteria of metabolic syndrome risk factors was established by the WHO in 1998.

Four consensus panels have established separate but similar criteria for the diagnosis of metabolic syndrome in adults since 1999 (Brietzke, 2007). Table 1 lists the four panels.
Table 1

**Consensus Panels with Recommendations for Diagnosing Metabolic Syndrome**

<table>
<thead>
<tr>
<th>Four Established Consensus Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Health Organization</td>
</tr>
<tr>
<td>United States National Cholesterol Education Program (Adult Treatment Panel III)</td>
</tr>
<tr>
<td>American Association of Clinical Endocrinology</td>
</tr>
<tr>
<td>International Diabetes Federation</td>
</tr>
</tbody>
</table>

*World Health Organization Definition*

The World Health Organization established a unifying definition of the syndrome in 1998, electing to refer to the condition as “metabolic syndrome” (Alberti & Zimmet, 1998). According to the WHO, the primary indicator for metabolic syndrome is the development of either type 2 diabetes or insulin resistance, demonstrated most commonly by fasting glucose cut-off of 100 mg/dL (Brietzke, 2007; Groop, 2000). In addition to the diagnosis of insulin resistance, to be diagnosed with metabolic syndrome a patient must have two or more of the criterian summarized in Table 2 (Alberti & Zimmet, 1998; Brietzke, 2007; Groop, 2000).
Table 2

Current WHO Metabolic Syndrome Criteria

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension or High blood Pressure</td>
<td>Greater than 140/90 mmHg</td>
</tr>
<tr>
<td>HDL Cholesterol</td>
<td>Less than 35 mg/dL (Men)</td>
</tr>
<tr>
<td></td>
<td>Less than 39 mg/dL (Women)</td>
</tr>
<tr>
<td>Plasma Triglycerides</td>
<td>Greater than 150 mg/dL</td>
</tr>
<tr>
<td>Body Mass Index (BMI) or</td>
<td>Greater than 30 kg/m²</td>
</tr>
<tr>
<td>Waist-To-Hip ratio</td>
<td>Greater than 0.90 (Men)</td>
</tr>
<tr>
<td></td>
<td>Greater than 0.85 (Women)</td>
</tr>
<tr>
<td>Urinary Albumin: Creatinine Ratio</td>
<td>Greater than 30 mg/g</td>
</tr>
</tbody>
</table>


Adult Treatment Panel III Definition.

Another commonly used criteria for defining metabolic syndrome is the Adult Treatment Panel III (ATP-III) criteria, established by the United States National Cholesterol Education Program (National Cholesterol Education Program [NCEP], 2002). According to the ATP-III criteria, six components contribute to an increase in cardiovascular risk, which are illustrated in Table 3. In addition, the ATP-III panel established clinical criteria for diagnosing metabolic syndrome in an efficient, simple manner, which are also summarized in Table 3 (NCEP, 2002). The ATP-III clinical
criteria are similar to those established by the WHO. However, the two criterion panels
differ in that ATP-III utilizes waist circumference and fasting glucose, and WHO utilizes
waist-to-hip ratio and urinary creatinine: albumin ratio.
Table 3

*Current ATP-III Metabolic Syndrome Clinical Criteria and Components Contributing to Cardiovascular Disease*

<table>
<thead>
<tr>
<th>Clinical Criteria</th>
<th>Measurement</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist Circumference</td>
<td>Greater than 102 cm (<em>Men</em>)</td>
<td>Abdominal (Visceral) Obesity</td>
</tr>
<tr>
<td></td>
<td>Greater than 88 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(<em>Women</em>)</td>
<td></td>
</tr>
<tr>
<td>HDL Cholesterol</td>
<td>Less than 40 mg/dL (<em>Men</em>)</td>
<td>Dyslipidemia</td>
</tr>
<tr>
<td></td>
<td>Less than 50 mg/dL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(<em>Women</em>)</td>
<td></td>
</tr>
<tr>
<td>Serum Triglycerides</td>
<td>150 mg/dL</td>
<td>Elevated blood pressure</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Greater than 130/85 mmHg</td>
<td>Insulin resistance</td>
</tr>
<tr>
<td>Fasting Glucose</td>
<td>Greater than 110 mg/dL</td>
<td>Proinflammatory state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prothrombotic state</td>
</tr>
</tbody>
</table>

American Association of Clinical Endocrinologists Definition

The American Association of Clinical Endocrinologists has established guidelines for diagnosis of what the organization refers to as “insulin resistance syndrome,” or the equivalent of metabolic syndrome (American Association of Clinical Endocrinologists [AACE] Position Statement, 2003). The guidelines are similar to those established by the WHO and ATP-III. However, the AACE primarily identifies insulin resistance syndrome as hyperinsulinemia and insulin resistance, which increases the chance that one will develop the umbrella of related abnormalities, including those described by the WHO and ATP-III (AACE, 2003).

International Diabetes Federation Definition

The most recent guidelines established have been described by the International Diabetes Federation (IDF) in 2006 (Alberti, Zimmet, & Shaw, 2006; Brietzke, 2007). As an international organization, the IDF has established criteria based upon ethnicity, focusing primarily on waist circumference. According to the IDF Position Statement on Metabolic Syndrome (2006), the criteria established by the WHO and the ATP-III panel were not intended to become diagnostic criteria; the recommendations were meant to be guidelines for clinicians and researchers. As a result, several different sets of criteria exist. While the IDF criteria closely mimic that of the ATP-III panel guidelines, the IDF indicates that the need for a single, universal diagnostic tool is increasingly important as more people are diagnosed with type 2 diabetes each year.
Metabolic Syndrome in Children

Although Table 1 illustrates the organizations that have established criteria for metabolic syndrome in adults, these criteria do not include children and adolescents. The third National Health and Nutrition Examination (NHANES III) conducted from 1988 through 1994, demonstrates the prevalence of overweight and obese youth in the United States (National Center for Health Statistics [NCHS], 2007; Weiss, et al., 2004). This nationwide survey provided health information of residents throughout the United States via interviews and direct physical surveys (NCHS, 2007). The four consensus panels that established metabolic syndrome risk cluster guidelines in adults have used the information from the NHANES III survey to attempt to establish guidelines for children and adolescents (Weiss, et al., 2004). However, as in the case of the adult criteria, there is no single set of criteria that defines metabolic syndrome in children and adolescents. In addition to consensus panels who have identified criteria for metabolic syndrome numerous researchers have attempted to identify independent diagnostic criteria for this syndrome. Table 4 summarizes the criteria used by several researchers to diagnose children and adolescents with metabolic syndrome, based upon the NHANES III survey data. The majority of the metabolic syndrome research conducted following NHANES III have employed primarily a modified definition of ATP-III criteria.
Table 4

*Comparison and Summary of Metabolic Syndrome Diagnosis Criteria in Children and Adolescents*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waist</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circumference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>≥90th percentile</td>
<td>(both male and female)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>≥90th percentile</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BMI (kg/m^2)</strong></td>
<td>≥97th percentile</td>
<td>≥85th percentile</td>
<td></td>
</tr>
<tr>
<td>Blood Pressure (mmHg)</td>
<td>≥95th percentile</td>
<td>≥90th percentile</td>
<td></td>
</tr>
<tr>
<td>(systolic only)</td>
<td></td>
<td>(systolic only)</td>
<td></td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>≥110</td>
<td>≥95th percentile</td>
<td>≥100</td>
</tr>
<tr>
<td>HDL Cholesterol (mg/dL)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>≤40</td>
<td>≤5th percentile</td>
<td>≤45th (15-19yrs)</td>
</tr>
<tr>
<td>Female</td>
<td>≤40</td>
<td>≤5th percentile</td>
<td></td>
</tr>
<tr>
<td>Fasting Plasma (mg/dL)</td>
<td>≥110</td>
<td>≥140</td>
<td>≥110</td>
</tr>
</tbody>
</table>
Several studies have investigated the diagnosis of metabolic syndrome in children. Cook, Weitzman, Auinger, Nguyen, and Deitz (2003) conducted an investigation of the prevalence and distribution of metabolic syndrome among adolescents (aged 12-19 years) based upon 2430 subjects from the NHANES III information. Subjects were diagnosed with metabolic syndrome if they displayed three of the five criteria shown in Table 4. The researchers concluded that 4.2% of adolescents aged 12-19 years were affected by metabolic syndrome including 6.1% of males and 2.1% of females. Among the overweight adolescents, 28.7% were diagnosed with metabolic syndrome. When extrapolating these results to the entire United States population, it was estimated that 910,000 adolescents have metabolic syndrome; accounting that nearly 30% of those who are overweight have metabolic syndrome.

Weiss, et al. (2004) studied 439 obese children and adolescents in Tel Aviv, Israel to determine the effect that varying degrees of obesity had on the prevalence of metabolic syndrome risk factors. The inclusion criteria included subjects between the ages of 4 and 20 years, whose BMI measured greater than the 97th percentile for their age and gender. The researchers used criteria modified from the ATP-III adult panel, as well as the WHO...
adult definition, as depicted in Table 6. As a result of changing body sizes in developing children and adolescents, the researchers chose to disregard waist circumference as a measurement tool. Following statistical analysis of a two-sample z-test, significance was determined by the z-score of the change in obesity. In place of waist circumference, obesity was defined as having a BMI with a z-score in the 97.72 percentile. The researchers stated that the presence of three of the criteria found in Table 6 were the basis for diagnosis. Weiss, et al. (2004) concluded that 38.7% of moderately obese subjects and 49.7% of severely obese subjects had metabolic syndrome. In contrast, neither the non-overweight, nor non-obese subjects met the metabolic syndrome criteria.

De Ferranti, Guavreau, & Ludwig, (2004) also conducted a study based upon the NHANES III survey data, and used a modified form of the adult ATP-III criteria displayed in Table 7 for diagnosis of metabolic syndrome. The researchers identified metabolic syndrome in adolescent subjects (12-19 years) when three or more of the criteria were present. A sample of 1960 adolescents that participated in the NHANES III survey were investigated after fasting for eight hours. Subjects with a BMI greater than the 85th percentile for age and gender were considered overweight or obese. The researchers concluded that 9.2% of the subjects studied displayed three or more criteria for metabolic syndrome. While no subjects showed all five abnormalities, 35 did display four of the five criteria. When extrapolated to the population, approximately 10% of adolescents in the United States display metabolic syndrome (De Ferranti et al., 2004). These differences suggest more research is needed.
The majority of the studies conducted pertaining to metabolic syndrome in children and adolescents have used growth charts to decide and define the criteria parameters to be used. The growth charts were established by the NCHS and were based upon results from the NHANES survey data and updated following each survey (NCHS, 2007). They consist of several percentile curves that illustrate selected body measurements of children and adolescents in the United States. Due to the rapid changes of body size in children and adolescents, the growth charts, which were revised in 2000, track the percentile of the child based upon the inferred data collected in the most recent NHANES survey (NCHS, 2007). The growth charts evaluate stature-for-age, weight-for-age, and BMI-for-age. The WHO has also adopted the NCHS growth charts for international use to track growth changes in children throughout the world.

International Diabetes Federation Diagnosis Criteria in Children

Amemiya et al. (2007) stated that the need for a standardized set of criteria for metabolic syndrome in children and adolescents has become increasingly important as the nationwide obesity rates increase. Similar to the adult criteria, the IDF proposed a clear, definite set of criteria to diagnose metabolic syndrome in children and adolescents (Zimmet, et al., 2007). The definitional criteria are grouped based upon age: 6–10 years, 10-16 years, and 16 years and greater compromise the three categories. Table 5 lists the risk factors for metabolic syndrome based upon these age groups. Zimmet, et al. (2007) stated that the syndrome is a cluster of cardiovascular and type 2 diabetes risk factors, including obesity. The IDF definition is simply the most recent definition of the
syndrome for youth, but as research continues to evolve in this area, the definition may be further modified. It was created as a means to supply clinicians with a universal and simple manner of diagnosing the syndrome in youth (Zimmet, et al., 2007). As knowledge and understanding of metabolic syndrome pathophysiology, natural progression, and resulting complications continues to grow, more definite criteria can be established.
### Table 5

**Current IDF Guidelines for Children and Adolescents Metabolic Syndrome Diagnosis**

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Obesity (Waist Circumference in cm)</th>
<th>Triglycerides (mg/dL)</th>
<th>HDL Cholesterol (mg/dL)</th>
<th>Blood Pressure (mmHg)</th>
<th>Fasting Blood Glucose (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>≥90th percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metabolic Syndrome cannot be diagnosed, but if the family history indicates, the patient should be monitored</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-16</td>
<td>≥90th percentile, or adult cut-off if lower</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥150</td>
<td>&lt;40</td>
<td>≥130/85</td>
<td>≥100</td>
<td></td>
</tr>
<tr>
<td>16 +</td>
<td>Adult guidelines should be employed for all older than 16 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


In addition to the guidelines depicted in Table 5, the IDF has stated that although they have not yet developed a complete definition for those less than 10 years old, any patient who has a family history of cardiovascular disease, type 2 diabetes, dyslipidemia, hypertension, or obesity, in addition to metabolic syndrome, should be monitored throughout the developmental years (Zimmet, et al., 2007). The monitoring may allow
early intervention and reduce that child’s risk of developing the syndrome. For the purpose of this study, the researcher has decided to use the IDF’s 2007 guidelines for children and adolescents and will use the same criteria for the 6 to 10 year age group as the 10 to 16 year age group.

Treatment of Metabolic Syndrome in Adults

Treatment of the disease may be addressed pharmacologically or through lifestyle modification. When a patient has been diagnosed with metabolic syndrome, the physician may treat each symptom separately, beginning with the major risk factors (Chobanian, et al., 2003; Genuth, et al., 2003). These factors include hypertension, LDL-C, and type 2 diabetes (glucose abnormalities). The physician will suggest lifestyle modification for the patient according to which of the aforementioned factors will be the most immediate threat (Grundy, et al., 2005). The most common factor addressed is hypertension, which can be treated through a low-sodium diet, the addition of 30 minutes of physical activity 5 days per week, and moderation in alcohol consumption (Chobanian, et al., 2003). The target blood pressure measurement that warrants a successful lifestyle modification is 130/80 mmHg. Should lifestyle modification be ineffective after three months, antihypertensive medications may be prescribed (Chobanian, et al., 2003). When the blood lipids, primarily LDL-C, are the risk factor for metabolic syndrome, lifestyle changes are rarely considered as a primary intervention, and typically drug therapy is the first choice by physicians (Grundy, et al., 2005). A focus on abdominal obesity treatment may also be considered for metabolic syndrome, but as the visceral fat is a physical
characteristic of other more severe physiological problems, it is considered a side benefit to the patient if weight is lost during lifestyle modification treatment of hypertension or elevated blood lipids (Grundy, et al., 2005).

Interventions for the Treatment of Metabolic Syndrome in Youth

Although several studies have evaluated the use of intervention plans in the treatment of obesity and metabolic syndrome in adults, few researchers have examined the effects of interventions on children. According to the American Academy of Pediatrics, the need for an evidence-based method of treatment of childhood obesity is becoming important as the prevalence of the health problem increases (Spear, et al., 2007). In the treatment of metabolic syndrome, the researcher must investigate nutrition strategies, physical activity strategies, or a combination of both, as well as whether the program will be more effective when applied to only the child or to the entire family. Because the goal of this study is to treat those who are already overweight and are at risk of developing life-long complications, the intervention aims will be grouped into the American Dietetic Association’s (2006) tertiary intervention. That is, the researchers will investigate ways to slow or reverse BMI, overweight complications, and metabolic syndrome risk factors.

Nutrition Interventions

Few formal research studies have studied both the long-term and short-term effects of nutrition intervention strategies in children with metabolic syndrome. Children
and adolescents are consuming an increasing amount of saturated fats, sodium, and simple sugars each day (Lytle & Fulkerson, 2002; Munoz, Krebs-Smith, Ballard-Barbash, & Cleveland, 1997). When one consumes foods that are less nutrient-dense, the outcomes include both short-term and long-term health implications and chronic diseases (American Dietetic Association, 2006; Greenstone, 2007; Hoelscher, Evans, Parcel, & Kelder, 2002). Research concluded that diet modification is necessary to achieve optimal health in those at risk for diabetes, metabolic syndrome, hypertension, impaired fasting glucose, and chronic high cholesterol (Greenstone, 2007; Hoelscher et al., 2002; Munoz et al., 1997). Greenstone (2007) suggested that clinicians should address the parents of children who have been identified as overweight. Advice offered should include: guidance in portion control; cooking to decrease added saturated and trans fats; and suggesting simple, low-calorie, nutrient-dense snacks. In some cases, parental involvement proved to have an impact on lifestyle improvement in the children (Brownell, Kelman, & Stunkard, 1983; Epstein, Valoski, Wing, & McCurley, 1994).

The traffic light diet, also referred to as the stoplight diet, is a method used to target 6- to 12-year-old children as the nutrition component of a larger family-based intervention program (Epstein, Myers, Raynor, & Saelens, 1998; Spear, et al., 2007). Consisting of 900-1300 kilocalories per day, the diet is designed and structured to increase the nutrient density of the meals consumed (Epstein, Myers, et al., 1998). The diet divides foods into three categories, which primarily consist of “green,” “yellow,” and “red” foods. The “green” foods, which consist of low-energy, nutrient-dense foods, may be eaten as often as one likes. The “yellow” foods, considered moderately energy and
nutrient dense, may be eaten in moderation, and consist of primarily grains. Sweets, saturated and \textit{trans} fats, and low-nutrient foods should be eaten sparingly and are considered “red” foods (Epstein, Myers, et al., 1998). The successful method is easy to understand, and may be extended to become a lifestyle way to view and consume foods.

Spear, et al. (2007) suggested in a review published by \textit{Pediatrics} that although limited interventions have been reviewed that consisted of only nutrition components, a few common characteristics have consistently been successful. Reduced calorie diets with a minimum 1200 kcal/day for children and adolescents to age 12 have been indicated to result in weight loss, when paired with other components. However, when the reduced-energy diet was not maintained, weight was regained in the participants (Saelens et al., 2002).

When designing a nutrition intervention, the recommended guidelines for adolescents and children follow similar plans. Hoelscher, Evans, Parcel, and Kelder (2002) stated that, as adolescents tend to consume too much fat, sugar, and sodium, and too few servings of fruits, vegetables, whole grains, and foods containing calcium and iron, they should be directed towards programs that focus on behavioral strategies, in a constant environment (Hoelscher et al., 2002). The WHO (1995) recommended that the adolescent’s condition and program be kept as confidential as possible; the more private the intervention, the more comfortable the adolescent will be participating.

Children less than 12 years require a different approach than do adolescents. A study conducted by Berkey, Rockett, Gillman, Field, and Colditz (2004) indicated that obese children whose parents either allow them to skip breakfast or feed them a smaller
meal at breakfast than dinner tend to eat more fat throughout the day (Berkey et al., 2004). Furthermore, Mrdjenovic and Levitsky (2005) concluded that children eat what is placed in front of them, regardless of their hunger level. As a result, the involvement of parents in child nutrition interventions is key to treating the obesity and overweight problem. Portion control should be emphasized as well, not only by the parents in controlling their children, but by the parents themselves.

Physical Activity Interventions

Obesity is caused by a chronic positive energy balance, usually as a result of too many kilocalories in and too few expended (LaFontaine, 2008; Meriwether, Lobelo, & Pate, 2008). This excessive energy balance can be countered with an increase in physical activity, which will result in an increase in kilocalories of energy expended. According to Meriwether et al. (2008), obesity is inversely related to physical activity levels and positively related to sedentary behavior. Physical activity levels have been shown to be quite low. For example, Pate, Pfeiffer, and Stewart (2004) assigned pedometers to preschool aged children for a school day, and found that within an eight-hour day, the mean activity level was less than one hour. Meriwether et al. (2008), stated that sedentary behavior is associated with increased television and video viewing, caloric intake, BMI and body fat, and decreased physical activity and scholastic achievement. In young adults, physical activity has been associated with the prevention of metabolic syndrome risk factors, as well as cardiovascular and type 2 diabetes risk factors (Carnethon, Gidding, Nehgme, Sidney, Jacobs, & Liu, 2003). Therefore, an intervention designed to
increase the physical activity level in children and adolescents will increase their energy expenditure, and may decrease risk factors associated with metabolic syndrome.

A small number of studies examining sole physical activity and its affect on obesity and metabolic syndrome risk factors in young adults, adolescents, and children have been conducted. The majority have found that the change was not significant enough to recommend only fitness as a treatment intervention. Parker, Schmitz, and Jacob (2005) conducted a longitudinal study to investigate any relationship between physical activity and hypertension in young adults older than 15 years. Over that time period, men and women were examined on an interval basis. At the conclusion of the time period, those who performed more physical activity as part of their daily activities had lower average systolic and diastolic blood pressure measurements than did those who performed smaller amounts of physical activity (Parker et al., 2005). The strongest recommendation in the age group when utilizing physical activity is early detection of metabolic syndrome risk factors and action to stop the progression of problem factors. Ferreira, Twisk, and van Mechelen (2005) conducted a longitudinal study in 364 adolescents as they developed into adults. The researchers used modified ATP-III criteria for metabolic syndrome in the adolescents, and the current ATP-III criteria for adults. Adults who had increased metabolic syndrome risk factors, or had been diagnosed with the syndrome, were found to have higher body fat, especially in the trunk, lower cardiovascular fitness, and lower levels of strenuous physical activity levels (Ferreira et al., 2005). As a result, the researchers recommended earlier interventions to counteract the possible poor outcomes of a life with low physical activity.
As reflected above most of the studies evaluating physical activity interventions were completed in young adults and adolescents. Children younger than 12 years old remain a relatively unstudied group. To examine the influence of physical activity levels on whole body and trunk adipose tissue in children ages 6-13 years, Nassis, Psarra, and Sidossis (2005) recruited 1362 healthy children from primary and secondary schools. Anthropometric data was gathered to calculate BMI, which was adjusted for overweight and obese groups by the WHO growth charts. Nassis et al. (2005) concluded that in overweight and obese children, those who were more physically active had lower truncal and overall body fat percentages than did overweight and obese children who were sedentary. Because trunk fat, which may measured by waist circumference, is a criterion for metabolic syndrome, it is important to realize that while the child may still be overweight, the physical activity may still decrease the child’s risk of developing metabolic syndrome.

The overall consensus in physical activity interventions is that while the programs may be effective in decreasing elevated obesity incidence and metabolic syndrome criteria those interventions may not lower certain risks such as development of cardiovascular problems. The earlier the intervention begins, the greater the chance that the patient will succeed in managing the health complications that could result if nothing was done.
Physical Activity and Nutrition Co-Interventions

A limited number of studies have focused on either nutrition education or physical activity alone as an intervention strategy. However, the two areas are highly integrated in weight loss and maintenance. By decreasing the intake of kilocalories, and thus the subsequent energy they provide, one can begin to manage the positive energy balance associated with obesity (LaFontaine, 2008; Meriwether et al., 2008). Additionally, physical activity requires the expenditure of energy to allow the body to accommodate the increased movement. In the American Dietetic Association’s Position Statement (2006) regarding pediatric overweight treatment, the recommendation for interventions includes both physical activity and nutrition education as equally important components of an effective program.

Leonard Epstein, PhD is a well-known researcher on the topic of co-interventions in the treatment of childhood obesity. A professor of psychology and pediatric behavioral medicine, he has primarily focused on behavioral change in terms of eating and health. Epstein has investigated several forms of diet and exercise changes to determine what outcome they have on child eating patterns and health risks. The traffic light diet, developed to increase nutrient density in the diets of preschool and preadolescent children, was designed to be used in conjunction with physical activity modifications (Epstein, Myers, et al., 1998). As part of a comprehensive plan, which includes physical activity, nutrition education and monitoring, and behavioral counseling, the diet has resulted in a decrease in obesity in children (see Table 6). The objectives for regulating childhood obesity include controlling body weight through physical activity on a daily
basis, as well as providing optimal nutrition to accommodate for growth and development, while minimizing loss of lean muscle mass, interrupting linear growth, and avoiding endocrine dysfunction (Epstein, Myers, et al., 1998). Much of Epstein’s research has examined the effects of co-interventions, pairing the traffic light diet, as well as other diet variations, with different physical activity and behavioral schemes. Table 6 reviews the studies conducted, including what type of nutrition program and physical activity program were conducted in each.

Table 6

*Physical Activity and Nutrition Co-Interventions Developed by LH Epstein and Colleagues*

<table>
<thead>
<tr>
<th>Study</th>
<th>Participant Age (years)</th>
<th>Nutrition Intervention</th>
<th>Physical Activity Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epstein, Wing, Steranchak, Dickson, and Michelson (1980)</td>
<td>6-12</td>
<td>Traffic Light diet: 900-1200 kcals/day</td>
<td>Exercise Information sessions, behavior modification vs. traffic light diet</td>
<td>Greater weight loss in behavior modification groups than nutrition education</td>
</tr>
<tr>
<td>Epstein, Wing, Koeske, Ossip (1982)</td>
<td>8-12</td>
<td>Traffic Light Diet: 900-1200 kcals/day</td>
<td>Aerobic Activity or Lifestyle Activity</td>
<td>No initial difference, but at 11 month follow-up a combination diet + activity maintained healthy weight</td>
</tr>
</tbody>
</table>
As indicated in Table 6, the success of co-interventions is far greater than that of an intervention strategy focusing on solely nutrition or physical activity.

When the focus was on either behavior modification or nutrition education, Epstein, Wing, and Steranchak, et al. (1980) concluded that with the traffic light diet and exercise information sessions, the behavior modification group responded better to treatment. Results from Epstein, Wing, Koeske, and Ossip, et al. (1982) concluded that lifestyle behavior information in conjunction with diet modification, improved weight
loss and BMI changes. This course of action was more successful than the combination of aerobic activity and diet modification, lifestyle modification alone, and aerobic activity modification alone. When the focus was programmed physical activity, lifestyle behaviors, or calisthenics, each paired with the traffic light diet, Epstein, Wing, Koeske, and Valoski (1985) concluded that the groups who participated in aerobic activity or lifestyle behavior modification had greater changes in weight and BMI than did the calisthenics participants. In comparing groups who participated in a thrice-weekly one mile walk, as well as the traffic light diet, with a group who only modified nutrition with the traffic light diet, the walking group reduced the body weight more than just the nutrition modification group (Epstein, Wing, Penner, et al., 1985). Epstein, Valoski et al., (1994) reviewed a co-intervention with mothers and their children. Employing the traffic light diet and lectures reviewing proper exercise habits and goals, Epstein, Valoski et al., (1994) concluded that the mother and child targeted together had more success in overall weight loss than did just the child.

Rodearmel, et al. (2006) conducted a family-based approach to treat parental obesity while preventing childhood obesity. Children ages 8-12 years were recruited if they were overweight or obese and had at least one parent willing to participate in the 13-week study. The study focused on implementing small, daily changes, including increased daily walking and the use of breakfast cereal as a snack. Significant results showed that walking was increased, cereal consumption was increased, and BMI-for-weight, as well as body fat-for-age, was decreased. Findings were primarily in mother-daughter relationships, although father-son relationships also displayed significant
results. The success of this family-based study that focused on smaller, manageable changes supports the intervention plan for the Take Action study.

Nemet et al. (2005) conducted a co-intervention study to examine both the short-term and long-term effects on obese children. In a 3-month intervention, the control group attended nutrition consultation sessions once each week with a registered dietitian (approximately 12 visits), while the test subjects and their parents attended nutrition consult sessions six times during the 3-month period. The intervention group received a balanced, hypocaloric diet, consisting of ~30% less kilocalories than the reported diet preceding the intervention. The intervention group also participated in a twice-weekly exercise program lasting one hour each and were encouraged to perform an addition 30 to 45 minutes of weight-bearing activity each week, as well as modify lifestyle activities. Following the initial 3-month intervention, significant decreases in body weight, BMI, and body fat percentage were recorded in the intervention group. Increases in habitual physical activity and fitness were also recorded in the intervention group. Significant decreases in energy intake, television screen time, total cholesterol, and LDL-C levels were also reported in the intervention group. At the 1-year follow-up, the intervention group reported decreases in body weight and BMI, as well as increased physical activity (Nemet et al., 2005). The results indicate that an effective manner of decreasing body weight, BMI, and body fat percentage is through twice-weekly exercise session, paired with a hypocaloric diet.

In a 16-month study, Brownell, Kelman, and Stunkard (1983) examined 42 obese adolescents of low- and middle-class families. Subjects were grouped as child alone (just
the child), mother with the child participating, or the mother and child in the intervention, but undergoing lessons separately. Weight and blood pressure changes were monitored in all groups. Of the three groups, no significant difference existed in pre-intervention weights and blood pressures. However, following the 16-week intervention, the mother-child separate group achieved the greatest weight decrease, while the child alone and mother-child together group remained nearly the same. After 1 year, the mother-child together and child alone groups both continued a slow but steady weight decrease, while the mother-child separate group had the greatest losses in body weight. Preceding the intervention, the most obese children had the highest blood pressure for their age (monitored by the CDC growth charts). The children who lost the most weight also achieved the greatest drop in blood pressure. Brownell et al. (1983) concluded that with a parent participating in the same intervention as the child, but not in the same room, the greatest weight changes will occur. Such positive correlations between improved weight and parent-child pairs indicate the importance for the Take Action study to employ the same format.

Appalachia and Obesity

Obesity in the Appalachian region has grown to be a greater problem than in the United States as a whole. A lack of nutritional knowledge among caregivers, limited access to registered dietitians and other health professionals, fewer physical education classes in schools, and fewer fitness opportunities available in rural communities contribute to the increase in obesity within the Appalachian region. As a result of these
factors, obesity prevalence has increased disproportionately compared to the rest of the nation (Heneghan & Malakoff, 1997; Wu et al., 2007). While success has been noted in employing physical activity and nutrition interventions, Hawley, Beckman, and Bishop (2006) note the importance of examining both environmental and individual factors when beginning a treatment program.

Financial Contribution to Health Implications

According to Wood (2005), generations of families in Appalachia who have had fewer educational opportunities tend to have difficulty rising above the low to the middle economic class. Additionally, a lack of mobility and funds to move to another region outside of Appalachia, as well as to improve the status of their life, may also result from poor economic status (Wood, 2005). Drawn from the 2000 United States Census, information regarding the labor force population has been analyzed (U.S. Census Bureau, 2001). Within Athens County, Ohio, 56.9% of the eligible population was employed, compared with 63% of the United States as a whole. The median household income within this Appalachian county was $27,322 per year, compared to a much higher $41,994 for the country. Finally, nearly 14% of the families in Athens County were considered at or above poverty, while the United States poverty level for families was recorded at 9.2%. The lack of higher education availability to low-income families contributes to the difficulty of earning and retaining a high-level management position almost non-existent.

According to Neal, et al. (2001), the obesity epidemic in children has been shown to be more severe in Appalachia than in the rest of the country. In a questionnaire
designed for primary care physicians in the Appalachian region, participants responded that the greatest problems associated with changing the obesity rates in the region included: patient motivation; lack of funds to change the diet; lack of interest in organized physical activity; limited support in beginning a program; and lack of reimbursement for travel and supplies when an intervention is proposed (Huttlinger, Shaller-Ayers, & Lawson, 2004).

The Coronary Artery Risk Detection in Appalachian Communities (CARDIAC) study performed in rural West Virginia stated that the Appalachian region’s mortality and morbidity rate of cardiovascular disease is one of the highest in the world (Neal, et al., 2001). In children, the most modifiable of the risk factors associated with cardiovascular disease includes poor nutrition and a sedentary lifestyle. Neal, et al. (2001) suggested the development and endorsement of school-based programs to address these issues with children, so as to act as a preventative measure, as well as alert parents of the effects of such lifestyles. Of the 1,338 fifth-grade Appalachian children screened, 44.5% were overweight or obese (Demerath et al., 2003).

Behavioral modification has been shown to be an effective treatment method for obesity (Epstein, Wing, Steranchak, et al., 1980). However, in rural communities, the lack of availability of proper fitness centers and access to the few that do exist provides a barrier to physical activity interventions (Heneghan & Malakoff, 1997). Hawley et al. (2006) examined the results of a behavior modification in obese middle school students and their families over a 1-year period in rural Kansas. The study was not conducted within Appalachia, but in a similar rural setting. The pilot study’s intentions included
goal-setting, self-efficacy, and readiness for change. The study included family participation in the intervention. While the one-year intervention period was determined to be too short, Hawley et al. (2006) found that families changed more during the period than did individual children. As a result, Take Action researchers were able to anticipate a greater change due to family participation in the intervention.

Summary

Metabolic syndrome may be diagnosed from four separate risk factor clusters. While the WHO criteria were developed first, and the ATP-III definition is most often utilized the IDF has developed a simple and clear definition for health care providers and clinicians to use. Children and adolescents do not have a defined set of metabolic syndrome criteria; the most accepted is the modified IDF criteria. The obesity rates in Appalachia far surpass those with the rest of the country, and thus intervention within the region that focus on ease of access and education are a necessity. Family-based interventions have proven to be the most successful; although children and parents need to be educated separately. While nutrition interventions, physical education interventions, and behavior modification interventions have proven to be successful, the results of co-interventions elicit much more success. The researchers of the Take Action study hoped to build upon the experience of these researchers.
CHAPTER 3: METHODOLOGY

The purpose of this study was to investigate the impact of an 8-week physical activity and nutrition education intervention on the incidence of the metabolic syndrome risk factors, as established by the IDF for children and adolescents up to 17 years, in those in the Appalachian community of Athens, Ohio. To the knowledge of this researcher, no studies have evaluated the effect of a physical activity and nutrition education intervention on the metabolic syndrome risk factors in at-risk children residing in an Appalachian community. As prevalence of these factors continue to increase regionally and nationally the data collected from this research will provide relevant information to clinicians and physicians in the area as a means of addressing the problem. The research project was approved by the Institutional Review Board in the Office of Research Compliance at Ohio University. Appendix B contains the current approved IRB.

Sample Size

This study was powered to have 40 adolescents and children. Participants were recruited throughout Athens, Ohio. To be eligible for recruitment and participation, potential participants were required to have a BMI classified as overweight or obese, as designated by the CDC. Additionally, he or she was required to be between the ages of 6 and 17 years. All participants were required to be cleared by a physician. Males and females were recruited. The children and adolescents, once cleared for participation, were required to have a consenting adult parent or guardian to participate in the program with
him or her. The parent was also required to obtain medical clearance for participation. All medical clearance documents were completed either by a completed referral form or a signed medical clearance form completed by his or her physician.

Recruitment of Subjects

The recruitment began informally in February 2008, as community physicians who knew the program’s recruitment guidelines suggested the intervention to eligible patients. Formal recruitment began in April 2008. Based upon the previous pilot study conducted in summer 2007, the researchers determined the population size would need to increase (N=80) so as to produce significant outcome data, as well as in anticipation of a large drop-out rate. Recruitment occurred through local pediatric offices and by fliers distributed throughout the community. The fliers contained contact information for the principal investigator, as well as a 24-hour answering service. A sample of the flier is provided in Appendix C. When potential participants contacted the researchers, an appointment with their physician was scheduled to review eligibility, as well as to obtain medical clearance. Following medical clearance, all eligible participants, including both children and adults, were given an informed consent to read through and sign. The principal investigator and Take Action researcher met weekly to update the participant roster, as well as confirm or deny participants based upon physician clearance or exclusion criteria. Once both the physical and informed consent were completed by both participants in each pair, vouchers to have blood work completed were distributed.
Pre-Testing Protocol

Fasting blood work was performed at O’Bleness Hospital between June 1 and June 16. Blood collection was done via venipuncture completed at the clinical lab by hospital phlebotomists. Inflammatory markers, lipids, hemoglobin A1C, and insulin levels were collected prior to anthropometric data collection. Pre-testing began June 16, 2008 at HeartWorks, located within O’Bleness Memorial Hospital in Athens, Ohio. The intervention began the following week.

Pre-Intervention Instruments and Testing

The pre- and post-testing was conducted at O’Bleness Memorial Hospital with the supervision of participating physicians. Medical students, exercise physiologists, nutrition and dietetics students were present to assist in the testing. Participants were instructed to choose a testing time during the week prior to the commencement of the intervention. Participants were instructed to consume a light meal prior to testing to discourage adverse reactions to aerobic testing.

Station 1. Upon entering Heart Works, participant pairs were introduced to Station 1. Two nutrition science students checked to ensure all paperwork and blood testing was completed and collected demographic data via a questionnaire from the adult participant. The survey included questions regarding family structure, income, exercise history, and health history. Sitting resting blood pressure (model HEM-711, Omron Co., Vernon Hills, IL) and resting pulse (Insta-Pulse 105, Ontario, Canada) were measured after a five minute rest. Two measurements were taken and the average recorded. The resting blood pressure was used in metabolic syndrome analysis.
Station 2. Height was recorded using a stadiometer and a metric scale (IP-0955, Leicester, England) at HeartWorks. Weight, body fat percentage, and BMI were recorded using a bioelectrical impedance scale (model BWB-800, Tanita Standing Scale, Arlington Heights, IL) at HeartWorks. Waist circumference was measured in centimeters at the iliac crest, naval, hips, and narrowest point, three times, and an average measurement was recorded.

Station 3. A sub-maximal treadmill test was administered to each participant to determine baseline fitness levels; these results were not used in data collection for this thesis. Each participant continued the test until a target heart rate of 85% of his or her age was achieved or if the patient displayed a reason to terminate the test (e.g. dysrhythmia, hypertensive response, angina). The sub-maximal treadmill test required the participant to walk at a constant pace of 3.0 miles per hour. The percent grade began at 6.0% and increased by 2.0% every two minutes. Heart rate was recorded by heart rate monitors (model CE 0537, Polar Electro OY, Port Washington, NY); manual blood pressure (model CE0123, Welch Allyn, Skaneateles Falls, NY) was recorded, and the participant’s RPE was recorded at the end of each stage. The sub-maximal treadmill test was terminated according to the previously mentioned signs. Four minutes of active recovery followed, consisting of treadmill walking at 1.7 miles per hour at a 0.0% grade. Six minutes of passive recovery finished the exercise testing. Prior to leaving HeartWorks, all participants recovered for 10 minutes, had recovery heart rate and blood pressure recorded each minute, and were given the option of a small snack for post-test
consumption. This data was not used for this analysis but is part of the larger trial protocol.

**Intervention**

The intervention took place twice per week on Tuesdays and Thursdays for 8 weeks with 2 hours per session. The adolescents (ages 12-17) and their parents participated beginning at 3:00 p.m., while children (ages 6-11) and their parents participated beginning at 5:30 p.m. The adolescents or children attended a nutrition education lecture session for approximately 1 hour, while their parents participated in 1 hour of supervised, structured physical activity. The groups switched at the end of 1 hour. At the end of the 2-hour session, the participants received a snack, which emphasized portion control, healthy ingredients, and little preparation time.

**Dietary Intervention**

Nutrition lectures lasted approximately 45 minutes. Appendix D displays a chronological outline of topics covered each week, as does Table 7 in more detail. The participants gathered in a large room with tables and chairs. Each participant was asked to submit his or her exercise log each Tuesday; the log recorded physical activity performed outside of the structured intervention setting. At the start of each session, participants were asked whether or not there was any confusion from the previous session. Adults and adolescents then began the new lesson for each day. Each session consisted of a powerpoint lecture, in which questions and key points were given with the
lesson goal of that day. This first session of the week covered the majority of the lecture; the second session of the week incorporated an experience or game to ensure the lesson of the previous session was learned. In many cases, the second session was a form of the game show *Jeopardy* or a question-answer session consisting of two teams playing against each other for points.
Table 7

*Nutrition Lecture Topics*

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week One</td>
<td>Introduction and Leading a Healthy Lifestyle</td>
</tr>
<tr>
<td></td>
<td>• Goal setting; Healthy lifestyle examples and discussion</td>
</tr>
<tr>
<td>Week Two</td>
<td>The Food Label: Interpreting and Analyzing</td>
</tr>
<tr>
<td>Week Three</td>
<td>Macronutrients and Micronutrients; What To Look For In The Food Label</td>
</tr>
<tr>
<td></td>
<td>• Carbohydrate, fat, protein, water, vitamin, mineral choices</td>
</tr>
<tr>
<td></td>
<td>• Broad examples of healthy vs. un-usable foods</td>
</tr>
<tr>
<td>Week Four</td>
<td>Portion Sizes; How to Use MyPyramid.gov</td>
</tr>
<tr>
<td></td>
<td>• Portion control and examples</td>
</tr>
<tr>
<td>Week Five</td>
<td>Grocery Shopping for Healthy Cooking</td>
</tr>
<tr>
<td></td>
<td>• Handouts and grocery store tour</td>
</tr>
<tr>
<td></td>
<td>• Age-appropriate tour of aisles</td>
</tr>
<tr>
<td>Week Six</td>
<td>Making Healthy Choices When Eating Away From Home</td>
</tr>
<tr>
<td></td>
<td>• Local and chain restaurant choices</td>
</tr>
<tr>
<td></td>
<td>• Distinguishing based on preparation and menu description</td>
</tr>
<tr>
<td>Week Seven</td>
<td>Learning to Cook in a Healthier Way</td>
</tr>
<tr>
<td></td>
<td>• After school snacks, breakfasts, cafeteria meals</td>
</tr>
<tr>
<td></td>
<td>• Cooking for the family and picky eaters</td>
</tr>
<tr>
<td>Week Eight</td>
<td>Wrapping Up Take Action</td>
</tr>
</tbody>
</table>

During the first 4 weeks of the intervention, all participants followed the same powerpoint format. The Week One Lecture Outline is available in Appendix E. During the second session of the week, participants were asked to recall the lesson from the first
session. The Week Two Lecture Outline is shown in Appendix F. The Week Three Lecture Outline is available in Appendix G. During Week Four, participants were referred to the MyPyramid.gov website to find easy comparison sizes for portions of different foods. The Week Five Lecture Outline of the presentation is available in Appendix H. Participants were grouped in child and adult pairs, and walked to the market, where the nutrition students gave the groups a tour of each section. Food labels were the main focus, although participants were given sample menu ideas, as well as ideas for shopping healthy on a budget. The second session of the week consisted of a group hike through a local park. The structure of the child portion of the intervention for the first 4 weeks followed that of the adolescent structure; the children and their parents attended each hour separately. For the remaining 4 weeks of the intervention, child participants and their parents attended lectures together, so as to keep the children occupied, as well as allow the parents and children to interact with each other in reference to the lessons. Week Six discussed healthy restaurant choices; participants were given copies of menus from local Athens, Ohio restaurants and chain restaurants, and the researchers discussed the healthy options, as well as why each option was considered healthy. The Week Seven Lecture Outline is shown in Appendix I. Cooking and baking methods and alterations were discussed. Week Eight consisted of a “wrap-up” session; participants were encouraged to ask questions in reference to the entire intervention. The second session of the week, and the last session of the intervention, was a potluck dinner of meals prepared by the participants according to the lectures on preparation, substitutions, and serving sizes. All participants provided recipes for the dished provided.
Physical Activity Intervention

Each participant was paired with a personal trainer. The personal trainers were undergraduate and graduate exercise physiology students, medical students, and nutrition students who had a background in exercise physiology. Prior to beginning exercise, each participant was fitted with a heart rate monitor. Each participant then completed a warm-up of 5-10 minutes in a group setting, consisting of walking on an indoor track at a comfortable pace for five minutes. Participants gathered in a semi-private area to stretch major muscle groups, including the upper and lower extremities and core. An informal education lecture was presented by the personal trainers at each session. The lecture addressed the topics discussed during the nutrition lectures, as well as introduced core strength topics. The physical activity training portion followed the warm-up. Each adult and adolescent participant and his or her personal trainer progressed to the cardiovascular room. The exercise prescription was based upon the participant’s individual sub-maximal data results. An interval-related training approach was used. The participant chose one of five pieces of cardiovascular equipment on which to exercise during the first stage of activity. Equipment included treadmills, recumbent or upright stationary bicycles, stair-climbers, and elliptical machines. Two separate activity bouts were used to ensure interest and variability in the participant’s exercise regime. The second stage closely mimicked the first, although the participant chose one of the four remaining cardiovascular equipment pieces. The interval training protocol increased in total time exercised as the participants became more accustomed to the training. The interval training program can be seen in Table 8.
Table 8

*Interval Training Exercise Protocol for Participants*

<table>
<thead>
<tr>
<th>Day Attended</th>
<th>Total Time(min) x Sessions</th>
<th>Heart Rate Range Intensities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 x 2</td>
<td>45-50/55-60% HRmax</td>
</tr>
<tr>
<td>2</td>
<td>13 x 2</td>
<td>45-50/55-60% HRmax</td>
</tr>
<tr>
<td>3</td>
<td>13 x 2</td>
<td>50-55/55-60% HRmax</td>
</tr>
<tr>
<td>4</td>
<td>16 x 2</td>
<td>50-55/55-60% HRmax</td>
</tr>
<tr>
<td>5</td>
<td>16 x 2</td>
<td>55-60/60-65% HRmax</td>
</tr>
<tr>
<td>6</td>
<td>17 x 2</td>
<td>55-60/60-65% HRmax</td>
</tr>
<tr>
<td>7</td>
<td>17 x 2</td>
<td>55-60/60-65% HRmax</td>
</tr>
<tr>
<td>8</td>
<td>26 x 1</td>
<td>55-60/60-65% HRmax</td>
</tr>
<tr>
<td>9</td>
<td>26 x 1</td>
<td>55-60/60-65% HRmax</td>
</tr>
<tr>
<td>10</td>
<td>26 x 1</td>
<td>55-60/65-70% HRmax</td>
</tr>
<tr>
<td>11</td>
<td>26 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
<tr>
<td>12</td>
<td>26 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
<tr>
<td>13</td>
<td>27 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
<tr>
<td>14</td>
<td>27 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
<tr>
<td>15</td>
<td>27 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
<tr>
<td>16</td>
<td>27 x 1</td>
<td>60-65/65-70% HRmax</td>
</tr>
</tbody>
</table>
At the end of the cardiovascular portion, participants returned to the nutrition lecture room. Child participants followed the same protocol as did the adults and adolescents, though the cardiovascular activity was pursued outdoors or on indoor courts, as weather allowed. Following the warm-up, children either played organized basketball, dodgeball or soccer in an indoor gymnasium, or played the same games outdoors. Outdoor activities included obstacle courses, water balloon fights, hiking, a day spent at the community pool, and tag.

**Snacks**

All snacks were prepared by nutrition assistants. Snack recipes were provided at the end of the intervention during the potluck dinner. Dishes ranged from fresh and seasonal fruit and vegetables grown locally, to low-fat and low-sugar brownies, homemade granola, and healthy nuts and seeds. Portion control was emphasized. All participants were given the option of a snack at the end of each 2-hour session.

**Post- Testing Protocol**

Post-testing was structured in the same manner as pre-testing, except participants were not asked to provide demographic information. Upon entering Heart Works, participant pairs were introduced to Station 1. Two nutrition science students checked to ensure all paperwork and blood testing was completed. A survey was provided in which participants discussed the positive and negative aspects of the intervention. Sitting blood pressure was measured after a five minute rest by an automated sphygmomanometer. Two measurements were taken, with the average recorded. At Station Two, height was
recorded using the stadiometer and the metric scale. Weight, body fat percentage, and BMI were recorded using the bioelectrical impedance scale. Waist circumference was measured in centimeters at the iliac crest, naval, hips, and narrowest point, three times, and an average measurement was recorded. The participants then moved to Station Three, where the sub-maximal treadmill test was administered to determine final fitness levels.

Data Analysis

All collected data were entered using the Statistical Package for the Social Sciences (SPSS version 16.0, 2008, Chicago, IL). Both pre-intervention and post-intervention data were entered according to each variable. Descriptive statistics and paired samples t-tests were conducted in this research study. Participants who did not complete any of the post-intervention screening were not included in final data entry. Descriptive statistics were used to summarize the variables and presented in terms of mean and standard deviation. The paired samples t-test was used for the individual metabolic syndrome characteristics to determine pre-intervention and post-intervention change. A $p$ value of 0.05 or less was considered significant.
CHAPTER 4: PRESENTATION AND ANALYSIS OF FINDINGS

Data Collection

The 2008 study followed an open public recruitment throughout Athens County, Ohio. Initial recruitment yielded responses from 26 families. Eighteen families that responded were eligible and available for pre-testing. Of these families, four of the families were eligible to enroll two children in the program. Fifteen families, including 17 youth, completed all required pre-testing phases. Eleven families, with 13 youth, completed the entire eight-week program, including both pre- and post-testing (completion rate among child and adolescent participants: 76.5%). Two families with two children each enrolled and completed the program. See Table 9 for participant records of the pre-testing and post-testing time periods. The study yielded pre-intervention and post-intervention data for 13 child and adolescent participants. Those youth participants that did not complete full post-testing were not included in final data calculation. Attendance records are shown for child and adolescent participants only.
Table 9

Tracked Completion of Child and Adolescent Participants

<table>
<thead>
<tr>
<th></th>
<th>Number of Participants Completing Pre-Test</th>
<th>Number of Participants Completing Week One</th>
<th>Number of Participants Completing Week Eight</th>
<th>Number of Participants Completing Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Participants</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Adolescent Participants</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Total Participants</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>13</td>
</tr>
</tbody>
</table>

For the purpose of measuring metabolic syndrome risk factors according to IDF criteria, the only necessary demographic included age. The age of the children who completed the intervention are listed below. All participants were residents of Athens County, OH \( n = 13, 100.0\% \). Overall, of those that completed pre-testing, female enrollment \( n = 8 \) contributed 61.5%; male enrollment \( n = 5 \) contributed 38.5%. Within the age divisions, the 12-17 year adolescent group \( n = 9 \) consisted of 7 females (77.8%) and 2 males (22.2%). The participants in the 6-11 year child group \( n = 4 \) consisted of one female (25.0%) and four males (75.0%). Age and gender of the 13 participants are summarized in Figure 1. Female enrollment outnumbered male enrollment overall. Males outnumbered females in the child group, while females outnumbered males in the adolescent group.
Body Mass Index (BMI) Measurements

The CDC recommends that weight of children ages 2 years through 20 years to be specified by age and gender specific percentiles using BMI (CDC, 2008; Mei et al., 2002). As BMI varies according to gender and age, the BMI percentile ranking provides a way to rank an individual against others in the same category. Table 11 displays the BMI percentiles of the participants according to the CDC recommendations. Appendix J displays the CDC age and gender growth charts used to plot BMI as percentiles for girls; Appendix K displays the charts for boys. A BMI value below 5% indicates underweight, BMI from 5% to 85% indicates normal weight, BMI from 85% to 95% indicates overweight, and BMI above 95% indicates obesity. During pre-intervention testing, as expected based on inclusion criteria, all child and adolescent participants were either overweight or obese. At the conclusion of the intervention, post-testing results showed
that while individual participants may have decreased BMI over the course of the study, no participants decreased to “normal weight.” Two adolescent participants (22.2%) remained in the same percentile. Three of the children, (75.0%), and two of the adolescents (22.2%), increased BMI percentiles. Individual pre-intervention and post-intervention BMI percentiles and CDC classifications are displayed in Table 10.
Table 10

*Pre- and Post-Intervention BMI Percentiles per CDC Designation*

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>BMI Percentile: Pre-Intervention</th>
<th>BMI Percentile: Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Female</td>
<td>99.1</td>
<td>99.2</td>
</tr>
<tr>
<td>9</td>
<td>Male</td>
<td>96.1</td>
<td>96.6</td>
</tr>
<tr>
<td>10</td>
<td>Male</td>
<td>99.1</td>
<td>99.0</td>
</tr>
<tr>
<td>11</td>
<td>Male</td>
<td>88.2</td>
<td>92.2</td>
</tr>
<tr>
<td>12</td>
<td>Female</td>
<td>94.4</td>
<td>96.4</td>
</tr>
<tr>
<td>13</td>
<td>Female</td>
<td>99.5</td>
<td>99.5</td>
</tr>
<tr>
<td>14</td>
<td>Male</td>
<td>90.9</td>
<td>90.8</td>
</tr>
<tr>
<td>14</td>
<td>Female</td>
<td>92.0</td>
<td>92.0</td>
</tr>
<tr>
<td>15</td>
<td>Female</td>
<td>94.5</td>
<td>94.0</td>
</tr>
<tr>
<td>15</td>
<td>Female</td>
<td>99.8</td>
<td>99.7</td>
</tr>
<tr>
<td>15</td>
<td>Female</td>
<td>97.5</td>
<td>97.4</td>
</tr>
<tr>
<td>17</td>
<td>Female</td>
<td>92.6</td>
<td>94.1</td>
</tr>
<tr>
<td>17</td>
<td>Male</td>
<td>99.3</td>
<td>98.9</td>
</tr>
</tbody>
</table>

Total 13 participants
Mean BMI data for participants are displayed in Table 11. Child participant data did not elicit a significant change ($SD = 1.56, p = 0.43$). Mean pre-intervention BMI was 28.88 kg/m$^2$; mean post-intervention BMI was 28.16 kg/m$^2$. Adolescent participant findings did not elicit a significant change ($SD = 1.11, p = 0.56$). Mean pre-intervention BMI was 32.17 kg/m$^2$; mean post-intervention BMI was 31.96 kg/m$^2$.

Table 11

*Pre- and Post-Intervention BMI Data per Age Group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre BMI Mean $(\text{kg/m}^2)$</th>
<th>Post BMI Mean $(\text{kg/m}^2)$</th>
<th>Standard Deviation (SD)</th>
<th>$p$ value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>28.88</td>
<td>28.16</td>
<td>1.56</td>
<td>0.43</td>
</tr>
<tr>
<td>12-17</td>
<td>32.17</td>
<td>31.96</td>
<td>1.11</td>
<td>0.56</td>
</tr>
</tbody>
</table>

*Note.* $*p < .05$.

Metabolic Syndrome Criteria Measurements

Neither the mean nor individual data for the child or adolescent groups indicated metabolic syndrome. The IDF criteria set indicates metabolic syndrome may be present when three or more of the following measurements are reported: waist circumference greater than the 90$^{th}$ percentile for age, blood pressure greater than 130/85 mmHg, fasting glucose greater than 100 mg/dL, fasting triglycerides greater than 150 mg/dL, and HDL
cholesterol less than 40 mg/dL. Using these criteria, no participant demonstrated
metabolic syndrome at the pre-intervention or post-intervention point of this study.

*Waist Circumference (WC)*

The current IDF metabolic syndrome risk criteria states that children above the
90th percentile for WC should be considered at risk; however, normative WC values, and
thus age- and gender-percentiles, in the United States have yet to be established (Li, Ford,
Mokdad, & Cook, 2006). Because WC is an indicator of weight status, for the purpose of
this research, the investigators chose to use participant BMI above the 85th percentile for
age as a means to establish weight status. The rationale for this is that it has been found
that BMI and WC measurements are closely related to gauging the risk for cardiovascular
risk factors, including metabolic syndrome criteria, and can be used in children and
adolescents (Camhi, Kuo, & Young, 2008; Ng, et al., 2007). Therefore, all participants
were considered to be at risk both pre-intervention and post-intervention according to
being either overweight or obese, per BMI percentiles.

Child participant data did not elicit a significant change in WC measurements ($SD= 1.34,
p= 0.08$). Mean pre-intervention waist circumference (WC) was 78.05 cm; mean post-
intervention WC was 76.26 centimeters. This may represent a trend. Adolescent
participant data did not elicit a significant change in WC ($SD= 1.84, p= 0.24$). Mean pre-
intervention findings were 93.32 centimeters; mean post-intervention findings were 92.55
centimeters. Waist circumference data are displayed in Table 12.
Table 12

*Pre- and Post-Intervention Waist Circumference Data per Criteria Group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre WC Mean (centimeters)</th>
<th>Post WC Mean (centimeters)</th>
<th>Standard Deviation (SD)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>78.05</td>
<td>76.26</td>
<td>1.84</td>
<td>0.08</td>
</tr>
<tr>
<td>12-17</td>
<td>93.32</td>
<td>92.55</td>
<td>1.84</td>
<td>0.24</td>
</tr>
</tbody>
</table>

*Note. *p < .05.

Resting Blood Pressure

The child group did not display statistical significance in resting systolic (SD = 3.15, p = 0.32) or diastolic blood pressure (SD = 18.12, p = 0.99). Mean pre-intervention systolic and diastolic blood pressures were 103.13 mmHg and 66.25 mmHg, respectively; mean post-intervention systolic and diastolic blood pressures were 101.25 mmHg and 66.13 mmHg, respectively. No child participants, pre-intervention or post-intervention, displayed an at-risk blood pressure. The adolescent group findings were not statistically significant in systolic (SD = 10.44, p = 0.76) or diastolic blood pressures (SD = 8.67, p = 0.08). Mean pre-intervention systolic and diastolic blood pressures were 114.00 mmHg and 75.00 mmHg, respectively; post-intervention systolic and diastolic blood pressures were 112.89 mmHg and 69.23 mmHg, respectively. One participant (11.1%) displayed an at-risk blood pressure over 130/85 mmHg pre-intervention; no participants did post-intervention. Blood pressure data are displayed in Table 13.
Table 13

*Pre- and Post-Intervention Resting Blood Pressure per Criteria Group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre SBP (mmHg)</th>
<th>Post SBP (mmHg)</th>
<th>SD: SBP</th>
<th>P value: SBP*</th>
<th>Pre DBP (mmHg)</th>
<th>Post DBP (mmHg)</th>
<th>SD: DBP</th>
<th>P value: DBP*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>103.13</td>
<td>101.25</td>
<td>3.15</td>
<td>0.32</td>
<td>66.25</td>
<td>66.13</td>
<td>18.12</td>
<td>0.99</td>
</tr>
<tr>
<td>12-17</td>
<td>114.00</td>
<td>112.89</td>
<td>10.44</td>
<td>0.76</td>
<td>75.00</td>
<td>69.28</td>
<td>8.67</td>
<td>0.08</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05.

*Fasting Glucose*

Statistically significant increases were found in the fasting plasma glucose levels of both the child and adolescent groups. The child group had a significant increase between pre-intervention and post-intervention (*SD* = 3.30, *p* = 0.03). Mean pre-intervention levels were 87.25 mg/dL; mean post-intervention levels were 93.50 mg/dL. No participant was considered at risk based on metabolic syndrome risk levels for blood glucose at pre-intervention; one participant (25%) displayed a fasting glucose level above 100 mg/dL. The adolescent group did have a significant increase in fasting plasma glucose levels (*SD* = 2.33, *p* = 0.007). Mean pre-intervention levels were 90.44 mg/dL; mean post-intervention levels were 93.22 mg/dL. One adolescent participant displayed fasting glucose levels above 100 mg/dL at pre-testing (11.11%); two participants (22.2%) displayed levels above 100 mg/dL at post-testing. Although the findings were significant, the goal of the study was to decrease fasting plasma glucose; therefore, the findings
should not be considered successful. Fasting plasma glucose data are presented in Table 14.

Table 14

*Pre- and Post-Intervention Plasma Glucose Levels per Criteria Group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre Glucose Mean (mg/dL)</th>
<th>Post Glucose Mean (mg/dL)</th>
<th>Standard Deviation (SD)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>87.25</td>
<td>93.50</td>
<td>3.30</td>
<td>0.03</td>
</tr>
<tr>
<td>12-17</td>
<td>90.44</td>
<td>93.22</td>
<td>2.33</td>
<td>0.007</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05.

**Fasting Serum Triglycerides**

The child group did not have a significant change in fasting serum triglyceride levels (*SD* = 25.68, *p* = 0.80). Mean pre-intervention measurements were 56.25 mg/dL; mean post-intervention findings were 59.75 mg/dL. No child participants met metabolic syndrome risk criteria for triglycerides pre-intervention or post-intervention. The adolescent group did not display a significant change in triglyceride levels (*SD* = 30.78, *p* = 0.38). Mean pre-intervention measurements were 90.56 mg/dL; mean post-intervention measurements were 100.00 mg/dL. One participant met metabolic syndrome risk criteria pre-intervention (11.11%); one participant met metabolic syndrome risk
criteria post-intervention (11.11%). It should be noted that these values were not from the same individual. Fasting serum triglyceride data are displayed in Table 15.

Table 15

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre Triglyceride Mean (mg/dL)</th>
<th>Post Triglyceride Mean (mg/dL)</th>
<th>Standard Deviation (SD)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>56.25</td>
<td>59.75</td>
<td>25.68</td>
<td>0.80</td>
</tr>
<tr>
<td>12-17</td>
<td>90.56</td>
<td>100.00</td>
<td>30.78</td>
<td>0.38</td>
</tr>
</tbody>
</table>

*Note. *p < .05.

HDL Cholesterol

The child group findings were not statistically significant (SD = 3.86, *p* = 0.72) for HDL cholesterol when comparing pre- to post-intervention data. Mean pre-intervention measurements were 56.75 mg/dL; mean post-intervention findings were 56.00 mg/dL. No child met metabolic syndrome risk criteria pre-intervention; one child (25.0%) had HDL levels lower than 40 mg/dL post-intervention. The adolescent group findings were not statistically significant for HDL levels pre- and post-intervention (SD = 3.14, *p* = 0.32). Mean pre-intervention measurements were 39.22 mg/dL; mean post-intervention measurements were 40.33 mg/dL. Five participants (55.56%) displayed HDL levels below 40 mg/dL pre-intervention; five participants (55.56%) displayed levels below 40 mg/dL post-intervention. The HDL cholesterol data are displayed in Table 16.
Table 16

*Pre- and Post-Intervention HDL Cholesterol Levels per Criteria Group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Pre HDL-C Mean (mg/dL)</th>
<th>Post HDL-C Mean (mg/dL)</th>
<th>Standard Deviation (SD)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>56.75</td>
<td>56.00</td>
<td>3.86</td>
<td>0.72</td>
</tr>
<tr>
<td>12-17</td>
<td>39.22</td>
<td>40.33</td>
<td>3.14</td>
<td>0.32</td>
</tr>
</tbody>
</table>

*Note. *p* < .05.

*Metabolic Syndrome Summary*

Table 17 provides a summary of participants who displayed measurements within metabolic syndrome parameters both pre-intervention and post-intervention.
Table 17

Participants Displaying Metabolic Syndrome At-Risk Measurements

<table>
<thead>
<tr>
<th></th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6-11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12-17&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Waist Circumference</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>(BMI &gt;85&lt;sup&gt;th&lt;/sup&gt; percentile)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glucose</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HDL-Cholesterol</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

<sup>Note</sup>. <sup>a</sup>Population of 4. <sup>b</sup>Population of 9.
CHAPTER 5: SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Metabolic syndrome is a growing concern among United States public health professionals in adults and in children as well. Nationwide goals continue to be set for halting the increase in overweight children. Organizations such as the CDC, Healthy People 2010, and the American Diabetes Association have launched initiatives to reduce the increase and level of overweight children in the United States.

Review of the Goals and Research Questions

Take Action was an intervention program targeted towards overweight children and adolescents with the intention to reduce the risk of developing or decreasing the presence of metabolic syndrome characteristics. The target population, Appalachian children, have a higher risk of developing metabolic syndrome risk factors, including hypertension, high blood pressure, and excessive unhealthy weight (Behringer, 1994; Huttlinger et al., 2004; Ornstein & Jacobson, 2006). Children residing within Appalachian communities have an increased risk of developing some of the risk factors for metabolic syndrome as well (Demereth et al., 2003).

The goal of this research was to reduce the metabolic syndrome risk criteria for a group of Appalachian youth participating in a diet and exercise intervention program. The criteria used to evaluate metabolic syndrome risk were the modified IDF criteria that state that metabolic syndrome may be diagnosed when three or more of the following conditions exist; however, in this study, waist circumference risk was determined by BMI percentile:
1. Waist circumference greater than 90th percentile for age;
2. Resting blood pressure greater than 130/85 mmHg;
3. Fasting plasma glucose greater than 100 mg/dL;
4. Fasting serum triglyceride levels greater than 150 mg/dL;
5. HDL cholesterol less than 40 mg/dL.

Specifically, the goal of this study was powered to reduce these risk factors by the following amount: mean waist circumference by 2.54 centimeters; mean systolic blood pressure by 5%; mean diastolic blood pressure by 10%; mean fasting blood glucose by 5%; mean fasting triglycerides by 5%; and an increase in mean HDL cholesterol by 5%.

Additionally, there was a goal to decrease BMI percentiles for 25% or more of the participants after the intervention. The reduction of metabolic syndrome as a whole was not an initial goal of the research; the reduction of individual risk criteria was the focus.

Summary of the Findings

With the implementation of an 8-week diet and physical activity intervention, no statistically significant changes in metabolic syndrome risk criteria were achieved. No participants decreased in weight-for-age BMI percentile rankings; in fact, two increased from overweight to obese. Overall, the findings indicate that the intervention was not successful. While the results show a decrease in mean child waist circumference, diastolic blood pressure and fasting triglycerides, the findings were neither significant nor did they meet the goals of the study. Very little improvement resulted from the 8-week study in mean waist circumference and glucose levels among the adolescents. The child
group saw an increase in every metabolic syndrome variable investigated except waist circumference. However, small improvements did result in the adolescent group for systolic and diastolic blood pressure, waist circumference, fasting glucose, and HDL cholesterol changed positively, though none of these results were statistically significant. Child BMI measurements and HDL cholesterol changed positively, as well.

Several modifications need to be addressed in future research to yield more significant results when implementing this type of intervention. It has been found that HDL cholesterol levels will initially decrease with weight loss in overweight and obese adults (Thompson, Jeffrey, Wing, & Wood, 1979). However, after a prolonged time period, the HDL levels will return to pre-weight loss levels, whether or not initial weight loss was regained, and will continue to increase. This reasoning may account for the decrease in HDL cholesterol levels in the adolescent group. Although BMI did not appear to decrease, there was weight loss among participants; however, weight loss was not a goal of the study and therefore was not reported directly. The change in height may account for the lack of BMI change, as will be discussed later in this section. The adolescent group results indicated a greater change in overall weight loss (demonstrated through BMI values) than did the child group findings. The increase in both adolescent and child group triglycerides and child glucose levels, may be a result of the lack of attention paid to stringency when post-testing the participants. The protocol is discussed later in this section. It is also possible that the intervention did not work, regardless of the weaknesses, limitations, and barriers encountered by both the researchers and the participants.
It is important to note that there is a need to clarify the definitions and risk factors cutoffs for metabolic syndrome in children and adolescents. With the increase in childhood obesity rates, the unclear designation of risk criteria measurements should be addressed in order to modify specific health concerns before the development of more serious complications occurs. In this study, the IDF criteria used was changed to accommodate the age groups pre-selected for this trial therefore participants up to 17 years were evaluated using youth criteria (the age cut-off of the IDF recommendation is 16 years). Recent studies have shown that while several studies have been conducted to evaluate the prevalence of metabolic syndrome in youth, the criteria and the measurements of the criteria differ based on the panel establishing them, as well as the country in which the studies were conducted. Weiss, et al. (2004) evaluated obese and overweight youth to determine metabolic syndrome prevalence, using the ATP-III criteria. Participants studied ranged in age from 4 to 19 years. De Ferranti et al. (2004) and Cook et al. (2003) evaluated youth using NHANES III data, and established metabolic syndrome with the ATP-III criteria. In an intervention program modeled much like this study, researchers in Israel measured only blood lipids without establishing metabolic syndrome criteria (Nemet et al., 2005). A very recent study conducted in Korea followed the IDF criteria for metabolic syndrome in elementary school children (Tak, An, Kim, & Woo, 2008); the same measurement parameters as were used in the Take Action study. The researchers recruited obese and overweight elementary school children, gauging eligibility based upon a BMI greater than 85th percentile or relative obesity based
on waist circumference. As a result of varying definitions and methodology in these studies it is difficult to compare one study to another in terms of feasibility and success.

In the future, screening for metabolic syndrome in children and adolescents may need to be based upon other factors, as opposed to BMI of parents and youth. The researcher in this study found that overweight or obese status did not identify children with metabolic syndrome. Thus, the question arises: which children and adolescents should be screened for metabolic syndrome and how? It is unreasonable to test all children in that subjecting all youth to annual venipuncture may not be cost effective or practical. A variety of studies that have examined metabolic syndrome in youth have recruited participants on the basis of BMI percentile ranking, studying those at or above the 85th percentile (Eliakim et al., 2002; Nemet et al., 2004; Tak et al., 2008). Therefore, it is interesting that there was a lack of significant change in metabolic syndrome risk criteria in this study, when similar methods of recruitment, as in other more successful studies, were employed. Therefore, as this evidence of interventions indicates typically success in decreasing not only obesity but also metabolic syndrome risk factors, it is possible that this line of study may need to be adjusted to find significant results in the future.

Weaknesses and Limitations in the Study Design, Research, and Outcomes

Several weaknesses in the program may have contributed to the lack of significant findings from pre- to post-intervention testing. Since recruitment was based upon participant BMI, the participants were not recruited solely for having metabolic
syndrome. In future studies, it may be worthwhile to recruit children and enroll only those children who meet criteria for metabolic syndrome. However, the investigators may have difficulty recruiting enough children and adolescents that meet both weight and metabolic syndrome criteria in this region, because there was a significant recruitment issue using broader criteria.

Pre-testing and post-testing procedures differed slightly, which may have impacted the outcomes. The investigators were not as stringent in ensuring that all participants followed protocol for post-testing venipuncture schedules; many of the participants were asked to have their blood drawn when they attended post-testing. Although these participants were asked if they had yet eaten anything that day, the researchers failed to take into account that the participants may have eaten within the last 8 hours, including snacks late in the evening. These mistakes possibly could have led to the noticeable increases in participant triglyceride and glucose values, especially in the child group. If triglycerides and fasting glucose will be included in future studies, confirmation of fasting status is critical. There was also a problem with some of the anthropometric measurements. Every participant grew one-half inch from the pre-testing to the post-testing. As cited earlier, this could possibly account for the improved BMI in the adults. Although the same testing equipment and same staff member measured each person, the growth change among each participant brings question to the validity of the post-intervention BMI values. These results could depend on whether the participants actually grew, grew more than reported, or did not grow at all. While it is likely that youth may grow at this rate, it is highly unlikely that all adults grew during the 10-week
time span. The possibly incorrect height data could decrease ending BMI values. The trend introduces the possibility that other results measured directly by an investigator, including the blood pressure and waist circumference measurements, may not be accurate as well. As opposed to the venipuncture data, which were recorded in the blood work lab at O’Bleness Hospital, room for human error must be considered in all anthropometric data.

It was found that the children, when asked each session about previously discussed topics, did not retain lecture information very well, and learned better by focusing on smaller, big picture information with repetition and games. Although the adolescent participants did not show the lack of focused attention that exemplified the children, they did not respond actively to review questions. In many cases, the adolescents needed to be prompted by the lecturers before responses were provided. Thus, another weakness is that the investigators made no attempt to assess the effectiveness of the nutrition education portion of the intervention.

Inclusion and exclusion criteria were based solely on the BMI status of participants; that is, children and adolescents whose BMI values fell in the overweight and obese percentiles were considered eligible. However, the findings demonstrate that screening simply by BMI does not indicate that a child or adolescent has metabolic syndrome. The IDF criteria designate that children should be screened for metabolic syndrome only if a parent displays metabolic syndrome risk factors. The parents involved in the study, while not directly reported in this research, displayed a mean BMI of 31.8 kg/m² pre-intervention, and 30.9 kg/m² post-intervention. Yet, even with this as a
screening guideline, children with metabolic syndrome were not identified. Given that both youth and adult BMI values indicated overweight or obese status, it was evident from the data presented in this thesis that BMI does not necessarily indicate presence of youth metabolic syndrome.

It should be noted that while the physical activity aspect was easily tracked by the personal trainers, the nutrition portion of the intervention could not be monitored as precisely. No manner of testing for knowledge gained was provided for the participants aside from group discussion. While physical activity was monitored each week and was tested both pre-intervention and post-intervention, the dietary portion was not monitored in any way. There was no way for the researchers to know how much knowledge the participants retained, and whether or not they changed their diets when away from the program. Although body composition was measured at post-testing, any change could be attributed to the improvement in physical activity. The addition of a registered dietitian could have substantially improved this protocol.

Barriers Presented by Participants and Researchers

During post-testing, participants were surveyed about barriers they encountered with the program. Barriers cited included the time of day, the fact that the program occurred twice per week, and the program being conducted during the summer vacation from school. These factors appear to affect both recruitment and retention. Many participants and their families took trips during the middle of the program. Because most of the adult participants were employed, many adolescent pairs were not consistently
present due to schedule conflicts with the 3:00 p.m. start time. Previous interventions have been conducted in the evenings and on weekends or have been built in to after-school activities, thus limiting some of the problems encountered with this study (Brownell et al., 1983; Eliakim et al., 2002; Nemet et al., 2005). As outlined in the methods, the adolescent participants were not permitted to attend the program without an adult counterpart; thus, adolescent participation depended on parent participation. A small number of participants in both groups were concurrently enrolled in summer activities including musical camps, summer schools, and day care. The time conflicts with the schools and camps may have played a role in both the poor enrollment and the attendance rate of certain participants. The summer break schedule of the schools within Athens County limited the time frame of the program to no longer than 10 weeks, which included one week at the beginning and one week at the end were required for pre-testing and post-testing. Participant suggestions for setbacks and obstacles of the program included: too little time to focus on relevant and problematic topics, too little time for one-on-one focus, and not enough supervision of structured and proper physical activity to allow participants to continue on their own once the intervention ceased. The investigators were aware of these limitations, but funding and staff limitations forced this program to occur in the summer.

The Take Action investigators cited the barriers to exercise found in the intervention in a review of the 2008 study. One of the most complicated obstacles was the lack of transportation to and from the site of the program (Wapner & Shubrook, 2008). The Appalachian Regional Commission and others who study the Appalachian area have
found that transportation, in addition to physical distance to densely populated areas and the lack of reliable public/private transportation, all contribute to the impaired healthcare of the region (Behringer et al., 1994). While gas vouchers were offered as weekly incentives for attendance, some of the participating families owned one vehicle; the four-hour program commitment, as well as the commute each week, was described as a hindrance on occasion.

Barriers to the program could not always be controlled by the participants. The program did not accommodate families with young children in need of care. On more than one occasion, mothers with younger children could not attend sessions due to having no available or affordable childcare. The researchers attempted to allow the young children to sit with their mothers on occasion, but it was found that their presence tended to disrupt the group and decrease the effect of the message presented. Although gas vouchers were provided each week to participating families, the unexpected increase in fuel cost during the intervention time frame severely affected the attendance of participating families from the more rural areas. Not only was the increase in gas cost an issue, but also commute time and terrain. Not all participants lived near Athens; the occasional pair of participants could not attend a session when the roads were impassible due to weather. More than one pair of participants had a commute of more than 45 minutes each way; occasionally, the cost of fuel was too high to make the drive.
Positive Outcomes to the Research

While several issues may have hindered more positive outcomes in the study, several participants responded positively to the study. Although not reported directly in the outcomes, many of the participants improved depression levels and self-esteem. In subsequent 3-month and 6-month follow-ups, more than half of the participants attended sessions, although no longer required. Participants continued to improve health status in many cases; they indicated to the research team that they no longer felt “intimidated” at the community center. Many of the participants, both youth and adult, formed friendship during the intervention and continued to nurture those bonds after the program ended. Additionally, although no significant change was reported, the adolescent group did improve diastolic blood pressure by nearly 6.0 mmHg (from 75.00 mmHg pre-intervention to 69.28 mmHg post-intervention). Such changes, while small and not necessarily scientific, should be reported so as to encourage the use of interventions in treating not only obesity and metabolic syndrome, but also self-esteem issues.

Conclusion and Recommendations

The Take Action study was unable to change the IDF criteria in children and adolescents. This was primarily due to recruitment issues and a short interventional period. The researchers were unable to extend the length of the intervention due to the limited time available for summer break from school. The long-term goal for Take Action is to develop an after-school program, so as to continue the intervention through the school year. However, the time constraints realized during the summer indicated that a
longer study may not be feasible in incorporating all of the educational goals while still keeping enrollment high. No participants qualified as having metabolic syndrome based solely on having three or more of the risk factors established by the IDF. All participants were considered to have at least one risk factor, as the BMI measurements were viewed as waist circumference indicators of central adiposity. However, although occasional participants also presented having more than that one risk factor, none showed three or more.

To address the lack of statistically significant results, as well as the continued rise in problems with overweight and obese children in Appalachia, the following recommendations are suggested:

1. An intervention program lasting longer than 8 weeks should be implemented to address daily concerns. This intervention took place during a fairly unstructured summer vacation time. However, during the school year, many habits change, which could result in a change of physical activity and nutritional routines. A 10-week program has been shown previously to result in significant changes and should be the minimum time frame devoted to an intervention in order to show such changes in most metabolic syndrome risk criteria (Brownell et al., 1983; Coppen, Risser, & Vash, 2008; Nemet et al., 2005).

2. A more specific recruitment plan to only include children who meet the criteria of metabolic syndrome should be considered in the future. The investigators assumed that obese children would also have metabolic
syndrome. Only participants at risk for developing the syndrome, whether based upon family history or current health implications, may participate with the goal of treating the at-risk criteria.

3. The many barriers to consistent participation within the Appalachian community need to be addressed before a more noticeable decrease in metabolic syndrome risk factors can be expected. Childcare should be made available to those who require it. An evening program should be offered, rather than an afternoon program to better accommodate the adult participants with less flexible work schedules. Offering food vouchers for the local grocery stores may increase the chance of participants purchasing healthier foods. A registered dietitian working with the program would provide valuable feedback to participants who may have questions the physicians cannot answer themselves, as well as spend time counseling the participants to make the diet changes more manageable.

4. A universal set of risk criteria for metabolic syndrome in children and adolescents needs to be developed. Without specific measurements and variables to change, healthcare professionals do not have an exact and specific goal to work towards. Likewise, standards should be determined for the different age groups. International data should be combined and professionals from the WHO and the IDF should work to develop criteria, because the prevalence of youth obesity and metabolic syndrome risks from the adult criteria are increasing worldwide.
5. In future interventions modeled after Take Action, nutrition researchers should consider implementing other means of education methods besides powerpoint lectures; if not, then the lectures should be refined to better suit the target audience. The attention span of the participants indicated this form of teaching may not be as effective. Additionally, implementing a means to evaluate nutrition knowledge and practices before and after the nutrition intervention could be useful. With the rise in childhood weight issue comes more national initiatives to decrease the spread of this problem. Working in one nationwide, public group, the implementation of an intervention to treat the obesity problem could help increase awareness and mainline the educational materials used. In such a case, the funding available to develop educational materials for the adults, adolescents, and children will be able to be geared towards the age-group needs. A main message coupled with proven methods throughout the country may assist in knowledge retention and diligence.

6. As discussed earlier, the necessity for a set definition for metabolic syndrome in children is vital if the area continues to be researched. When determining which children should be monitored for metabolic syndrome, the question arises as to which methods for screening will be most helpful. The American Medical Association recently released a guidelines statement in regards to the assessment of metabolic syndrome in children. The committee re-emphasized the recommendation of CDC designations of BMI percentile rankings; all
children should undergo yearly weight, height, and BMI evaluation (AMA, 2007). They further indicated that all youth should routinely be subject to dietary and physical activity screening and the collection of skinfold data. The AMA guidelines suggest that in children assessed as overweight or obese, further screening for metabolic syndrome should ensue. Such careful screening among children and adolescents may aid in the prevention of metabolic syndrome, although the lower healthcare coverage in rural Appalachia may be a cause for concern. It is possible that all children should be screened in school, where the district nurses may have a higher chance of monitoring children than do physicians in the Appalachian region.
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National Cholesterol Education Program. (2002). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation,


Metabolic syndrome (adult): Based upon the World Health Organization definition, the presence of three or more of the criteria in the following table (Brietzke, 2007).

**WHO Criteria for Metabolic Syndrome in Adults**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension or High blood Pressure</td>
<td>Greater than 140/90 mmHg</td>
</tr>
<tr>
<td>HDL Cholesterol</td>
<td>Less than 35 mg/dL (Men)</td>
</tr>
<tr>
<td></td>
<td>Less than 39 mg/dL (Women)</td>
</tr>
<tr>
<td>Plasma Triglycerides</td>
<td>Greater than 150 mg/dL</td>
</tr>
<tr>
<td>Body Mass Index (BMI) or Waist-To-Hip ratio</td>
<td>Greater than 30 kg/m²</td>
</tr>
<tr>
<td></td>
<td>Greater than 0.90 (Men)</td>
</tr>
<tr>
<td></td>
<td>Greater than 0.85 (Women)</td>
</tr>
<tr>
<td>Urinary Albumin: Creatine Ratio</td>
<td>Greater than 30 mg/g</td>
</tr>
</tbody>
</table>

Metabolic Syndrome (children): Based upon the IDF guidelines, three or more of the criteria displayed in the following table (Zimmet et al., 2007):
**Metabolic Syndrome Criteria for Children**

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Obesity (WC in cm)</th>
<th>Triglycerides (mg/dL)</th>
<th>HDL Cholesterol (mg/dL)</th>
<th>BP (mmHg)</th>
<th>Fasting Blood Glucose (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-9</td>
<td>≥90th percentile</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-15</td>
<td>≥90th percentile,</td>
<td>≥150</td>
<td>&lt;40</td>
<td>≥130/85</td>
<td>≥100</td>
</tr>
<tr>
<td></td>
<td>or adult cut-off if</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 +</td>
<td>Adult guidelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Metabolic Syndrome cannot be diagnosed, but if the family history indicates, the patient should be monitored.

Type 2 Diabetes Mellitus: Previously referred to as non-insulin-dependant diabetes, the metabolic disorder results when the cells of the body build a resistance to insulin (American Diabetes Association [ADA], 2007).

Artherosclerosis: The process of the deposit of fatty substances, such as cholesterol and saturated fats, on the artery walls, resulting in a build-up and consequently, blockage of the blood flow (American Heart Association [AHA], 2008).

Dyslipidemia: Elevation of blood triglyceride levels, total cholesterol levels, or decreased high density lipoprotein cholesterol levels, which can result in the development of artherosclerosis (AHA, 2008).
APPENDIX B: HUMAN SUBJECTS APPROVAL

The amendment, detailed below, and submitted for the following research study has been approved by the Institutional Review Board at Ohio University. Approval date of this amendment does not affect the expiration date of the original approval.

Amendment: Add Melissa Lusic as co-investigator to lead data analysis portion.

Project: Project TAKE ACTION "Teamwork with Age-Appropriate Kids Exercise in Appalachia with Interventions for Overweight and Nutrition"

Project Director: Jay Shubrook
Thomas Murray
Andy Wapner
Grace Brannan
Samanta Cox
Ashley Simpson

Advisor: None

Department: Family Medicine

Jacqueline Legg, M. B. A., Chair
Institutional Review Board

Date: 2/5/04
Are You Interested in Feeling Better?

We are doing a summer program that can help you live a healthier life!

TAKE ACTION 2 will be held during June, July, and August at the Athens Community Center

TAKE ACTION 2 is looking for children ages 6-17 years AND an interested parent to take part in our study this summer.

Are you interested?

Please email the supervising doctor, Dr. Jay Shubrook, at shubrook@ohio.edu for more information

TAKE ACTION 2 Includes:

♦ Gas Vouchers available
♦ Free Athens Community Center Pass
♦ Your personal health information
♦ Advice to help you eat smart
♦ Participation in group exercise and games
APPENDIX D: DIETARY INTERVENTION TOPICS

Week 1: Importance of healthy eating

a. In relation to quality and quantity of life
   i. Growth importance
b. In relation to physical activity
c. In relation to healthcare costs
d. Websites to employ
   i. Traffic Light Diet
   ii. Fruits and Veggies More Matters
   iii. MyPyramid.gov

Week 2: Macronutrients and Micronutrients

e. Overview of carbohydrates, fats, and proteins
f. How each provides energy for the body to act each day
g. Show that there are other things in foods

Week 3: Food Label and Food Guide Pyramid

h. What can happen if not getting appropriate amounts
i. Adequate, easy sources of the essentials
j. Use to demonstrate healthy foods and how often they should be eaten
k. Possibly tie in with snacking, farmer’s market, or macro/micro lectures
   Erase the snack stigma
l. Demonstrate that snacks are a GOOD thing
m. Healthy choices? Favorites?
   n. Know that dessert is ok if once and a while in small portions

Week 4: Serving sizes and Portions

o. Using visual aids to demonstrate appropriate portion control
p. Describing how much in each day
q. WHY one should consume each amount of each food category
r. Eating in front of the tv, while doing work, etc.
s. How to know when you’re hungry vs. when you’re full

Week 5: Grocery store/ Farmer’s Market

t. Interactive
   u. i.e. show 2 meat samples, as which is better; regular vs. reduced fat pb
      (always choose reg)
   v. explain why thy should choose one over the other
w. discuss why beneficial
   1. support local economy
   2. less likely to have preservatives bc they aren’t shipped from far away
   3. less likely to have adverse reactions to chemicals use don produce bc they are surrounded by them on a daily basis
x. Grocery store tour- walk (for physical activity)

**Week 6: Healthy restaurant options**

y. If they’re on the go, then demonstrate why good or why bad
z. i.e. choose a regular hamburger over chicken sandwich

aa. provide examples from websites, handouts, etc.

bb. Make lists each Sunday of the week meals as a family, then shop together

c. Engage children in actively choosing healthy foods; work together
d. Give out Calorie King Books

**Week 7: Preparation of foods**

e. Decrease fats when cooking

i. i.e. don’t fry; sauté in small amounts of olive oil/ cooking spray/ vinaigrettes

ii. steam, microwave, boil

iii. broil/ grill meats

ff. Decrease condiment use

i. Show appropriate ketchup, dressing, butter uses

ii. Decrease toppings ie. bacon bits, croutons, etc on salads

**Week 8: Tie everything together; review goals, etc.**
APPENDIX E: WEEK ONE LECTURE OUTLINE

• Welcome to TAKE ACTION 2!
  Teamwork with Age-Appropriate Kids Exercise in Appalachia with Interventions for Overweight and Nutrition
• A guide to healthy living
• What is Healthy?
• What do you think is involved with being healthy?
  o Nutrition?
  o Being happy?
  o Physical activity?
  o Feeling good about yourself?
• Being healthy involves all of these!
• It is important to maintain a balance of all to live a healthy lifestyle
• Why is it important to live a healthy life?
• Proper nutrition is a big part of development and continuing health
  o For example: osteoporosis, diabetes, and heart disease can be managed through healthy eating
• Exercise helps keep the body and its immune system (your body’s ability to fight disease) strong
• What else is important?
  o Sleep!
• Sleep!
  Your body is recharged and repaired when you sleep
• It is best to get 7-9 hours of continuous sleep each night
  o You’ll be able to focus and be more productive during the day
  o You’ll have more energy
  o Sleep boosts your immune system and is necessary for your nervous system
• Other benefits to a healthy lifestyle?
• More and more employers are focusing on their employee’s health
  o A healthier lifestyle cuts down on health care costs
  o If you live a healthy lifestyle, you are already ahead of the game when it comes to being considered for a job
• With a healthier immune system and life, you’ll:
  o Take less sick days
  o Be more productive on the job
  o By not smoking, you’ll take fewer breaks and get more done
  o Your kids will miss less days at school
    ▪ As well as be able to focus and get better grades
• Fewer visits to the doctor means fewer co-pays or out-of-pocket expense
• Less prescriptions (less pills!)
• In terms of chronic illnesses like diabetes and heart disease:
  o Less hospitalizations when you get older
• Fewer procedures
• Longer life expectancy
• Higher quality of life
• Remember…
• These are baby steps!
• Not drastic changes
  o Get your whole family involved
  o Work together to improve your day-to-day health
• This needs to be a lifelong goal
  o Involves compromising
  o “Everything in moderation”
• Some websites to access…
• Guidelines for produce, with recipes, shopping tips, and preparation:
  o www.fruitsandveggiesmorematters.org
• Track your fitness progress:
  o www.americathemove.org
  o www.healthyohioans.org
• Check whether the foods you eat are healthy:
  o www.trafficlightdiet.com
• Food Pyramid
  o www.mypyramid.gov
• Your healthcare provider
APPENDIX F: WEEK TWO LECTURE OUTLINE

- How Much is Too Much and How Do I Know?
- A guide to food labels and serving sizes
- The Food Guide Pyramid
- Can you name the food groups?
  - Grains
  - Vegetables
  - Fruits
  - Meats and Beans
  - Milk
  - Oils
  - Discretionary
- What do you think is most important?
  - They’re all important!
- Grains
- The orange stripe of the Pyramid
- Give us some examples of one serving of grains.
  - Bowl of cereal- how much cereal is that?
  - Bread
  - Pasta
  - Pretzels
- Grains
- What do you think a whole grain is?
  - Make sure the ingredient label says “whole” before the first grain
  - “Enriched” does not mean whole grain
  - “Wheat bread” is not whole wheat unless it says “whole”
- What do whole grains do for me and why are they important?
  - Fiber is present in whole-grain products
  - It takes longer to digest, so you feel full longer
  - It cleans your intestines
- Vegetables and Fruits
- The green and red stripes on the Pyramid
- What colors of vegetables do you think are the healthiest?
  - Dark green and orange: greens, broccoli, carrots, peppers, sweet potatoes
- Give us an example of a serving of vegetables
  - 1 cup of raw or cooked vegetables
  - 1 cup of vegetable juice like V8 or 100% fruit juice
  - 2 cups of raw, leafy greens
  - 1 cup of raw fruit
  - ½ cup of dried fruit like raisins
- Eat a variety of different fruits
- Meats and Beans
- The purple stripe on the Pyramid
• How big is one serving of meat?
  o A deck of cards or the size of your fist
• Some sample servings:
  o 1 egg
  o 1 tablespoon of peanut butter
  o ¼ cup of cooked dry beans
  o ½ ounce of nuts or seeds (for example: 7 almonds)
• Dairy
• The blue stripe on the Pyramid
• What’s your favorite source of milk and dairy foods?
• Some serving options:
  o 1 cup skim, 1%, or 2% milk or yogurt
  o 1.5 ounces of natural cheese/2 ounces processed cheese (1 slice American cheese)
    ▪ About the size of 8 die
  o ½ cup frozen yogurt or cottage cheese
• Oils and Discretionary Calories
• Choose to eat these foods as little as possible
• “Sometimes foods”
• Most American’s get their requirements for this food group in their regular diet
  o You don’t need to seek these foods out
• Try to stay away from fats that are solid at room temperature, like butter, margarine, and lard
• The Food Label
• Have you ever really looked a food label before?
• What does all that writing mean?
• Serving Size
  o Per package
• Calories
  o Where are the majority coming from?
• Nutrients
• Daily Values
  o Should help you gauge the healthy content of the food
• Key Things to Look For
• Servings per container
• Calories from fat
• Saturated fats
• Trans fats
• Fiber and Sugar
• Sodium
• Cholesterol
• Thursday’s Activity
• Bring in a food label from a food you typically eat
• We will go over how to read the label and what to look for, as well as compare!
APPENDIX G: WEEK THREE LECTURE OUTLINE

- A Guide to Macro- and Micronutrients
- A couple quick facts…
- Between 1989 and 1995, the increase in carbohydrates in children and teens came from:
  - Pizza, pasta, Mexican foods, and soft drinks
- 68%-75% of U.S. children exceed the current dietary guidelines for total saturated fat intakes
- Protein is an incredibly important part of muscle growth, hair growth, injury recovery, and organ function, among several other functions
- Carbohydrates… a quick review
- Remember simple sugars versus complex sugars?
- Carbohydrates provide the energy to help you:
  - Get out of bed
  - Brush your teeth
  - Walk to school
  - Eat lunch
  - Run around outside
  - Think clearly in class and at work
  - Remind us since not everyone was here last week…
- What is a simple carbohydrate?
- What is a complex carbohydrate?
- So what is fiber?
  - Fiber is a component of unrefined carbohydrates
  - Nondigestible
  - Expands inside your stomach, making you feel fuller
  - Cleans out your “guts” on the way out
- Give us some examples of fiber foods
- He-Man: Protein!
- Several important functions:
  - Dun, dun, dun… the tissue builder
  - Enzymes for digestion
  - Amino Acids- responsible for everything from DNA building to muscle building
- Comes from plants and animals
  - Plant sources include:
    - Legumes (such as?)
    - Nuts
    - Egg Beaters
  - Animal sources include:
    - Dairy
    - Meats
    - Fish
Not found in great quantities within fruits and vegetables
  - Some do contain little proteins
Fats… not such a bad thing after all!
Also called “lipids”
Fat is a good thing!
  - Should have about 1/3rd of your daily calories from fat sources
  - Provides long-term energy, especially during low-impact exercise like walking and swimming
  - Helps absorb vitamins A, D, E, and K
  - Help keep the nervous system, brain, and skin healthy
The AWESOME Fats
Monounsaturated
  - Best fat source you can have
  - What are some examples?
Polyunsaturated
  - The second-best fat source: Omega-3 and Omega-6 fatty acids
  - What are some examples?
The AWFUL Fats
Saturated Fats
  - How to know if its saturated: solid at room temperature
    - Example: butter, tropical fats
Trans Fats
  - The worst of all the fats! Also known as “hydrogenated” and “man-made”
    - “The stealth fat” because its hidden in so many foods
    - The chemical structure is at weird angles, which causes it to get stuck
      - May also increase bad cholesterol
      - Top Ten Foods which contain trans fats? Why do you think these are all full of trans fats?
Cholesterol!
  - The Good…HDL
  - The bad…LDL
  - And the ugly…VLDL
Triglycerides
  - The beginning form of all fats
So How Much Do Kids Need?
Kids 4-8 years
Kids 9-13 years
Girls 14-18 years
Boys 14-18 years
What are vitamins?
Vitamins are important chemicals found in all foods, as well as in the body (in different amounts)
how do Vitamins help my body?
• Some vitamins help protect your body by protecting cells from damage
  o Vitamin E, Vitamin C, and Vitamin A
• How do vitamins help my body?
• Many vitamins are needed for your hair, vision, teeth, and skin
• How do vitamins help my body?
• Vitamins help your nervous system and immune system stay healthy and function properly
  o Vitamin E, Vitamin K, Thiamin, Riboflavin, Niacin, Vitamin B₆, Folate, Panthothenic Acid, Vitamin C
• Minerals!
• Minerals are other chemicals found in nature, and are also essential for your body to work well
  o You may recognize mineral names from the periodic table of elements.
    This is because minerals are elements!
• Minerals in your body
• Some are necessary for bone health
• Minerals in your Body
• Some are required for proper muscle function
• Minerals in your body
• Many are required to keep your blood vessels and heart working correctly
• Others help your body’s metabolism (it’s “engine”) work correctly
• Vitamins and Minerals come in all kinds of foods…
• Citrus fruits, spinach, strawberries, green beans, broccoli, potatoes, peppers
  o Magnesium
  o Vitamin C
  o Vitamin A
  o Potassium
• Meats, Beans, Cereal, and Potatoes
• Vitamin B₆
• Niacin
• Thiamin
• Riboflavin
  o All B-Vitamins
• Dairy Foods
• Vitamin D
• Calcium
• Potassium
• Magnesium
• Vitamin A
• Phosphorus
• Seafood and Fish
• Iodine
• Iron
• Potassium
• Vitamin D
• Eggs!
• Iron
• Vitamin E
• Vitamin K
• Phosphorus
APPENDIX H: WEEK FIVE LECTURE OUTLINE

- Lets Go Shopping!
- The grocery store and Farmer’s Market
- Starting Out…
- Going shopping can be really confusing and time-consuming when you are trying to shop healthy
  - Comparing labels and looking for nutrition facts can take awhile to get used to when you first start out
- It gets a lot easier as you get used to it
- Your kids can help out too!
- Easy guidelines
- Shop the perimeter
  - Healthier foods usually need to be refrigerated or kept moist
  - Produce, fresh meats, cheeses, dairy, eggs, and 100% juices are all located on the outside
  - Look for bright colors, not bright packaging
    - A red pepper, not a Nabisco box
- When you are trying to make a decision…
- Example: Crackers
  - Look for the word “whole” in the ingredient list (whole wheat, whole oats)
  - Look at fiber content: more than 2 grams per serving
- Example: Meat
  - Look for lean or low-fat cuts
    - Broil, 90% lean, breast meat, round (tip, eye of), rump roast, sirloin, tenderloin or centerloin, and most wild game
    - Skinless poultry
  - High protein, low fat, and excellent flavor
  - Fish: high in protein, low in price
    - Tuna in water, frozen fresh-water fish such as walleye, perch; salmon
    - Less fishier tasting: tilapia, cod, mahi-mahi, orange roughy
- Example: Produce
  - Choose fresh, frozen, or canned
  - Make sure the frozen do not have added oils or sugars
  - Watch the sodium content in canned foods, as well as syrups in canned fruits
  - Choose water-packed
- Example: Dairy Products
  - Choose low-fat and non-fat dairy products
  - Make sure to watch the expiration date
  - Choose high-fat, hard cheeses vs. processed cheeses in equal amounts
    - American cheese and a block of Swiss
  - Lactose Intolerance people can eat yogurt or lactose-free milk
- Try Silk soymilk or Lactaid
- Farmer’s Markets
- Buying local has its advantages
  - Cheeses have a lower chance of containing bad fats and residues from antibiotics and hormones
  - Produce is most likely grown in fields with natural fertilizers, and will have better and cheaper choices for organic
    - Better flavor, color, and nutrition content
  - Breads and grains have less preservatives and are fresh-baked and so have better taste and texture
    - More likely to have whole grains
  - Meats will have a great selection of wild or free-range animals (which live healthier lives); leaner selections
    - Will have less hormones
    - Selections often include bison and venison
- Greatest advantage?
  - You support your local farmers!
APPENDIX I: WEEK SEVEN LECTURE OUTLINE

• Substitutions and Alterations: Making Cooking Healthier
• TAKE ACTION Summer 2008
• Why Substitute?
• Substitutions in cooking and baking are some of the easiest ways to improve the nutritional content of your food
• When substituting, you can often keep the flavors and textures the same while still enjoying the foods you like
• Think of the changes as a “recipe makeover”
  o Doesn’t have to be extreme…. Little changes will add up over time
• Changes can encompass:
  o Substituting
  o Altering
  o Omitting
  o Adding
  o Combining
• Health benefits can include
  o Lowering sodium
  o Lowering sugar
  o Decreasing saturated and trans fat
  o Decreasing/ eliminating cholesterol
  o Eliminating unneeded calories
  o Increasing protein
  o Increasing fiber
  o Increasing vitamins and/or minerals
  o Increasing mono- and polyunsaturated fats
• Don’t forget…
• Just because something is healthier doesn’t mean its going to taste nasty
• We aren’t trying to get you to hide weird things in food, like disguising beets in ground meat
• These are simple changes that can be made to improve the quality of the foods you eat on a daily basis
• Baking
  o Substitute half of the butter or shortening with applesauce (smooth, not chunky)
    ▪ Do not do this for pie crusts or yeast breads; the batter will become “gummy”
  o If a recipe calls for 3/4 cup of oil/butter/shortening, try decreasing to 2/3 cup. The decrease won’t change the recipe or the taste
    ▪ However, don’t attempt to eliminate the fat completely; the end product will appear dense and unbaked
Instead of using all whole eggs, replace half of the eggs with 2 egg whites each 
  - i.e. if a recipe call for 2 eggs, use 1 whole egg and 2 egg whites
Use low fat sour cream when baking instead of full-fat sour cream 
  - If baking something sweet, its fine to use fat-free sour cream. Don’t do this for a savory recipe; as nonfat sour cream is heated, it becomes sweet
Skim and 1% milk can almost always be used in place of while milk in recipes. Its an extremely easy way to reduce fat content in muffins!
If the recipe calls for heavy cream, substitute evaporated skim milk when making a casserole or soup. If baking, use light cream.
Switch to healthier fats.
  - Cut out lard, butter, palm oil, coconut oil, and shortenings made with these oils.
  - Use healthy oils such as olive, canola, soybean, sunflower, safflower, sesame, peanut, and cottonseed.
  - Remember: olive oil cannot be used for baking.
Try low-fat cream cheese or Neufchatel in place of regular when making cheesecakes. The flavor is the same.
Try substituting half of the sugar in a recipe with Splenda or Apriva. 
  - Don’t use saccharin (Sweet and Low) or aspartame (Equal); they will not hold up under heat.
When baking, usually salt can be completely eliminated without affecting the flavor.
Use ½ cup of mini chocolate chips in place of 1 cup regular size chocolate chips
Dips, Snacks, and Munching
  - Try unsalted, roast nuts in place of salted nuts
  - Plain, nonfat yogurt can be used in place of sour cream when making cream-based dressing or dip (such as dill dip)
  - Low-salt or unsalted pretzels
  - Buy popping corn and pop your own in a stew pot with a small amount of canola oil
    - The flavor can be adjusted if you want your own seasonings
    - You control the salt and butter content
    - The corn turns out crisper and fresher
    - Takes 2 minutes longer than microwave popping corn
  - Try veggie or fruit sticks and snacks in place of chips
    - Perfect example: plantain chips
    - All you need is a cookie sheet and a knife
  - Try snacking on high fiber cereal- put a pre-measured amount in a bowl or baggie
  - Sweeten and flavor water or tea with lemon, ginger, or mint
  - Make ice cube trays of juice cubes, then plop 2 into a glass of plain or seltzer water for a fruit splash
• Try freezing sugar-free Jello or pureed fresh fruit in ice cube trays with tooth picks in the top; they make an interesting “popsicle”
• Use fresh fruit instead of fruit syrups on ice cream or in yogurt
• Cooking
  • You can use low-fat cheese when cooking or making burgers
    o Don’t use nonfat; it won’t melt
  • Try using fresh, grated cheese; ¼ cup of fresh sharp cheddar has the same flavor as 1 cup of bagged shredded mild cheddar
  • Try to cut half of the added salt in a dish
    o You’ll eliminate up to 50% of your DV of sodium, without sacrificing the flavor
• Use herbs and spices to enhance the flavor of a dish
  o They had little to no sodium
  o Fresh herbs:
    ▪ You’ll need to add extra fresh than you will dried to get the same flavor
    ▪ Add fresh herbs within the last 5 minutes of cooking to avoid the bitter, overcooked taste
    ▪ Excellent options: rosemary, sage, thyme, mint, tarragon, chives, oregano, basil
    ▪ Purchase the herbs when in season, then freeze in plastic baggies to keep fresh through the winter
• Try olive oil + fruit juice (lemon juice, raspberry mash, etc.) to make a vinaigrette for salads.
  o Adding plain, low-fat yogurt makes the dressing creamy
• Need buttermilk? Try 1 Tb vinegar or 1 Tb lemon juice + skim milk to equal the amount called for
• Use ½ c shredded coconut + 1 tsp. coconut extract in place of 1 cup shredded coconut
  o Keeps the flavor with half the saturated fat
• Mix a pasta sauce with half salsa to cut back on the sugar
• If using canned fruit, try substituting half the added sugar in a recipe with some of the juice from the fruit can
• Use whole wheat biscuit dough (Pillsbury or in the health food aisle) in place of regular pizza crust dough
• Remember…
• On occasion, your family may notice a change in a recipe
• Try to keep everyone in tune with the recipe changes, and keep track of what tastes great vs. what tastes awful
• Have fun 😊
APPENDIX J: CDC BMI PERCENTILE CHART: GIRLS

CDC Growth Charts: United States

Body mass index-for-age percentiles:
Girls, 2 to 20 years

Published May 30, 2000.
SOURCE: Developed by the National Center for Health Statistics in collaboration with
the National Center for Chronic Disease Prevention and Health Promotion. (2000)
APPENDIX K: CDC BMI PERCENTILE CHART: BOYS

CDC Growth Charts: United States

Body mass index-for-age percentiles: Boys, 2 to 20 years

Published May 30, 2000
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).