LIFESTYLE, PSYCHOSOCIAL, AND DEMOGRAPHIC PREDICTORS OF METABOLIC SYNDROME IN OVERWEIGHT AND OBESE YOUTH

By

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ATPIII	Adult Treatment Panel III
BMI	Body Mass Index
CBCL	Child Behavior Checklist
CDC	Centers for Disease Control
CI	Confidence Interval
FAD	Family Assessment Device
HbA1C	Glycated Hemoglobin
HDL	High Density Lipoprotein
IDF	International Diabetes Federation
LDL	Low Density Lipoprotein
MetS	Metabolic Syndrome
METS	Metabolic Equivalent of a Task
MetS-1	Youth who met criteria for MetS
MetS-0	Youth who did not meet criteria for MetS
NCEP	National Cholesterol Education Program
NHANES	National Health and Nutrition Examination Survey
OR	Odds Ratio
PACER	Progressive Aerobic Cardiovascular Endurance Run
PTSD	Post Traumatic Stress Disorder
QOL	Quality of Life
SES	Socioeconomic Status
SEQ	Social Experiences Questionnaire
T2DM	Type 2 Diabetes Mellitus
WHO	World Health Organization

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Metabolic Syndrome (MetS) is important to examine in youth in that it predicts later disease state (e.g. type 2 diabetes mellitus and cardiovascular disease) and is seen to track into adulthood (Morrison, Friedman, & Gray-McGuire, 2007; Casazza, Dulin-Keita, Gower, Fernandez, 2009). Despite a focus in extant literature on examining factors associated with increased risk of MetS in youth, several limitations exist (e.g. little research on psychosocial functioning in this population, contradictory findings associated with behavioral/lifestyle and demographic variables, a focus on "healthy volunteers" as opposed to at-risk groups, etc.). The current study examined the relationship between lifestyle, demographic, and psychosocial variables and MetS in 194 participants between the ages of 8-12 presenting as part of a treatment seeking sample of overweight and obese youth. It looked to overcome weaknesses seen in extant literature, using a modified version of the most up-to-date criteria for examining MetS in youth, while focusing specifically on a group of children at increased risk for MetS (Pan & Pratt, 2008). The current study utilized multiple measurements of psychosocial functioning from parent and child ratings, as well as objective

measurements of health and lifestyle variables. In our sample, 57.2% of participants met criteria for metabolic syndrome. The average BMI *z*-score in youth who presented with MetS was higher than in youth who did not meet criteria (MetS-1, M = 2.21, SD = 0.35; MetS-0, M = 2.08, SD = 0.42). Findings indicated that for each unit increase of 1.0 in a child's BMI z-score, the odds of meeting criteria for metabolic syndrome increased by a factor of 2.44 (95% CI of 1.13, 5.25; $p = 0.02$). Additionally, body fat percentage in youth who met criteria for metabolic syndrome was higher than in youth who did not meet criteria (Mets-1, M = 40.27, SD = 7.24; MetS-0, M = 38.04, SD = 8.27), with these differences approaching significance (OR = 1.039; 95% CI of 0.999, 1.08; $p = 0.055$). Finally, analysis of peer victimization relative to MetS diagnosis approached statistical significance ($p = 0.06$), as average levels of peer victimization were higher in youth who met criteria for metabolic syndrome than in youth who did not meet criteria (MetS-1, M = 20.85, SD = 8.79; MetS-0, M = 18.56, SD = 7.45. The associated odds ratio was 1.03 (95% CI of 0.99, 1.08). All other differences in demographic, lifestyle, and psychosocial variables were not significantly associated with increased odds of meeting criteria for metabolic syndrome. The variables examined in the current study provide important information with regards to areas of potential intervention and prevention, and the need for further delineation of the factors associated with MetS, in pediatric overweight youth.

CHAPTER 1
INTRODUCTION

Metabolic Syndrome Introduction

Metabolic Syndrome (MetS) is seen in approximately 3.5% of youth in the United States, with rates as high as 60% in overweight and obese youth (Pan & Pratt, 2008; Tailor, Peeters, Norat, Vineis, & Romaguera, 2009). Increasing prevalence is seen coinciding with increasing weight status (Caprio, 2005). It is critical to better understand metabolic syndrome given its importance in predicting later disease state. Children, adolescents, and adults who are diagnosed with MetS are at an increased risk for later diseases including cardiovascular disease, Type 2 Diabetes Mellitus (T2DM), and stroke (Morrison, Friedman, & Gray-McGuire, 2007; Morrison, Friedman, Wang, & Glueck, 2008). Additionally, metabolic syndrome in youth tracks into adulthood (Casazza, Dulin-Keita, Gower, Fernandez, 2009; Eisenmann, Welk, Wickel, & Blair, 2004). As such, focusing on pediatric metabolic syndrome may allow for management of this syndrome at an earlier age, decreasing its continuation into adulthood.

A majority of the recent research in pediatric metabolic syndrome has focused on establishing prevalence rates and working towards a coherent definition to diagnose this syndrome in youth. Despite attempts at determining definitive prevalence rates based on recent National Health and Nutrition Examination Surveys (NHANES), Pan and Pratt reported that rates of metabolic syndrome in youth can be wide ranging (2008). This is primarily due to inconsistencies in how the syndrome is defined (Cizmecioglu, Etiler, Hamzaoglu, & Hatun, 2009; Mancini, 2009). A meta-analysis of 36 studies examining children worldwide, reported that anywhere from 1.2% to 22.6% of youth meet criteria for metabolic syndrome in community-based and general population samples (Tailor, et al., 2009). Often, this research is limited in its focus on “healthy volunteers” who present with lower rates of MetS as opposed to examining overweight and obese youth who typically present with higher rates of medical comorbidities such as metabolic syndrome (Casazza et al., 2009).

Overweight and obesity in the United States has increased over the past four decades, with approximately 32% of youth ages two to nineteen years currently meeting criteria for overweight (greater than the 85th percentile for height and weight by gender) or obese (greater than the 95th percentile for height and weight by gender) weight status (Ogden, Carroll, Curtin, Lamb & Flegal, 2010). Today’s heaviest youth are heavier than they were in the past (Epstein, Paluch, Roemmich, & Beecher, 2007; Ogden et al., 2010). Some common medical comorbidities in overweight and obese youth are moderate to severe sleep apnea, atherosclerosis, high blood pressure, non-alcoholic fatty liver disease, steatohepatitis, dyslipidemia, and poor glucose tolerance. These, and other health markers of increased incidence in overweight youth, are related to both metabolic syndrome as well as comorbid or later developed diseases (e.g. type two diabetes) (Pratt, Lenders, Dionne, Hoppins, et al., 2009; Shield, Crowne, & Morgan, 2008). Due to the growing economic burden associated with these disorders, it is especially pertinent to further delineate the factors which put children at increased risk of having metabolic syndrome, in addition to investigating potential areas of intervention to decrease this risk (Moore, Davis, Baxter, Lewis, & Yin, 2008). It is postulated that metabolic syndrome and its associated disorders can be impacted and/or prevented, for example by changing lifestyle behaviors, such as diet and exercise variables related to weight status (Holst-Schumacher, Nunez-Rivas, Monge-Rojas, & Barrantes-

Santamaria, 2009). Similarly, psychosocial risk factors seen in overweight and obese youth may be important to examine in youth with metabolic syndrome (Goldbacher & Matthews, 2007).

Prior to examining psychological and behavioral factors associated with metabolic syndrome, it is important to understand the physiological symptoms associated with syndrome diagnosis. Metabolic syndrome is a disease classified by a cluster of symptoms, typically consisting of the presence of three out of five values above or below given standards on specified health parameters. The health parameters typically examined in MetS are weight status, glucose control, blood lipids (cholesterol and triglycerides), and blood pressure (Hoffman, 2009).

Metabolic Syndrome: Diagnosis and Associated Factors

Diagnosing and examining metabolic syndrome is difficult as there is currently a lack of consensus as to the diagnostic criteria for this syndrome in children and adults. Currently, three primary definitions exist in diagnosing adult metabolic syndrome, released by the National Heart Lung and Blood Institute's Adult Treatment Panel III (ATP III), the World Health Organization (WHO), and the American Association of Colleges of Pharmacy (Table 1-1). At present there are over 40 definitions used throughout pediatric literature (Morrison, Ford, & Steinberger, 2008) (Table 1-2). The most commonly referenced and widely accepted criteria was developed by Cook and colleagues in 2003, revised from the adult ATP III MetS criteria (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). The definition by Cook and colleagues was revised in 2008 to incorporate recommendations including: the American Diabetes Association recommendation that glucose level impairment should be lowered from 110 mg/dL to 100 mg/dL; the National Heart, Lung, and Blood Institute updates on percentile values for blood pressure; and, research by Fernandez and colleagues in 2004 emphasizing the use of age, sex, and ethnicity-specific waist circumference values (Casazza et al., 2009; Cook, Auinger, Li, & Ford, 2008). Specifically, to diagnose metabolic syndrome based on this criteria, a child or adolescent needs to meet three or more of the following: 1) waist circumference above the 90th percentile for gender and age, 2) triglycerides greater than 110mg/dL (>1.24 mmol/L), 3) high-density lipoprotein cholesterol less than 40mg/dL, 4) blood pressure greater than the 90th percentile for height, age, and sex, and/or 5) blood glucose >100 mg/dL (>6.10 mmol/L) (Cook et al., 2008).

While the Cook and colleagues definition is commonly accepted and widely used across all age ranges for youth given its incorporation of recent updates and guidelines across all health parameters, additional definitions have been extensively cited throughout literature (Table 1-2). Additionally, a recent consensus definition was created for youth aged 10-16 years old, incorporating the Cook and colleagues definition with several other well-cited definitions. This definition was released in 2007 by the International Diabetes Federation (IDF). According to the IDF, metabolic syndrome in youth can be diagnosed based on the presence of abnormal levels on at least two of four health parameters, specifically blood pressure, glucose, triglycerides, and HDL-cholesterol. Abdominal obesity based on waist circumference percentiles must be present as well (IDF Task Force on Epidemiology and Prevention of Diabetes, 2007). Despite the positive intention of this task force in creating a unified definition, the criteria itself has some weaknesses. First, it specifically targets children in the narrow age range of 10-16, with children under 10 unable to be diagnosed, and children over

16 assigned adult diagnosis criteria. Second, this definition emphasizes high weight status as a mandatory criteria, which is both different from adult diagnostic criteria (for which high weight status is one of five main components equally weighted in diagnoses), and therefore may exclude children who are not overweight but have other health symptoms (Scott, Grundy, Brewer, Cleeman et al., 2004). Third, it is thought that this definition may exclude some children who would meet diagnostic criteria based on other definitions. This is apparent when examining prevalence based on the World Health Organization criteria, which produces higher rates of diagnoses than IDF criteria (Cizmecioglu et al., 2009; Mancini, 2009). Clearly this lack of consensus on definitive diagnostic criteria, even among major health organizations, is a weakness in current literature. These discrepancies make it difficult to identify and examine common factors associated with metabolic syndrome across research, however such work has been pursued using the 40+ definitions to make diagnoses. Across literature, in order to examine metabolic syndrome, the same five health parameters are used consistently, with criteria for abnormality being the main discrepancy across classifications.

Definition of Health Parameters

As previously discussed, there are five health parameters examined in determining if a child meets criteria for metabolic syndrome. The first parameter examined is weight status, a variable of particular importance given that overweight and obesity are frequently associated with the presence of metabolic syndrome (Pan & Pratt, 2008; Siviero-Miachon, Spinola-Castro, Guerra-Junior, 2008). Either waist circumference or body mass index (BMI), but typically not both, are used in representing weight status. Waist circumference is defined as the distance around the body measured at the narrowest waist, and midpoint between the floating rib and iliac crest (Johnson, Kuk, Mackenzie, Huang, et al., 2009). As a measure of body fat distribution, waist circumference correlates with intra-abdominal adiposity, which is linked to higher metabolic risk (Eisenmann, 2007; Syme, Abrahamowicz, Leonard, Perron, Pitiot, Qiu, et al., 2008). A person's BMI is an estimate of their body fatness based on their height and weight (Nhlbisupport, 2009). In children BMI is examined based on gender and age normed percentiles. The majority of definitions for metabolic syndrome use waist circumference, rather than BMI, as a measure of weight status because the presence of abdominal obesity is typically better correlated with the additional health risk factors associated with metabolic syndrome when compared to an elevated BMI (Scott et al., 2004). However it has been suggested that both variables may have the same power in predicting MetS risk in children (Barzini, Hosseinpanah, Fekri, & Azizi, 2010).

Of the remaining four health parameters, three are examined based on simple blood analyses. The second parameter examined in determining presence of metabolic syndrome is a child's triglyceride level. Triglycerides are a form of fat which are measured based on how many milligrams are present per deciliter of blood (American Heart, 2009). Cholesterol levels are the third health marker examined in diagnosing metabolic syndrome. Cholesterol is a soft, fat-like, waxy substance found in the bloodstream and in all the body's cells. Cholesterol is both produced by the body and consumed through ones diet. There are two primary types of cholesterol, low-density lipoprotein (LDL), also known as "bad" cholesterol and high-density lipoprotein (HDL), also known as "good" cholesterol (American Heart, 2009). High-density lipoprotein cholesterol levels are the type of cholesterol typically examined in diagnosing metabolic syndrome (D'Adamo, et al., 2009). Blood glucose levels are the fourth health marker examined in diagnosing metabolic syndrome. Elevated glucose is a marker of insulin resistance. Glucose levels can be examined using fasting plasma glucose concentration tests, oral glucose tolerance tests, or by measuring glycated hemoglobin A1C. The first two measures examine glucose levels in a single day, whereas the third measure examines chronic glucose levels over time (International Expert Committee, 2009). It is estimated that by using a single time point measure such as the oral glucose tolerance test, up to 2/3 of adolescents with Type 2 Diabetes may not be diagnosed (l'Allemand-Jander, 2010). Blood pressure is the fifth and final health parameter examined in diagnosing MetS. A person's blood pressure is the ratio of the pressure in their arteries when their heart beats (normal is <120) over the pressure in their arteries between heartbeats (normal is <80), and is typically examined manually using standardized methods (American Heart, 2009). Although these five health parameters are consistently used in diagnosing metabolic syndrome, there is disagreement as to the values which should be used across diagnostic criteria (Scott et al., 2004) (Table 1-2).

Given the importance of metabolic syndrome in predicting future disease risk, and the tracking of this syndrome from childhood into adulthood, early identification of MetS and additional factors associated with it is of particular importance, especially in populations of increased risk (such as pediatric overweight) (Casazza et al., 2009). When examining this syndrome, it is important to examine factors outside of the previously identified health values which may be related to meeting criteria for MetS. Further examination of other factors potentially associated with a child or adolescent's risk for MetS will help to direct efforts of prevention and intervention. These include demographic factors, family factors, behavioral/lifestyle factors, and psychosocial factors.

Demographic Variables and Metabolic Syndrome

Several demographic factors have been identified as related to metabolic syndrome in youth, however specific findings as to the directionality of these variables has not always been consistent. Risk factors which have been identified as typically associated with increased odds of a metabolic syndrome diagnosis include older age, male gender, being of Caucasian or Hispanic descent, and having low socioeconomic status (Cruz, Weigensberg, Huang, Ball, Shaibi, & Goran, 2004; Johnson, Kroon, Greenway, Bouchard, Ryan, & Katzmarzyk, 2009; Lehman et al., 2005; Pan & Pratt, 2008; Sumner, 2009).

Higher rates of metabolic syndrome have been reported in older youth (e.g. Pan & Pratt, 2008). The positive association between metabolic syndrome and being of increased age may be in part related to the increased rates of overweight and obesity in older youth (Ogden et al., 2010). As such, this relationship may not be seen in a population which includes only overweight/obese youth. Additionally, there is a lack of a consensus definition to diagnose metabolic syndrome in children and adolescents, with some research groups using criteria only allowing for diagnosis in youth within a restricted age range (between the ages of 10 and 16) (IDF Task Force on Epidemiology and Prevention of Diabetes, 2007). This may also contribute to the lower rates of MetS reported in younger children.

In addition to age discrepancies in diagnosis rates, gender differences have been found in rates of MetS in youth. Males have been found to meet criteria for metabolic syndrome more frequently than females. Pan and Pratt, for example, reported that three times more males than females met criteria for metabolic syndrome based on NHANES data (2008). These differences may be due to inherent physiological differences between males and females, due to differences in diet quality (e.g. females tend to consume healthier diets than males), or due to other currently unidentified constructs (Dwyer, Magnussen, Schmidt, Ukoumunne, Ponsonby, Raitakari, et al., 2009; King, Torres, Potter, Brooks, & Coleman, 2004; Pan & Pratt 2008).

With regards to the impact of ethnicity on disease risk, increased rates of metabolic syndrome have been consistently seen in Caucasian and Hispanic youth when compared to youth of African American descent (e.g. Cruz et al., 2004). However, it is difficult to determine the true impact of demographics on MetS diagnosis. It has been postulated that low diagnosis rates in African American's may be resultant of ethnic differences intrinsic in metabolic syndrome components (e.g. lower basal lipid levels, higher basal HDL levels seen in African Americans), as opposed to resultant of better health functioning (Moore et al., 2008; Sumner, 2009). Ethnic-specific criteria for such components have not been formulated, so future research will most likely replicate previous findings, with lower levels of metabolic syndrome in African American youth. As such, conclusions on ethnicity and MetS should be examined with caution.

Another demographic variable examined in its relationship to MetS in youth is socioeconomic status (SES). Being of lower SES may be related to increased health risks in youth, as well as later, in adulthood (Lehman et al., 2005). Based on extensive literature reviews, very few studies were found that gathered information on SES and MetS status during childhood. Findings in this domain were inconsistent, with some research indicating a positive relationship between low SES and MetS (e.g.

Chichlowska et al., 2009), and some indicating no significant relationship (e.g. Ekelund, Andersson, Andersen, Riddoch, Sardinha, Luan, et al., 2009). Lehman and colleagues, for example, found that being of lower SES in childhood was associated with greater metabolic syndrome risk in adulthood. This relationship was found both directly between lower SES and higher MetS risk, as well as via a pathway between low SES, poor psychosocial functioning, and greater health risk (Lehman et al., 2005). Across research in this domain there is a significant weakness however. Findings have been reported based on adult participants reports of current functioning and health status, and retrospective recall of their SES in childhood (e.g. Chichlowska et al., 2009; Lehman et al., 2005; Schooling et al., 2007). As such, it is difficult to determine if the significant findings would exist if examining such variables concurrently in childhood. Additionally, contradictory research has indicated that SES and metabolic syndrome are not significantly related (Ekelund et al., 2009; Lucove, Kaufman, & James, 2007; Parker, Lamont, Unwin, Pearce, Bennett, Dickinson, et al., 2003). Similar weaknesses can be seen across literature in this domain however, with adult report of childhood functioning examined in its relationship to adult health status. Additionally, some research within this domain examined SES variables calculated based solely on parent occupation or parent education. It has been recommended that SES should capture both of these domains, allowing for a more detailed index of SES (e.g. Lucove et al., 2007; Parker et al., 2003). Of all research examined looking at metabolic syndrome and SES, only one study was found which overcame the aforementioned weaknesses in current literature. Ekelund and colleagues examined the relationship between MetS diagnosed in childhood and concurrent SES (based on the Hollingshead Index combining parent education and occupation status), with findings indicating no significant relationship between these variables. Given the varied findings across literature and methodological weaknesses in much existing research, it is difficult to fully delineate the relationship between SES and MetS at this time.

Family Factors and Metabolic Syndrome

Several familial factors have been identified as related to increased risk for metabolic syndrome. First, children of parents who also have metabolic syndrome or meet criteria for individual components of the disease are more likely to be diagnosed with metabolic syndrome (Azizi, Farahani, Ghanbarian, Sheikholeslami, et al., 2009). Parents who are diagnosed with type 1 or type 2 diabetes, or who are overweight or obese are also more likely to have children with metabolic syndrome. This is not surprising given the strong familial link seen in obesity, and the strong association between weight status and metabolic syndrome in youth and adults (Boney, Verma, Tucker, Vohr, 2005). The relationship between health risks in parents and in their children is understood as being due to a combination of genetic and environmental components, and as such it is important to examine these and other family factors which may be associated with MetS in youth.

It has been suggested that the presence of a chronic pediatric condition such as obesity or diabetes can cause increased stress and distress among family members, leading to disruptions in family structure and cohesion, in addition to having negative impacts on health outcomes (Herzer, Godiwala, Hommel, Driscoll, Mitchell, Crosby, et al., 2009). In youth with chronic illnesses, family functioning variables have been examined, such as problem solving, communication, affective responsiveness, presence of physical/verbal abuse, and affective involvement, with poorer family functioning seen in these youth when compared to healthy controls (Lehman et al., 2005; Herzer et al., 2009). These variables can be assessed in a variety of ways, via single items on larger measures (e.g. Berge, Wall, Bauer, Newmark-Sztainer, 2010; Lehman et al., 2005), via well-validated questionnaires such as the Family Assessment Device (FAD) (e.g. Chen & Clark, 2007), or via observation techniques such as the McMaster Interaction Coding System (e.g. Piazza-Waggoner, Modi, Powers, Williams, Dolan, Patton, 2008). While the observational techniques allow for a unique examination of these variables without the inherent biases of self-report, these techniques are time-intensive and more expensive. The use of single-item measures are less time-intensive, however they do not allow for the more detailed examination of constructs which can be measured using well-validated questionnaires, for example, the FAD. Research using the FAD to examine family functioning across multiple chronic health conditions, has reported poorer family functioning in 13-36% of these families, with obese youth appearing to be at greatest risk compared to other chronic health groups (such as youth with cystic fibrosis or epilepsy) (Herzer et al., 2009).

It can be postulated that family functioning difficulties might be seen in youth with obesity and comorbid metabolic syndrome, however there is little existing research supporting this idea. Of existing research, one group found that in adults with metabolic syndrome, their reports of harsh parenting and risky family environments during childhood were related to adult health status (Lehman, et al., 2005). The ability to make conclusions based on these findings is limited in that child health status is unknown, and recall of childhood family functioning may be inadequate in adulthood, making it difficult to extrapolate on potential relationships between family functioning and childhood metabolic syndrome. Similar findings by Pulkki and colleagues indicated that negative child-rearing attitudes by parents were associated with increased health risks (specifically those associated with the cluster of symptoms within metabolic syndrome) (2003). Again, it is difficult to generalize these findings due to weaknesses seen in the studies methodology. For example, the relationship between MetS and family functioning was reported based on individual MetS components (not via meeting criteria for metabolic syndrome) in their relationship to parent report of maternal hostility (not via a validated measure of family functioning). Despite previous research in other chronic illness groups indicating the potential for a relationship between family functioning and MetS in youth, there is very little existing research in this domain. The existing research suffers from methodological weaknesses which limit the ability to make definitive conclusions about this relationship.

Behavioral/Lifestyle Factors and Metabolic Syndrome

There is a myriad of extant research on the associated behavioral/lifestyle factors associated with MetS in youth. While this research has some limitations, findings have consistently identified individual factors such as diet, physical activity, and physical fitness as related to MetS. Delineating relationships between dietary components, overall diet quality, physical activity, physical fitness, and MetS will be especially important when examining these variables in overweight and obese youth, a group which typically displays poor diet quality, low levels of physical activity and fitness, as well as high rates of metabolic syndrome (Eisenmann, 2007; Holst-Schumacher et al., 2009).

Dietary factors

Several dietary factors are positively associated with MetS presence in youth (Table 1-3). Specifically, dietary factors associated with increased MetS prevalence and individual components of MetS include: an overall higher total energy intake (Aeberli, Spinas, Lehmann, l'Allemand, 2009), as well as specific intake levels of individual dietary components (e.g., Aeberli et al., 2009; Casazza, et al., 2009; Ventura, Davis, Alexander, Shaibi, et al., 2008; Zimmermann & Aeberli, 2008). Positive associations between MetS and high intake of carbohydrates, dietary fat, fructose, and cholesterol have been seen, while negative associations between high dietary fiber and protein intake and MetS rates have been found. A wide variety of techniques have been used to examine diet in its relationship to MetS in youth, with a lack of consistent findings across research (Table 1-3). One study for example indicated that diet quality overall, not most individual dietary components, was related to metabolic syndrome prevalence in youth (Pan & Pratt, 2008). While the results from this study were based off of a large, nationally representative dataset, the findings should be examined with caution. Pan and Pratt utilized a single 24-hour dietary recall when examining diet variables in the aforementioned study. It has been suggested that it is adequate to examine overall diet quality in predicting MetS in youth, and that a multiple-pass method using 24-hour dietary recalls are an acceptable measure of dietary intake. However, such recalls may not adequately capture the quality of individual dietary components, especially if only one 24 hour period is examined. Very few studies utilize three 24-hour dietary recalls when examining the metabolic syndrome and dietary factors in youth (e.g. Ventura, Loken, & Birch, 2006).

While 24-hour recalls of diet provide detailed information about diet in youth, they are often time consuming and require much personnel time and resources (e.g. food models). This has led to the development of questionnaires which can assess the same information gathered in 24-hour diet recalls. For example, the BLOCK 2004 was created to examine diet quality over one week periods. This questionnaire was developed based on the 24-hour diet recalls used in the NHANES 1999-2000 (Block, 2004). When examining diet quality via self-report questionnaires or diet recalls, it is important to consider the potential for self-report biases however. Additionally, most assessments do not account for the variability often seen in dietary patterns day-to-day, week-to-week, and even seasonally (Block, 2004). Self-report questionnaires measures may be beneficial however in that they allow for the examination of both overall diet quality and individual dietary components in their association with MetS syndrome over larger periods of time then those frequently seen when using 24-hour recall methods (Casazza et al., 2009).

Physical activity and fitness factors

While some research suggests that diet has a greater influence on MetS prevalence in youth than physical activity (Casazza, et al., 2009), activity and fitness levels have also been shown to be important predictors of meeting criteria for metabolic syndrome in youth (Eisenmann, 2007). Physical activity is defined as any body movement produced by the contraction of skeletal muscles that increases energy expenditure above basal levels (Kohl & Hobbs, 1998; Ortega, Ruiz, Castillo, Sjostrom, 1998). Daily physical activity in youth is made up of activities which blend structured, unstructured, planned, unplanned, incidental, solitary, and social events for competition, leisure, work, education, and transportation purposes (Dollman, Okely, Hardy, Timperio, Salmon, & Hills, 2008). Physical fitness is an integrated measure of most/all body functions involved in the performance of physical activity and exercise (Ortega et al., 2008). Cardiorespiratory fitness (reported as $V0_2$max is the construct which is thought to best represent fitness levels in youth overall. This construct measures the capacity of cardiovascular and respiratory systems to carry out prolonged strenuous exercise (Ortega et al., 2008). As when assessing diet quality, there are many ways to assess physical activity and physical fitness in youth.

Physical activity. When looking to assess physical activity in youth, self-report is not recommended for children under the age of 10. There are benefits to self-report however, as it allows for information to be gathered on specific physical activity behaviors (Dollman et al., 2008). When assessing physical activity, it has been recommended that dimensions such as duration, frequency, intensity, mode, and domain be collected. No known tool is able to assess all recommended dimensions of physical activity however (Dollman et al., 2008). Here, it appears that objective measurements, not self-report, allow for accurately gathering the majority of this data. Therefore, tools such as accelerometers and pedometers are often used in assessing physical activity in youth. Pedometers are small, non-intrusive devices which detect motion associated with walking, and are typically used to examine step frequencies. This does not allow for examination of activities (such as biking) in which motions do not fall within the plane of movement detected by pedometers (Dollman et al., 2008). Accelerometers are motion sensors capable of detecting acceleration and deceleration in more than one direction of movement, and as such they accurately examine energy expenditures across a range of intensities and activities (Dollman et al., 2008; King, Torres, Potter, Brooks, Coleman, 2004). Accelerometers allow for both assessment of overall energy expenditure, in addition to assessment of METS (the energy cost of activities, based on multiples of a subjects basal metabolic rate) which range from light activity (<2.9 METS), to moderate activity (3-5.9 METS), to vigorous activity (6-11 METS) (Adams, Caparosa, Thompson, Norman, 2009).

Low levels of physical activity are generally found to be positively associated with meeting criteria for MetS in children and adolescents (e.g. DuBose, Eisenmann, & Donnelly, 2007; Eisenmann, 2007; Janssen & Cramp, 2010), although some contradictory findings exist (e.g. Shaibi & colleagues, 2005) (Table 1-4). Most research examining physical activity and MetS has utilized either self-report surveys or accelerometers in examining activity rates. Given that self-report of physical activity in youth under the age of ten is not recommended (Dollman et al., 2008), results of research utilizing self-report methods in this age group should be examined with caution (e.g. Kaladashi & colleagues, 2007; Ventura & colleagues, 2008). Additionally, it is difficult to generalize findings from research utilizing self-report of physical activity as different assessment tools (e.g. activity checklists, self-report of involvement in lifestyle versus organized activities, self-report of sedentary activities) are used inconsistently across research. Here, examining findings based on non-objective measurements of activity via accelerometer data overcomes the aforementioned weaknesses associated with self-report methods. When examining physical activity using accelerometers to determine the relationship between activity levels and MetS, consistent findings have not be seen in existing literature however. Some research has indicated a positive association between low physical activity and high MetS risk (e.g. Ekelund et al., 2009), some research has indicated no relationship exists (e.g. Martinez-Gomez et al., 2009), and some research has indicated that a relationship between physical activity and individual MetS components, but not MetS overall, exists (e.g. Ventura et al., 2006). The lack of consistent findings is a significant weakness in this domain. Additionally, the findings within this domain are typically gathered through assessments of healthy volunteers or in population based studies. In overweight and obese youth, higher rates of MetS are seen than in healthy volunteers; however no research exists objectively examining the relationship between physical activity and MetS specifically in this population. Physical activity levels are typically lower in overweight youth than in non-overweight youth, with activity being a frequent target of change in lifestyle interventions for pediatric overweight (Raynor, 2008). As such, it appears that overweight youth represent an important group in which to examine physical activity variables and MetS to direct intervention and prevention efforts.

Physical fitness. Physical fitness measurements in youth are typically gathered via field or clinic based fitness tests. Despite the emphasis on using manualized assessment methods, such assessments can be prone to error due to administrator differences (Castro-Pinero et al., 2009). Of the many physical fitness assessments (e.g. the treadmill test, the vertical jump test, the broad jump test, force plate analysis tests, the 30 meter sprint test, the 4x10 meter shuttle run, the flex arm hang test, etc.), the gold-standard test for measuring physical fitness is the 20 meter shuttle run (e.g. Ortega et al., 2007). Fitness assessed via the 20 meter shuttle is correlated with abdominal adiposity, cardiovascular disease risk profile, metabolic risk, insulin resistance, insulin variance, and hypertension (Ortega et al., 2007). Given that the health risk factors correlated with cardiovascular fitness are typically those examined in children with MetS, the 20 meter pacer test should provide important information in assessing such youth. Studies examining physical fitness and metabolic syndrome in youth are frequently criticized however for not examining cardiorespiratory fitness represented by gold-standard techniques (Eisenmann, 2007).

When examining physical fitness and its relationship to metabolic syndrome in youth, a positive relationship appears to exist between high fitness levels and low MetS risk, with extensive literature reviews discovering only one report of contradictory findings (Shaibi et al., 2005) (Table 1-4). Of note, Shaibi and colleagues found no association between physical fitness and MetS in a group of 9-12 year-olds with comorbid T2DM (2005). They postulated that no significant relationship existed due to the higher importance of other physiological factors seen in youth with T2DM, such as body composition and insulin sensitivity, in predicting metabolic syndrome. This research was unique in its focus on a group of participants with a chronic illness (T2DM), as opposed to only including healthy volunteers. A second study was examined which looked at the relationship between MetS and physical fitness in a chronic illness group. Torok & colleagues assessed physical fitness across three reference groups: 1) obese youth with MetS; 2) obese youth without MetS; and, 3) normal weight youth (2001). Their findings indicated that lower fitness rates were associated with having metabolic syndrome and being obese as compared to being obese without metabolic syndrome (2001). While this research was unique in its inclusion of multiple reference groups including a pediatric obese sample, it suffered from significant weaknesses including having a small sample size (68 children total: 22

with MetS, 17 obese, and 29 normal weight youth) and its use of only male adolescents (Torok et al., 2001). Additionally, although the researchers measured fitness via $V0_2$max, they did not utilize the 20 meter shuttle run, considered to be the gold standard measure of physical fitness in youth (Ortega et al., 2008). This weakness was seen consistently throughout literature, with fitness more frequently assessed via cycle ergometer and treadmill tests (e.g. McMurray et al., 2008; Shaibi et al., 2005). Only two studies were identified which used the 20 meter shuttle run method in examining the relationship between fitness and MetS in children and adolescents. Ventura and colleagues (2006) and Martinez-Gomez and colleagues (2009) utilized this technique, with findings indicating a positive association between high fitness and low MetS risk. Both research groups examined this relationship in healthy volunteers however, with Ventura & colleagues examining this relationship in female youth only, limiting the generalizability of their findings. Similar to physical activity, lower physical fitness is typically seen in overweight youth (Eisenmann, 2007). A significant gap exists in current literature, with only one study examining the relationship between fitness and MetS in overweight youth, and no research utilizing gold standard assessment techniques to examine fitness in this population.

Physical activity vrs. physical fitness. There has been some disagreement as to the relative importance of physical activity compared to physical fitness in their relationship with MetS, despite the high correlation between physical fitness and physical activity levels (Ortega et al., 2008). Fitness levels may be of higher importance than activity levels when examining metabolic syndrome prevalence in obese youth, as high fitness levels are seen to attenuate disease risk in children and adolescents above and beyond activity levels alone (Eisenmann, 2007). When examining both physical fitness and physical activity in their relationship to MetS, the majority of research has shown that the inclusion of fitness variables cause activity variables to become insignificant (e.g. Brage, Wedderkopp, Ekelund, Franks, Wareham, Anderson et al., 2004; Rizzo et al., 2007). Findings in this domain are also inconsistent however. Hong and colleagues, for example, found that activity variables continued to significantly predict risk for factors associated with MetS (such as high blood pressure and poor cholesterol) above adjustment for fitness (Hong, Kim, & Hang, 2009). It also may be that the relatively higher importance of fitness compared to activity is specific to children who show high levels of adiposity, with this relationship not seen in normal weight children in one study (Parrett, Valentine, Arngrimsson, Castelli, & Evans, 2010). It is difficult to compare findings across these and other studies given the use of different assessment techniques for both fitness and activity, in addition to the frequent examination of children meeting criteria for individual components of the metabolic syndrome rather than those meeting full MetS criteria.

Psychosocial Factors and Metabolic Syndrome

It can be hypothesized that a relationship exists between psychosocial functioning and metabolic syndrome. Poor psychosocial functioning is thought to increase behaviors associated with negative health, and decrease behaviors associated with positive health (Goldbacher & Matthews, 2007). Psychological factors have been shown to influence risk for diseases such as heart disease, diabetes, and obesity, chronic diseases known to be associated with metabolic syndrome. When considering the link between psychosocial functioning, health risks, and chronic illness, it seems plausible that metabolic syndrome is also associated with higher rates of psychosocial difficulties (Janicke, Harman, Kelleher, & Zhang, 2008; Mustillo, Worthman, Erkanli, Keeler, et al., 2003). Additionally, given the previously established relationship between obesity and higher rates of psychosocial functioning difficulties, it is possible that metabolic syndrome, commonly an obesity related health condition, is also associated with higher rates of psychosocial difficulties (Janicke et al., 2008; Mustillo et al., 2003). It has been suggested that an increase in psychiatric conditions comorbid to metabolic syndrome may negatively impact both health behaviors as well as therapeutic interventions targeting obesity (l'Allemand-Jander, 2010). However, despite existing research indicating the potential for a relationship between psychosocial functioning and MetS, little extant literature exists specifically examining this relationship. Cross-sectional and prospective studies have suggested a link between psychosocial factors (e.g. depression, stress, and anger) and metabolic syndrome in adult populations, with little research examining this relationship in youth (Goldbacher & Matthews, 2007; Weigensberg, Toledo-Corral, & Goran, 2007).

Janicke and colleagues examined the relationship between comorbid psychiatric diagnoses and obesity-related medical comorbidities (such as type 2 diabetes, dyslipidemia, and metabolic syndrome) in a pediatric sample. They found that as many as 35% of those with obesity related comorbidities also had psychiatric diagnoses (2008). Across these youth, those with metabolic syndrome had the highest rates of comorbid psychiatric conditions. Janicke and colleagues postulated that the relationship between obesity related health conditions and psychiatric conditions seen in their study may have been due to one or more of several factors. For example, barriers to healthy lifestyle behaviors may be present in those who also have a mental health diagnosis, impacting health status. Alternatively, obesity related health conditions may be resultant of side effects of psychiatric medications which impact metabolic parameters (Janicke et al., 2008). While this study was unique in its examination of clinically diagnosed metabolic syndrome and psychiatric conditions in youth, it suffered from several weaknesses which limit its generalizability and ability to direct intervention efforts, indicating and need for further research in this domain. For example, the potential relationship between MetS and specific psychiatric diagnoses (e.g. depression, anxiety, and oppositional defiance disorder) was not extrapolated within this study. Additionally, the psychiatric conditions were classified by identifying the presence of ICD-9 codes, limiting the ability to examine a wide range of functioning and to understand the degree of psychosocial impairment.

Externalizing factors

When specific psychosocial functioning domains and metabolic syndrome are examined in youth, findings appear to be consistent with those seen in adult populations. For example, both hostility and outward expressions of anger have been shown as associated with prospective and comorbid symptoms associated with MetS (Mueller, Meininger, Liehr, Chandler, & Chan, 1998; Raikkonen, Matthews, & Salomon, 2003; Ravaja & Keltikangas-Jarvinen, 1995; Ravaja, Keltikangas-Jarvinen, & Keskivaara, 1996). Across the majority of research in this domain however, significant methodological weaknesses impact the ability to generalize findings across research. One significant weakness is the use of healthy volunteers to examine the proposed relationship between MetS and externalizing conditions. Due to the low rates of MetS seen in healthy volunteers, research in this domain has not always utilized well-established methods for determining what qualifies a child as having, or being at risk for, MetS. The group of participants examined by Ravaja and colleagues for example did not include any participants who met criteria for the metabolic syndrome (1996). Children were instead classified as at risk for metabolic syndrome based on parent disease characteristics, greatly decreasing the ability for findings to be generalized to youth with MetS. Raikkonen and colleagues examined the relationship between MetS and hostility across a wide age range of healthy youth using longitudinal methods. Youth were classified as meeting criteria for MetS based on having at least two of the symptoms above normal limits, as opposed to the three out of five criteria typically used (Raikkonen et al., 2003). Other research which found a positive association between externalizing symptoms (such as hyperactivity, aggression, and anger) and metabolic syndrome was limited in that psychosocial functioning was examined in its relationship to individual MetS components, as opposed to meeting criteria for MetS. Additionally, it is difficult to generalize findings across research given the frequent gender differences seen in studies examining the relationship between externalizing symptoms and metabolic syndrome. Several studies indicate that the relationship between externalizing factors and metabolic syndrome can only be seen in males (e.g. Mueller et al., 1998; Ravaja et al., 1996; Ravaja et al., 1995). Higher rates of externalizing conditions are seen in males than females, which may have impacted the findings in this domain (Janicke et al., 2008).

Internalizing factors

Depression. With regards to internalizing conditions and metabolic syndrome in youth, again, little previous literature exists. One study, found that adolescent females with Post Traumatic Stress Disorder (PTSD) and comorbid depression were more likely to have endocrine/metabolic/immune disorders (Seng, Graham-Bermann, Clark, McCarthy, & Ronis, 2005). In this study, ICD-9 diagnostic codes were used to identify those with a presence of either endocrine, metabolic, or immune disorders, with the specific disorder not specified. As such, it is difficult to extrapolate the direct relationship between these psychosocial variables and presence of metabolic syndrome. Another study, looking specifically at parent report of child temperament and MetS in youth, found that “positive emotionality”, defined as demonstrating cheerfulness and friendliness, was related to having lower risk of MetS components (Ravaja & Keltikangas-Jarvinen, 1995). While having “positive emotionality” cannot be specifically defined as having low levels of depression, these findings, as well as those regarding PTSD and depression, indicate a further need to examine internalizing behaviors and MetS in youth.

Peer victimization and stress. Peer victimization typically involves repeated exposure to aggression perpetrated by others, and may involve a real or perceived power imbalance between a bully and a victim (Crick & Bigbee, 1998; Storch & Ledley, 2005). Some groups of children are particularly at risk for victimization, including those belonging to chronic illness groups, as these children may have observable characteristics (such as a high weight status in pediatric overweight populations), which invite victimization (Fekkes, Pijpers, Fredriks, Vogels, & Verloove-Vanhorick, 2005; Van Cleave & Davis, 2006). Here, being victimized is thought to have negative impacts on health behaviors in these chronic illness groups (e.g. impacting physical activity rates and adherence to medical regimens) (Gray, Ingerski, Janicke, & Silverstein, 2008; Janicke et al., 2009). Despite the examination of victimization and its relationship to health status across a wide range of chronic illness groups, and the negative impact of victimization seen in these groups, a significant gap in research exists. There is no current research examining victimization rates in youth with metabolic syndrome. Existing research instead has focused on the relationship between stress and metabolic syndrome. Gini and colleagues have hypothesized that victimization leads to a higher number of health complaints due to the high level of stress associated with being bullied, and the consistency across time of these experiences (2007). High stress levels examined via physiological and self-report data are positively associated with MetS (e.g. Holmes, Eisenmann, Ekkekakis, & Gentile, 2008; Sen, Aygun, Yilmaz, & Ayer, 2008; Weigensber et al., 2008). However stress is often a poorly defined construct within this research. Therefore, information gathered via child report of victimization in youth with metabolic syndrome may allow for a better understanding of the impact of victimization and stress in this chronic illness group.

Quality of Life. An individual's personal perception of their overall satisfaction with life and well-being is reflected in their quality of life (Wilkins-Shurmer et al., 2002). Quality of life has many dimensions across emotional, social, scholastic, and physical well-being domains (Hommel, Davis, & Baldassano, 2008). Research suggests that children with chronic illnesses, such as those who are overweight or have cancer, have significantly lower quality of life when compared to healthy peers (Schwimmer, Burnwinkle, & Varni, 2003). It has been postulated that this relationship exists due to the physical functioning, physical appearance, and lifestyle differences frequently seen in youth with chronic illnesses. Children with metabolic syndrome are frequently visibly overweight, and may have difficulties in physical functioning due to their physiological differences (e.g. high blood pressure) (Schwimmer et al., 2003). As such, children with metabolic syndrome may suffer from lower quality of life, similar to youth in other chronic illness groups. However, to date, no research has been done examining this relationship.

Metabolic Syndrome Summary

In summary, several limitations exist in the extant literature which future studies should look to examine and clarify. First, no unifying definition exists for examining MetS in youth. While several definitions exist which are used more frequently, this lack of a consensus definition makes the replication and comparison of findings across research difficult (D'Amo et al., 2010; IDF Task Force on Epidemiology and Prevention of Diabetes, 2007). A second limitation is that little research exists examining health status concurrently with psychosocial functioning and demographic variables. Often, research in these domains is completed in populations made up of adults with MetS, focusing on their recall of home environments, SES, and family functioning during childhood (Goldbacher & Matthews, 2007; Weigensberg et al., 2007). Adult recall of child functioning is particularly problematic as it does not allow researchers to examine these variables in their relationship to concurrent disease state in childhood. Additionally, without knowledge of childhood disease state, it is not possible to make conclusions of directionality in such research. A third weakness is that contradictory findings exist in the literature examining behavioral and lifestyle factors associated with MetS (such as diet and physical activity/fitness). For example, research findings vary with regards to whether overall dietary intake or specific dietary factors are of increased importance in predicting MetS risk, as well as whether physical fitness or physical activity are more important predictors (e.g. Casazza et al., 2009). Additionally, it has been debated whether dietary factors or physical activity/fitness variables overall are more important in their relationship with MetS prevalence (Casazza et al., 2009; Eisenmann 2007). A fourth limitation seen in extant literature is the paucity of research on psychosocial factors in youth with MetS (such as depression and anger) which have been found to be associated with MetS in adults. Additionally, the majority of the research in this domain is limited in its scope of psychosocial functioning, has not focused on clinically significant problems, and also demonstrates limited use of validated measures (e.g. Raikkonen, et al., 2003). A final limitation in current research is the use of “healthy volunteers” when examining factors associated with MetS in youth (Casazza et al., 2009). It appears that an important at-risk group, the pediatric overweight population, exists in which more focused research could provide important information for intervention and prevention efforts. Many of the aforementioned variables (e.g. family functioning, psychosocial functioning, behavioral/lifestyle factors, demographic factors) are often a focus of intervention and research in pediatric overweight samples. Therefore, it will be important to better delineate the relationship between such variables and MetS risk in this population.

Table 1-1. Diagnostic Criteria for Adult Metabolic Syndrome

Definition	Gender	Health Parameter	Cut point for Abnormality
		Weight status	
ATPIII[1]	Male		Waist circumference>102cm
	Female		Waist circumference>88cm
WHO[2]	Non-specific		BMI>30
AACP[3]	Male		Waist/hip>0.9
	Female		Waist/hip>0.85
			BMI>25
		Triglycerides	
ATPIII			150 mg/dL
WHO			150 mg/dL
AACP			150 mg/dL
		HDL Cholesterol	
ATPIII	Male		<40 mg/dL
	Female		<50 mg/dL
WHO	Male		<35 mg/dL
	Female		<39 mg/dL
AACP	Male		<40 mg/dL
	Female		<50 mg/dL
		Blood Pressure	
ATPIII			>130/85 mmHg
WHO			Antihypertensive medication and/or 140/90 mmHg
AACP			>130/85 mmHg
		Insulin Resistance	
ATPIII			>110 mg/dL fasting glucose
WHO			T2DM, impaired fasting glucose, impaired glucose tolerance, or other met criteria
AACP			110-126 md/dL fasting glucose

[1]ATPIII is the Adult Treatment Panel III
[2]WHO is the World Health Organization
[3]AACP is the American Association of Colleges of Pharmacy

Table 1-2. Diagnostic Criteria for Child Metabolic Syndrome

Definition	Health Parameter	Cut point for Abnormality
Cook & colleagues (2003)[1]	Weight status	Waist circumference>90th %ile age/sex specific
Cook & colleagues (2008)[2]		Waist circumference>90th %ile age/sex/race specific
Cruz & colleagues[3]		Waist circumference>90th %ile age/sex/race specific
Caprio[4]		BMI z-score>2.0 age/sex specific
Weiss & colleagues[5]		BMI z-score>2.0 age/sex specific
IDF[6]		Waist circumference>90th %ile
	Triglycerides	
Cook & colleagues (2003)		>110 mg/dL age specific
Cook & colleagues (2008)		>110 mg/dL age specific
Cruz & colleagues		>90th %ile age/sex specific
Caprio		>95th %ile age/sex specific
Weiss & colleagues		>95th %ile age/sex specific
IDF		>150 mg/dL
	HDL Cholesterol	
Cook & colleagues (2003)		<40 mg/dL
Cook & colleagues (2008)		<40 mg/dL
Cruz & colleagues		<10th %ile age/sex specific
Caprio		<5th %ile age/sex specific
Weiss & colleagues		<5th %ile age/sex specific
IDF		<40 mg/dL
	Blood Pressure	
Cook & colleagues (2003)		>90th %ile age/sex/height specific
Cook & colleagues (2008)		>90th %ile age/sex/height specific
Cruz & colleagues		>90th %ile age/sex/height specific
Caprio		>95th %ile age/sex/height specific
		>95th %ile age/sex/height specific

Table 1-2. Continued

Definition	Health Parameter	Cut point for Abnormality
Weiss & colleagues		>95th %ile age/sex specific
IDF		>130/85
	Glucose	
Cook & colleagues (2003)		>110 mg/dL
Cook & colleagues (2008)		>110 mg/dL
Cruz & colleagues		Impaired glucose tolerance
Caprio		Impaired glucose tolerance
Weiss & colleagues		Impaired glucose tolerance
IDF		>100 mg/dL

[1] Revised from the adult ATP III definition
[2] Revised to incorporate recommendations from: the American Diabetes Association, the National Heart, Lung, and Blood Institute, and Fernandez and colleagues (2004)
[3] Revised from the adult ATP III definition
[4] Revised from the NCP, ATP, and WHO criteria
[5] Revised from the National Cholesterol Education Program's Adult Treatment Panel and WHO criteria
[6] Revised from Cook et al., 2003; de Ferranti et al., 2004; Cruz et al., 2004; Weiss et al., 2004; and Ford et al., 2005.

Table 1-3. Dietary Factors and Pediatric Metabolic Syndrome

Authors	Assessment	Reference Group	Findings
Ventura & colleagues (2006)	Three 24-hour dietary recalls	5-12 y/o female healthy volunteers	Sweetened beverage consumption associated with MetS risk.
Ventura & colleagues (2008)	Two 24-hour dietary recalls	10-17 y/o overweight Hispanic children with family history of T2DM	Cholesterol and fiber intake associated with MetS components.
Kim & colleagues (2007)	One 24-hour dietary recall	10-19 y/o healthy volunteers	Only waist circumference associated with dietary intake.
Pan & Pratt (2008)	One 24-hour dietary recall	12-19 y/o healthy volunteers	Overall diet quality and fruit consumptions associated with MetS.
Kelishadi & colleagues (2008)	Parent report of family dietary habits	6-18 y/o healthy volunteers	Higher fat intake and white bread intake positively associated with MetS risk. Higher fruit, vegetable, and dairy intake negatively associated with MetS risk.
Casazza & colleagues (2009)	Two 24-hour dietary recalls	7-12 y/o healthy volunteers	Carbohydrate and fat intake associated with MetS components.
Aeberli & colleagues (2009)	Two 24-hour dietary recalls plus a one-day diet record	6-14 y/o healthy volunteers	Total caloric, fat, and protein intake associated with MetS components.
O-Sullivan & colleagues (2010)	3 days of diet records	13-15 y/o in Australian cohort study	Higher dietary glycaemic index glycaemic load, and carbohydrate intake associated with MetS.
Ambrosini & colleagues (2010)	Food frequency questionnaire	14 y/o healthy volunteers	“Western” diet (compared to “Healthy” diet) associated with greater odds of MetS.

Table 1-4. Physical Fitness (PF) Physical Activity (PA) and Pediatric Metabolic Syndrome

Authors	Fitness Assessment	Activity Assessment	Reference Group	Findings
DuBose & colleagues (2007)	Cycle ergometer	N/A	7-9 y/o healthy volunteers	PF acts as moderator b/w BMI and MetS risk.
Ekelund & colleagues (2009)	Cycle ergometer	Accelerometer	10-15 y/o healthy volunteers	PA & PF associated with MetS risk.
Rizzo & colleagues (2007)	Cycle ergometer	Accelerometer	9-16 y/o healthy volunteers	High MetS risk associated with high BMI and low PF. PA associated with MetS risk in girls only. Association b/w PA and MetS lost when PF included in prediction model.
Brage & colleagues (2004)	Cycle ergometer	Accelerometer	8-10 y/o healthy volunteers	PA & PF associated with MetS risk. Association b/w PA and MetS decreases when PF included in prediction model.
McMurray & colleagues (2008)	$V0_2$max via cycle ergometer	Self-report survey	7-10 & 14-17 y/o volunteers	Youth with MetS 6x more likely to have low PF, 5x more likely to have low PA.
Ruiz & colleagues (2007)	$V0_2$max via cycle ergometer	N/A	9-10 y/o healthy volunteers	Low MetS risk associated with high PF.
Eisenmann & colleagues (2007)	Treadmill time to exhaustion	N/A	8-18 y/o healthy volunteers	Highest MetS rates in youth with high BMI and low PF.
Janssen & Cramp (2007)	$V0_2$max via treadmill	N/A	12-19 y/o NHANES	PF predicts MetS dx and levels of MetS components.
Brufani & colleagues (2008)	$V0_2$max via treadmill	N/A	7-10 y/o with T2DM	Low MetS risk associated with high PF.
Shaibi & colleagues (2005)	$V0_2$max via treadmill	N/A	9-12 y/o with T2DM	PF and MetS not significantly related

Table 1-4. Continued

Authors	Fitness Assessment	Activity Assessment	Reference Group	Findings
Torok & colleagues (2001)	$V0_2$max via treadmill	N/A	3 groups of 12-16 y/o males: 22 obese with MetS, 17 obese, 29 normal weight	PF lower in youth with MetS than in obese youth.
Hong & colleagues (2009)	$V0_2$max via treadmill	Accelerometer	12-13 y/o healthy volunteers	PA & PF associated w/ MetS components. Association b/w PA and MetS present above adjustment for PF.
Parrett & colleagues (2010)	$V0_2$max via treadmill	Pedometer	7-11 y/o children	PA & PF associated w/MetS risk and/or components. PF protective above PA for MetS risk.
Ventura & colleagues (2006)	$V0_2$max via 20m shuttle run[1]	Activity Checklist	5-12 y/o female healthy volunteers	Low MetS risk associated with high PF. PA associated with MetS components, not MetS overall.
Martinez-Gomez & colleagues (2009)	$V0_2$max via 20m shuttle run[1]	Accelerometer	13-17 y/o healthy volunteers	PF associated with MetS. PA not associated with MetS.
Casazza & colleagues (2009)	N/A	Accelerometer	7-12 y/o healthy volunteers	PA associated with MetS components, not Mets overall.
Campbell & colleagues (2010)	N/A	Accelerometer	Birth cohort assesses at mean age of 13	PA associated with MetS components (however only associated with insulin after controlling for age, sex, height, and weight) and body fat percentage.
Moore & colleagues (2008)	N/A	Self-report survey	4^{th}, 6^{th}, 8^{th}, & 11^{th} grade healthy volunteers	Low PA associated with 3x greater odds of MetS.
Pan & Pratt (2008)	N/A	Self-report survey	12-19 y/o healthy volunteers	Trend towards lower MetS rates with increasing PA.

Table 1-4. Continued

Authors	Fitness Assessment	Activity Assessment	Reference Group	Findings
Kaladashi & colleagues (2007)	N/A	Self-report survey	6-18 y/o healthy volunteers	Low PA associated with higher MetS risk.
Platet & colleagues (2006)	N/A	Self-report survey	12 y/o in a physical activity intervention group (ICAPS)	PA associated with MetS components, not Mets overall.
Okosun & colleagues (2010)	N/A	Self-report survey	12-17 y/o healthy volunteers	Decreasing MetS risk associated with increase in PA intensity.
Okosun & colleagues (2010)	N/A	Self-report survey	12-16 y/o healthy volunteers	Higher leisure time physical activity associated with decreased MetS risk

[1] Gold standard PF assessment

CHAPTER 2
PURPOSE OF STUDY

Study Summary

The current study examined the relationship between lifestyle, demographic, and psychosocial variables and Metabolic Syndrome (MetS) diagnosis in a treatment seeking pediatric sample of overweight and obese youth. It is unique and expands upon extant literature in several ways. First, it focuses specifically on a group of children at increased risk for MetS, treatment seeking overweight and obese youth, allowing for a detailed examination of the variables which may predict having higher odds of being diagnosed with MetS in this population. Second, the variables examined in the current study provide important information with regards to areas of potential intervention and prevention of MetS in overweight and obese youth (e.g. lifestyle/behavioral factors). Third, the current study utilized criteria modified from the most up-to date definition proposed by Cook and colleagues (2008) for examining metabolic syndrome in youth, and look at the relationship between concurrent levels of functioning, lifestyle activities, and meeting syndrome criteria. Fourth, this study utilized multiple measurements of psychosocial functioning from parent and child ratings, as well as objective measurements of health and lifestyle variables. This overcomes weaknesses seen in previous research primarily relying upon self-report data from single information sources across these domains. Finally, the current study is unique in its focus on psychosocial variables which have not been thoroughly examined in youth with MetS (such as internalizing and externalizing behaviors, quality of life, and peer victimization). The aforementioned variables have been shown to be relevant in other chronic illness groups in their association with health status variables (Goldbacher & Matthews, 2007;

Janicke, Gray, Kahhan, Follansbee-Junger, Marciel, Storch, & Jolley, 2009). It is of particular importance to examine these psychosocial variables given that to date research has found that lifestyle variables (such as diet and activity variables) only explain a small to modest amount of the overall variance in receiving a MetS diagnosis (Holmes et al., 2008).

Aims and Hypotheses

Aim 1

To examine whether demographic variables (specifically age, race, parent education level, total family income, child gender, and parent health status) are associated with increased odds of meeting criteria for MetS.

Hypothesis 1. Being of increased age, male gender, lower parent education levels, lower total family income, Caucasian or Hispanic descent, and having a parent who reports a medical diagnosis (MetS, diabetes, or cardiovascular disease) or is of overweight/obese weight status will each be associated with increased odds of meeting criteria for MetS.

Aim 2

To determine the relationship between the degree of overweight (based on BMI *z*-score or body fat percentage) and meeting criteria for MetS.

Hypothesis 2. Being of increased weight status (higher BMI *z*-score) and having higher body fat percentage will be associated with increased odds of meeting criteria for MetS.

Aim 3

To examine whether lifestyle variables (e.g. physical fitness, physical activity levels, dietary intake) are associated with an increased odds of meeting criteria for MetS, controlling for relevant demographic and weight status variables.

Hypothesis 3. Having lower levels of physical fitness (fewer total laps completed as part of the 20 meter PACER test), lower levels of physical activity (based on both overall energy expenditure and average METS of activities measured objectively with accelerometry), and poorer diet quality (based on higher percent calories from fat) will be associated with increased odds of meeting criteria for MetS.

Aim 4

To examine whether psychosocial functioning variables (specifically psychosocial health related quality of life, physical health related quality of life, receipt of peer victimization, family functioning, internalizing behavior problems, and externalizing behavior problems) are associated with increased odds of meeting criteria for MetS, controlling for relevant demographic and weight status variables.

Hypothesis 4. Poorer psychosocial and physical health-related quality of life (rated separately by both child subjects and their parents), higher rates of peer victimization (based on child self-report), having lower levels of global family functioning (based on parent report), and having higher levels of internalizing and externalizing behavior problems (based on parent report of child behaviors) will be associated with increased odds of meeting criteria for MetS.

CHAPTER 3
METHODS

Research Methods and Procedures

The current study is a cross-sectional data analysis examining the relationships between meeting criteria for Metabolic Syndrome (MetS) and demographic, lifestyle, and psychosocial factors in a pediatric overweight sample. The information gathered in this study is part of a larger study evaluating the impact of a family lifestyle intervention on pediatric weight status, in overweight and obese children living in underserved rural communities.

Participants

This study consists of 229 overweight and obese children, between the ages of 8 to 12 years old at the time of study entry, and their parent/legal guardians living in rural counties within North Central Florida. Participants were included if they met weight status criteria [based on the Centers for Disease Control (CDC) criteria] and if they had a participating parent or legal guardian (less than 75 years old) who lived in their home. Children were excluded if they or their participating parent/legal guardian had: any restrictions or medical conditions that contraindicated participating in a program that included mild energy restriction or physical activity; other health restrictions (specifically a resting blood pressure exceeding 140/90 mm Hg); medication regimens including antipsychotic agents, monoamine oxidase inhibitors, systemic corticosteroids, other specific antibiotics, chemotherapeutic drugs, or the use of prescription weight-loss drugs taken within the last six months; and/or conditions or behaviors which were likely to affect the study (e.g. unwilling or unable to give consent, unable to read English, major psychiatric disorder, child with major cognitive or developmental delay or a pattern of aggressive or oppositional behavior).

Procedure

Recruitment. Participants were recruited through a combination of direct solicitation methods (e.g. direct mailings to households and health care providers) as well as press releases, brochures delivered through local schools, identification of patients through a clinical database by the medical team associated with the study, and presentations/brochure distribution by research team members and community agents. Prospective participants were first encouraged to call the research office in order to learn more about the study and complete an initial phone screening to determine eligibility. Phone calls and phone screenings were completed by trained staff working as part of the research team. Families who met initial eligibility criteria and expressed interest in the research program were scheduled for an in-person screening visit. Families who successfully completed the initial in-person screening visit were next scheduled for a baseline assessment visit that occurred approximately two weeks prior to the initiation of the treatment protocol.

At their assessments interested participants and their parent/legal guardian were asked to provide informed consent/assent. Measurements of height, weight, waist size, body fat percentage, and metabolic parameters (blood lipids, blood sugars, blood pressure) as well as questionnaires on dietary intake, physical activity, and psychosocial functioning were completed by the participating child. Measurements of height, weight, as well as questionnaires on parent and child demographic information, medical history, family functioning, and child psychosocial functioning were completed by the participating parent/legal guardian. Please refer to the appendix to view measures created specifically for use in the current study.

Measures

The following measures were collected across the two assessment visits. Physiological and anthropometric evaluations were collected by a trained nurse or nurse technician. Questionnaire data was collected by trained research assistants.

Child measures

Presence of Metabolic Syndrome. In order to determine the prevalence of Metabolic Syndrome, subjects were identified based on modified criteria proposed by Cook and colleagues, as having at least 3 of the following: 1) waist circumference above the 90th percentile for gender and age, 2) triglycerides greater than 110mg/dL (>1.24 mmol/L), 3) high-density lipoprotein cholesterol less than 40mg/dL, 4) systolic and/or diastolic blood pressure greater than the 90th percentile for height, age, and sex, and/or 5) glycosylated hemoglobin (glucose concentration, A1C) greater than 5.7% (2008). Criteria have been modified such that criteria 5 reflects recent standards in medical care of diabetes, utilizing A1C levels as opposed to fasting blood glucose levels in identifying individuals with high risk for future diabetes (American Diabetes Association, 2010). All other criterion are consistent with the definition of Metabolic Syndrome proposed by Cook and colleagues in 2008. A dichotomous variable was created based on meeting or not meeting the proposed criteria (1 = YES, 0 = NO).

Height and weight. Height without shoes was measured to the nearest 0.1 centimeter using a Harpendon stadiometer. Weight was measured to the nearest 0.1 kilogram using certified digital scale with one layer of clothing on, without shoes, and with pockets emptied.

Body fat percentage. Body fat percentage was measured using a bioelectrical impedance scale. Such scales use a small, harmless, electric current that travels throughout the body to measure resistance, which then indicates body fat percentage. The scale used in the current study, Tanita BC-533, was created for use with children 7-17 years old and utilizes a child specific mode which takes into account a child's weight, height, age, and gender to ensure accurate measurements. It has been shown to be safe and effective and has been used in previous research examining body fat percentage in youth (Denova-Gutierrez, Jimenez-Aguilar, Halley-Castillo, Huitron-Bravo, Talavera, Pineda-Perez, et al. 2008).

Resting heart rate and blood pressure. Resting heart rate and resting systolic and diastolic blood pressure were taken three times, two minutes apart, using a manual blood pressure cuff at the end of a 5 minute period in which each child was seated, with feet resting on the floor in a quiet room free of distractions. The first reading was discarded, and the last two readings were averaged.

Blood analyses. Under aseptic conditions, while using standard procedures, approximately 2-3 drops of blood were collected via a finger prick and analyzed for glycosylated hemoglobin (glucose concentration, A1C), triglycerides, total cholesterol, LDL-cholesterol, and HDL-cholesterol using a point-of-care device. The Cholestech LDX and GDX System devices were used to analyze the blood samples (Inverness Medical, 2010), which meets all relevant National Cholesterol Education Program (NCEP) guidelines and is certified by the CDC's Cholesterol Reference Method Laboratory Network.

Physical activity. Child physical activity was assessed using the Sensewear Armband Accelerometer. The Sensewear armband includes a 3-axis accelerometer, heat flux sensor, galvanic skin response sensor, skin temperature sensor, and a near-body ambient temperature sensor. This allows the armband to gather information about body motions across multiple planes, to measure heat produced by the body as a result of physical activity, and to distinguish between waking and sleep states (Liden, Wolowicz, Stivoric, Des, Teller, Vishnubhatla et al., 2001). Children were asked to wear the accelerometer for seven consecutive days, 24 hours per day, (except when bathing or swimming), and they were given a prepaid mailer for its return. Data gathered from three week days and one weekend day (on days in which accelerometers were worn for a minimum of 16 total hours) were averaged to examine overall energy expenditure and METS equivalent of activity across the week. The Sensewear armband technology (Bodymedia, Inc., Pittsburgh, PA) provides an objective assessment of total physical activity energy expenditure and allows for examination of intensity of physical activity based on METS equivalents. To increase accuracy, the device is pre-programmed with each participants height, weight, age, gender, and handedness prior to its use.

Physical fitness. To assess cardiorespiratory fitness, the Progressive Aerobic Cardiovascular Endurance Run (PACER) test was used. The PACER is a multistage test adapted from the 20-meter shuttle run test, and is considered the gold standard in measuring children's cardiorespiratory fitness (Ortega et al., 2008). Prior to beginning the test, baseline heart rate and blood pressure values were obtained, and potential illnesses/injuries were assessed to ensure the participant was not at increased health risk when engaging in test procedures. To conduct the PACER test a 20-meter distance was measured and demarcated by cones. The PACER test involved running back and forth across this 20-meter course with a trained research assistant in time to music played from a CD. Beeps on the sound track indicated when the child should reach the end of each 20 meter section of the course. The test began at a slow pace (8.0 mph), and increased by 1.0 mph at the end of the first minute and then by increments of 0.5 mph each additional minute thereafter. During each 20 meter section of the PACER, the research assistant provided the child with scripted statements of encouragement. The child continued running until the pace could no longer be maintained, as indicated by the child not reaching the end of the lap in time with the sound track beep on two laps, at which point the test was concluded (Cooper Institute for Aerobics Research, 1992). The last lap completed during the PACER was examined to measure the child's physical fitness.

Dietary intake. The BLOCK Kids 2004 is a 77-item questionnaire that was used to assess child dietary intake over the preceding month. The food list for this questionnaire was developed from the NHANES 1999-2002 dietary recall data. The nutrient database was developed from the USDA Nutrient Database for Dietary Studies, version 1.0. Parents helped the child complete this measure (Block, 2004). Percent calories from fat were examined in determining diet quality of children in the current study.

Health-Related quality of life. The PedsQL is a 23-item scale that measures health-related quality of life in healthy children and those with acute and chronic health conditions. This measure includes two summary scores in the domains of Psychosocial Health (incorporating subscales in the domains of Emotional, Social, and School Functioning) and Physical Health. The Psychosocial Health and Physical Health scales were utilized in current analyses. The measure has been reported to have excellent internal consistency, clinical validity, and factor-analytic support for subscales (Varni, Seid, & Kurtin, 2001).

Social interactions. The child's perception of peer victimization and social support were measured with the Social Experiences Questionnaire (SEQ). This is a 15-item self-report measure. Items are rated on a 5-point Likert scale. The SEQ contains 3 subscales (examining receipt of overt victimization, covert victimization, and prosocial support) consisting of 5 items each. The overt and covert victimization subscales can be examined individually, or combined to create a Total Victimization score. A Total Victimization score was created for current analyses. Good psychometric properties have been reported with these subscales (Crick & Grotpeter, 1996).

Parent measures

Height and weight. Height without shoes was measured to the nearest 0.1 centimeter using a Harpendon stadiometer. Weight was measured with one layer of clothing on, without shoes, and with pockets emptied to the nearest 0.1 kilogram using a certified digital scale.

Demographic information. This questionnaire obtained family background information such as: parent/child age, parent/child gender, race, marital status, education, occupation, and family income. This information was collected from the parent/legal guardian for themselves in addition to their partner if applicable.

Parent medical history. Parents were asked to complete a 14-item survey about their medical history, with a focus on weight-related conditions. Items which were utilized in current analyses included those indicating presence of three specific health conditions: MetS, diabetes, and/or cardiovascular disease.

Child health-related quality of life. The parent-report of the PedsQL was used to assess child health-related quality of life. The domains match the child report version of this measure. Similar to analyses run for the child-report version of this measure, overall scores on the Psychosocial Health and Physical Health scores were utilized. To create each score, the mean was computed as the sum of the items over the number of items answered in the Emotional, Social, and School Functioning Scales (Psychosocial Health) and on the Physical Functioning Scale (Physical Health) (Varni & Limbers, 2009).

Family functioning. The Family Assessment Device (FAD) is a 60-item measure that provides an assessment of family functioning. This measure provides information across 7 scales (problem solving, communication, affective regulation, affective involvement, roles, behavioral control, and global family functioning). Global family functioning (12 items) was used in current analyses. Each item in the measure was rated on a 4-point Likert scale. Individuals were asked to respond to each item in terms of how well it described their own family. Scores on the global family functioning scale range from 12-48, with higher scores indicating better family functioning (Miller, Epstein, Bishop, Keitner, 2007).

Child Behavior Checklist*.* The CBCL is a parent rating scale that assesses internalizing and externalizing behavior problems in children between the ages of 4 and 18 years. The internalizing behavior problems and externalizing behavior problems scales were each looked at individually with regards to their relationship with MetS. Each item in the measure was rated on a 3-point Likert scale. The anchors range from “0-Not true” to “2-Often true”. Extensive reliability and validity data have been reported on the CBCL, including excellent internal consistency and 15-day test-retest reliability, a stable factor structure, and positive relations with other measures of childhood behavior

(Achenbach, 1991; Achenback & Rescorla 2001; Bingham, Loukas, Fitzgerald, & Zucker, 2003).

Statistical Analyses

Initial Analyses

In order to determine the prevalence of MetS in the current sample, first a dichotomous variable was created based on meeting criteria above or below specified values on at least 3/5 health variables. Following the creation of this yes/no variable descriptive statistics were run to examine prevalence rates in the sample. Metabolic Syndrome prevalence rates specific to each of the independent variables were also calculated.

Additionally, descriptive statistics were run across demographic variables (e.g. age, gender, legal guardian status) to examine sample demographics, and across psychosocial functioning (e.g. peer victimization, quality of life) and lifestyle variables (e.g. diet, physical activity), to further describe the sample.

Further Analyses

Given that presence of a MetS diagnosis is represented as a dichotomous variable, a logistic regression was used to express the natural log odds of MetS occurring or not occurring based on the relative contributions of each of the independent variables (continuous and categorical). The 95% confidence interval (CI) associated with the odds ratios (OR) in each logistic regression was also examined. When examining categorical independent variables (such as gender or racial/ethnic background) the odds ratio was used to represent the ratio of the odds of MetS diagnosis in one group of an independent variable versus the odds of it occurring in another group (e.g. male versus female). When the odds are the same across groups, the odds ratio is equivalent to 1.0, meaning that receiving a MetS diagnosis is equally likely regardless of the value of the independent variable. Odds ratios larger than 1.0 (with 95% CI not including 1.0) indicate that receiving a MetS diagnosis is more likely in the first group of the independent variable. In analyses including continuous independent variables (such as SES or peer victimization) the odds ratio analyses were examined to allow for interpretation of increased odds of meeting MetS criteria based on unit changes within the independent variable. The odds ratio value represents the change in odds associated with a unit change in the predictor variable. This change in odds is considered a significant change if the 95% CI does not include 1.0.

Aim 1. In order to examine the relationship between demographic variables and meeting criteria for MetS, logistic regressions were performed on the participants MetS diagnosis (presence of diagnosis, yes or no) with age, gender (male or female), race (Caucasian compared to African American, Caucasian compared to Hispanic, Caucasian compared to Biracial/Other, Hispanic compared to African American, and Hispanic compared to Biracial/Other), SES (parent education levels and total family income) and parent health status (parent presenting with overweight/obese weight status or reporting a comorbid health condition) as independent variables. Adjusted odds ratios and 95% confidence intervals were calculated for these regression estimates.

Aim 2. In order to examine the relationship between weight status and meeting criteria for MetS, logistic regressions were performed on the participants MetS diagnosis (presence of diagnosis, yes or no) with BMI *z*-score and body fat percentage as independent variables, controlling for significant demographic variables. Adjusted odds ratios and 95% confidence intervals were calculated for these regression estimates.

Aim 3. In order to examine the relationship between lifestyle variables and meeting criteria for MetS, logistic regressions were performed on the participants MetS diagnosis (presence of diagnosis, yes or no) with physical fitness levels (total laps completed during the PACER), physical activity levels (total energy expenditure and average METS based on the Sensewear armband), and dietary intake (based on the percent calories from fat as calculated from the BLOCK) entered individually into four analyses as independent variables, controlling for significant demographic variables and weight status variables. Adjusted odds ratios and 95% confidence intervals were calculated for each of the four regression estimates.

Aim 4. In order to examine the relationship between psychosocial functioning variables and meeting criteria for MetS, logistic regressions were performed on the participants MetS diagnosis (presence of diagnosis, yes or no) with parent and child report of quality of life (scores ranging from 0-100 on the Psychosocial Health and Physical Health Scores based on the PedsQL, with higher scores indicating better quality of life), child report of peer victimization (scores ranging from 10-50 based on the SEQ Total Victimization score, with higher scores indicating higher rates of victimization), parent report of family functioning (scores ranging from 12-48, with higher scores indicating better family functioning based on the global family functioning score on the FAD), and parent report of child internalizing behavior problems and externalizing behavior problems (T-scores, with higher scores indicating higher levels of problem behaviors on the CBCL, and scores over 69 indicating clinically significant problem behaviors) as independent variables in separate analyses, controlling for significant demographic variables and weight status. Adjusted odds ratios and 95% confidence intervals were calculated for these regression estimates.

All statistical analyses were conducted using SPSS© statistical software (version 17.0).

CHAPTER 4
RESULTS

Initial Analyses

Demographics

In the current study, 229 youth participated, however 35 were excluded from analyses due to missing data on one or more physiological symptoms required to identify metabolic syndrome. The current analyses include the 194 remaining participants. The participating children were between 8 and 12 years old (age: M = 9.9; SD = 1.4). The average BMI z-score of the participants was 2.15 (0.38), presenting with average body-fat of 39.3% (7.77). There were more female than male participants (44.8% male). The racial/ethnic breakdown of child participants was as follows: Caucasian (65.5%), Hispanic (12.4%), African Americans (13.9%), and Biracial/Other (8.2%). Participating legal guardians were predominantly mothers (88.7%), with fathers (6.7%), grandparents (3.6%), and other guardians (1.0%) comprising a smaller percentage of the participating sample. The sample was primarily of lower socioeconomic status, with relatively low to moderate parent education and income levels (17.1% of parents with high school education or less compared to 8.3% of parents with advanced degrees; 48.7% of families reporting average household income below $39,999 compared to 15.0% of families reporting average household income above $80,000) (Table 4-1).

Metabolic Syndrome Criteria

Within the current sample, 57.2% of child participants were identified as meeting criteria for Metabolic Syndrome. The percentage of youth who met criteria for individual

MetS symptoms is as follows: Waist circumference-89.7%; Triglycerides- 74.2%; HDL- 55.2%; HBA_1C- 32.5%; Blood pressure- 11.9%.

Aim 1: Effects of Demographics on Presence of Metabolic Syndrome

In order to examine the relationship between demographic variables and the presence of MetS, logistic regressions were performed on the participants that met criteria for MetS (presence of diagnosis, yes or no) with the following demographic variables: age, gender, race, SES, and parent health status, as independent variables. Participant race was examined in five separate models comparing Caucasian participants to African American, Hispanic, and Biracial/Other participants, and comparing Hispanic participants to African American and Biracial/Other participants. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated for these regression estimates (Table 4-3). Please see Table 4-2 for a comparison of demographics for youth who meet criteria for MetS (MetS-1) to those who do not meet criteria for MetS (MetS-0).

Model 1: Age. Differences in the average age for youth who met criteria for MetS (M = 10.00, SD = 1.38) compared to those who did not meet criteria for MetS (M = 9.81, SD= 1.51) were non-significant (*Wald* χ^2 (1) = 0.856, $p = 0.53$). The OR is 1.10 with a 95% CI of (0.90, 1.34), which suggests that differences in age were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 2: Gender. Differences in rates of gender in youth who met criteria for MetS (45% males, 55% females) compared to those who did not meet criteria for MetS (44.6% males, 55.4% females) were non-significant (*Wald* χ^2 (1) = 0.004, $p = 0.95$). The OR is 0.98 with a 95% CI of (0.55, 1.74) which suggests that differences in gender were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 3: Racial/ethnic background. When comparing youth who met criteria for MetS to those who did not, differences in racial/ethnic background were not associated with greater odds of meeting criteria for metabolic syndrome. More youth who met criteria for MetS were Hispanic or Biracial/Other. Racial/ethnic breakdown is as follows: MetS-1, 64.9% Caucasian, 14.4% Hispanic, 11.7% African American, 9.0% Biracial/Other; MetS-0, 66.3% Caucasian, 16.9% African American, 9.6% Hispanic, 6.0% Biracial/Other.

Model 3a: Caucasian compared to African American participants. The results from the logistic regression analysis in Model 3a were non-significant (*Wald* χ^2 (1) =0.65, p = 0.41). The OR is 1.41 with a 95% CI of (0.61, 3.24).

Model 3b: Caucasian compared to Hispanic participants. The results from the logistic regression analysis in Model 3b were non-significant (*Wald* χ^2 (1) = 0.82, p = 0.37). The OR is 0.66 with a 95% CI of (0.26, 1.64).

Model 3c Caucasian compared to Biracial/Other participants. The results from the logistic regression analysis in Model 3c were non-significant (*Wald* χ^2 (1) = 0.20, p = 0.66). The OR is 0.79 with a 95% CI of (0.27, 2.29).

Model 3d: Hispanic compared to African American participants. The results from the logistic regression analysis in Model 3d were non-significant (*Wald* χ^2 (1) = 1.75, p = 0.19). The OR is 2.15 with a 95% CI of (0.69, 6.7).

Model 3e: Hispanic compared to Biracial/Other participants. The results from the logistic regression analysis in Model 3e were non-significant (*Wald* χ^2 (1) = 0.07, p = 0.79). The OR is 1.2 with a 95% CI of (0.32, 4.5).

Model 4a: SES- Total family income. Differences in total family income for youth who met criteria for MetS (50.9% of families report <$39,999 total yearly income) compared to those who did not meet criteria for MetS (45.8% of families report <$39,999 total yearly income) were non-significant (*Wald* χ^2 (1) = 0.015, $p = 0.90$). The OR is 0.99 with a 95% CI of (0.81, 1.20) which suggests that youth living in homes of lower family income was not associated with greater odds of meeting criteria for metabolic syndrome.

Model 4b: SES- Parent education. Differences in the levels of parent education in youth who met criteria for MetS (18.9% of parents with high school education or less) compared to those who did not meet criteria for MetS (14.6% of parents with high school education or less) were non-significant (*Wald* χ^2 (1) = 0.62, $p = 0.43$). The OR is 0.89 with a 95% CI of (0.67, 1.19) which suggests that youth with a parent reporting lower education levels was not associated with greater odds of meeting criteria for metabolic syndrome.

Model 5: Parent health status. Differences in the rates of parental medical conditions (overweight/obese, cardiovascular disease, diabetes, and/or metabolic syndrome) in youth who met criteria for MetS (91.9% of parents with a medical condition) compared to those who did not meet criteria (90.4% of parents with a medical condition), were non-significant (*Wald* χ^2 (1) = 0.14, $p = 0.71$). The OR is 1.21 with a 95% CI of (0.45, 3.30) which suggests that youth with a parent reporting a relevant medical condition or being of overweight/obese status were not associated with greater odds of meeting criteria for metabolic syndrome.

Aim 2: Relationship between Weight Status and Metabolic Syndrome

The relationship between weight status (BMI z-score; body fat percentage) and meeting criteria for MetS was examined using two logistic regressions. As there were no significant demographic variables, these were not included in further analyses. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated for these regression estimates (Table 4-5). Please see Table 4-4 for a comparison of weight status for youth who meet criteria for MetS (MetS-1) to those who do not meet criteria for MetS (MetS-0).

Model 6a: Weight status- BMI z-score. The average BMI *z*-score in youth who met criteria for metabolic syndrome (MetS-1, M = 2.21, SD = 0.35) was higher than in youth who did not meet criteria (MetS-0, M = 2.08, SD = 0.42). The results from the logistic regression analysis in Model 6a were significant (*Wald* χ^2 (1) = 5.18, p = 0.02). The OR is 2.44 with a 95% CI of (1.13, 5.25) which suggests that for each unit increase of 1.0 in a child's BMI z-score, the odds of meeting criteria for metabolic syndrome increased by a factor of 2.44.

Model 6b: Weight status- body fat percentage. The average body fat percentage in youth who met criteria for metabolic syndrome (Mets-1, M = 40.27, SD = 7.24) was higher than in youth who did not meet criteria (MetS-0, M = 38.04, SD = 8.27). The results from the logistic regression analysis in Model 6b approached significance (*Wald* χ^2 (1) = 3.69, p = 0.055). The OR is 1.039 with a 95% CI of (0.999, 1.08).

Aim 3: Relationship between Lifestyle Variables and Metabolic Syndrome

The relationship between lifestyle variables (physical fitness; physical activity- total energy expenditure; physical activity- average METS; dietary intake- percent calories from fat) and meeting criteria for MetS was examined using four logistic regressions, controlling for BMI *z*-score (Table 4-7). As there were no significant demographic variables, these were not included in these analyses. Please see Table 4-6 for a comparison of lifestyle variables for youth who meet criteria for MetS (MetS-1) to those who do not meet criteria for MetS (MetS-0).

Model 7: Physical fitness. When examining the data for normality, an outlier was removed for a participant who completed 36 laps on the PACER test (z-score = 7.58). Differences in the average physical fitness (total PACER laps completed) in youth who met criteria for metabolic syndrome (M = 8.17, SD = 3.08) compared to youth who did not meet criteria (M = 8.53, SD = 3.14) were non-significant (*Wald* χ^2 (1) = 0.78, p = 0.38). The OR is 1.04 with a 95% CI of (0.95, 1.15) which suggests that differences in physical fitness between youth were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 8a: PA-Energy expenditure. When examining the data, 141 out of the 194 participants wore the accelerometer for the minimum amount of time to calculate physical activity data. Thus, 53 participants were excluded from PA analyses due to a lack of sufficient data. When assessing for normality, two outliers were removed for participants who recorded an energy expenditure of 8151 (z-score = 7.998) and 4526 (z-score = 3.01). Differences in the average energy expenditure in youth who met criteria for metabolic syndrome (M = 2298.59, SD = 483.65) compared to youth who did not meet criteria (M = 2278.48, SD = 531.36) were non-significant *Wald* χ^2 (1) = 0.45, p = 0.50). The OR is 1.00 with a 95% CI of (0.999, 1.001) which suggests that differences in energy expenditure between youth were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 8b: PA-METS. When examining the data, 141 out of the 194 participants wore the accelerometer for the minimum amount of time to calculate physical activity data. Thus, 53 participants were excluded from PA analyses due to a lack of sufficient data. When assessing the data for normality, two outliers were removed for participants who recorded average METS of 2.32 (z-score = 3.06) and 2.39 (z-score = 3.36). Differences in the average METS of physical activity in youth who met criteria for metabolic syndrome (M = 1.57, SD = 0.21) compared to those who did not meet criteria (M = 1.61, SD = 0.23) were non-significant (*Wald* χ^2 (1) = 0.20, $p = 0.65$). The OR is 0.67 with a 95% CI of (0.11, 3.9) which suggests that differences in physical activity intensity between youth were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 9: Diet quality. When examining the data for normality, two outliers were removed for participant's who reported 57.68% calories from fat (z-score = 4.16) and 53.28% calories from fat (z-score = 3.41). Differences in the average reported percent calories from fat in youth who met criteria for metabolic syndrome (M = 32.87, SD = 5.43) compared to those who did not meet criteria (M = 33.39, SD = 5.59) were non-significant (*Wald* χ^2 (1) = 0.55, $p = 0.46$). The OR is 0.98 with a 95% CI of (0.93, 1.03) which suggests that the differences in reported percent of calories from fat in participant's diets were not associated with greater odds of meeting criteria for metabolic syndrome.

Aim 4: Relationship between Psychosocial Functioning and Metabolic Syndrome

The relationship between psychosocial functioning variables (parent and child report of QOL via Psychosocial and Physical Health scores; parent report of global family functioning; peer victimization, and parent report of child internalizing/externalizing behaviors) and meeting criteria for MetS was examined using eight separate logistic regressions, controlling for BMI z-score (Table 4-9). As there were no significant demographic variables, these were not included in these analyses. Please see Table 4-8 for a comparison of psychosocial variables in youth who meet criteria for MetS (MetS-1) to those who do not meet criteria for MetS (MetS-0).

Model 10a and 10b: Parent report of QOL. Differences in the average psychosocial QOL (parent report) in youth who met criteria for metabolic syndrome (M = 71.43, SD = 15.21) compared to those who did not meet criteria (M = 72.93, SD = 15.35) were non-significant (*Wald* χ^2 (1) = 0.05, p = 0.83). The OR is 0.998 with a 95% CI of (0.98, 1.02) which suggests that differences in the participant's psychosocial quality of life based on parent report were not associated with greater odds of meeting criteria for metabolic syndrome.

Differences in the average physical QOL (parent report) in youth who met criteria for metabolic syndrome (M = 76.21, SD = 19.73) compared to those who did not meet criteria (M = 75.30, SD = 20.10) were non-significant (*Wald* χ^2 (1) = 0.66, p = 0.42). The OR is 1.01 with a 95% CI of (0.99, 1.02) which suggests that differences in the participant's physical quality of life based on parent report were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 11a and 11 b: Child report of QOL. When examining the data for normality, an outlier was removed for a participant who reported a score of 21.67 (z-score = 3.40). Differences in the average psychosocial QOL (child report) in youth who met criteria for metabolic syndrome (M = 74.28, SD = 16.30) compared to those who did not meet criteria (M = 75.31, SD = 14.29) were non-significant (*Wald* χ^2 (1) = 0.02, *p* = 0.90). The OR is 0.999 with a 95% CI of (0.98, 1.02) which suggests that differences in the participant's psychosocial quality of life based on self report were not associated with greater odds of meeting criteria for metabolic syndrome.

Differences in the average physical QOL (child report) in youth who met criteria for metabolic syndrome (M = 78.55, SD = 15.43) compared to those who did not meet criteria (M = 79.67, SD = 15.78) were non-significant (*Wald* χ^2 (1) = 0.01, *p* = 0.94). The OR is 1.001 with a 95% CI of (0.98, 1.02) which suggests that differences in the participant's physical quality of life based on self report were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 12: Peer Victimization. The average level of peer victimization was higher in youth who met criteria for metabolic syndrome (M = 20.85, SD = 8.79) than in youth who did not meet criteria (M = 18.56, SD = 7.45). The results from the logistic regression analysis in Model 12 approached significance (*Wald* χ^2 (1) = 3.52, *p* = 0.06). The OR is 1.03 with a 95% CI of (0.99, 1.08).

Model 13: Global Family Functioning. When examining the data for normality, an outlier was removed for a participant who reported a score of 39 (z-score = 3.64). Differences in the global family functioning score (parent report) of youth who met criteria for metabolic syndrome (M = 20.30, SD = 4.70) compared to those who did not meet criteria (M = 21.21, SD = 4.90) were non-significant (*Wald* χ^2 (1) = 1.36, *p* = 0.24). The OR is 0.96 with a 95% CI of (0.90, 1.03) which suggests that differences in the global family functioning were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 14a: Internalizing behavior problems. Based on parent report of child behavior problems, differences in rates of internalizing behaviors between youth who met criteria for metabolic syndrome (M = 57.14, SD = 9.89) and those who did not meet criteria (M = 56.49, SD = 10.00) were non-significant (*Wald* χ^2 (1) = 0.07, p = 0.80). The OR is 1.00 with a 95% CI of (0.97, 1.04) which suggests that differences in the participant's internalizing behavior problems were not associated with greater odds of meeting criteria for metabolic syndrome.

Model 14b: Externalizing behavior problems. Based on parent report of child behavior problems, differences in rates of externalizing behaviors between youth who met criteria for metabolic syndrome (M = 52.75, SD = 11.24) and those who did not meet criteria (M = 52.13, SD = 9.84) were non-significant (*Wald* χ^2 (1) = 0.20, p = 0.66). The OR is 1.01 with a 95% CI of (0.98, 1.04) which suggests that differences in the participant's externalizing behavior problems based were not associated with greater odds of meeting criteria for metabolic syndrome.

Follow-up Analyses

Metabolic syndrome has been examined in extant literature as both a dichotomous variable (yes or no based on a participant meeting criteria for at least 3/5 symptoms) as well as a continuous variable (total number of symptoms a participant meets criteria for). Results vary based on criteria and definition of MetS used (e.g. Patino-Fernandez, Delamater, Sanders, Brito, & Goldberg, 2008; Ventura et al., 2006). Thus, in order to further explore the potential relationship between: weight status, lifestyle variables, and psychosocial functioning (independent variables); and metabolic syndrome, linear regression analyses were run to examine the impact of the IV's on MetS as a continuous variable. Number of total MetS symptoms (ranging from 0-5) was included as the dependent variable. Additionally, analyses were run to examine the relationship between pubertal status and MetS, controlling for age. Weight status variables (BMI z-score and body fat percentage) were seen to predict increased rates of MetS symptoms (results presented below). All other exploratory analyses were non-significant.

BMI z-score. When examining the relationship between BMI z-score and total MetS symptoms, BMI z-score was found to be strongly associated with total symptoms ($F(1, 191) = 22.77$, $p < 0.000$).

Body fat percentage. When examining the relationship between body fat percentage and total MetS symptoms, body fat was found to be strongly associated with total symptoms ($F(1, 182) = 17.336$, $p < 0.000$).

To further delineate the impact of weight status on metabolic syndrome, participants were re-classified into three groups based on being: 1) overweight- between the 85th and 94th percentile for BMI, 2) obese- between the 95th and 98th percentile for BMI, and 3) 99th percentile and above for BMI. Logistic regressions were run to examine the potential differences in odds of meeting criteria for metabolic syndrome between groups one and two and groups two and three. Please see Table 4-10 for MetS rates by BMI percentile groups.

Overweight compared to obese. Differences between group one (85th-94th percentile) and two (95th to 98th percentile) were not significantly associated with increased odds if meeting criteria for MetS. These findings suggest that having a BMI in the 85^{th}-94^{th} percentile compared to a BMI in the 95^{th}-98^{th} percentile do not significantly increase ones odds of meeting criteria for metabolic syndrome.

Obese compared to 99^{th} percentile and above. Differences between groups two (95^{th} to 98^{th} percentile) and three (>99^{th} percentile) were significantly associated with increased odds of meeting criteria for MetS (*Wald* χ^2 (1) = 4.794, p = 0.03). The OR is 1.96 with a 95% CI of (1.07, 3.57). These findings suggest that differences between having a BMI in the 95^{th}-98^{th} percentile compared to a BMI above the 99^{th} percentile significantly increase ones odds of meeting criteria for metabolic syndrome by 1.96.

Table 4-1. Demographic variables

		N	M	SD	%
Child					
Age			9.9	1.4	
Gender					
	Male	87			44.8
	Female	107			55.2
Race/Ethnicity					
	Caucasian	127			65.5
	African American	27			13.9
	Hispanic	24			12.4
	Biracial/Other	16			8.2
Weight Status					
BMI z-score			2.15	0.38	
Bodyfat %			39.3	7.77	
BMI percentile	85th to 94th	13			6.7
	95th to 98th	91			46.9
	99th and above	90			46.4
Parent					
Relationship to Child					
	Mother	172			88.7
	Father	13			6.7
	Grandparent	7			3.6
	Other	2			1.0
Education Level					
	High School or less	33			17.1
	Advanced Degrees	16			8.3
	Other	144			74.2
Household Income					
	<\$39,999	94			48.7
	\$40,000-79,999	70			42.6
	>\$80,000	29			15.0

N = Number of Participants; M = Mean; SD = Standard Deviation

Table 4-2. Demographic variables: Youth with MetS compared to youth without MetS

		MetS-1	MetS-0
Age		10.0 (1.38)	9.81 (1.51)
Gender	Males	45%	44.6%
	Females	55%	55.4%
Race/Ethnicity	Caucasian	64.9%	66.3%
	Hispanic	14.4%	9.6%
	African American	11.7%	16.9%
	Biracial/Other	9.0%	7.2%
Parent education	High school (HS) or less	18.9%	14.6%
	Some education after HS	71.3%	76.9%
	Advanced degree	9.8%	8.5%
Total family income	<$40,000	50.9%	45.8%
	$40,000-$80,000	32.7%	41.0%
	>$80,000	16.4%	13.2%
Parent health status	Overweight/obese and/or health condition	91.9%	90.4%
	Neither overweight/obese nor health condition	8.1%	9.6%

*$p < 0.05$
**$0.05 < p < 0.10$
MetS-1 = Youth with MetS; MetS-0= Youth without MetS; M = Mean; SD = Standard Deviation

Table 4-3. Demographic variables: Logistic regression analysis summary for the odds of meeting MetS criteria based on demographics

Demographic Variable	Wald χ^2	p	OR*	95% CI
Age (in years)	0.856	0.53	1.10	0.90, 1.34
Gender (males compared to females)	0.004	0.95	0.98	0.55, 1.74
Caucasian compared to African American	0.65	0.41	1.41	0.61, 3.24
Caucasian compared to Hispanic	0.82	0.37	0.66	0.26, 1.64
Caucasian compared to Biracial/Other	0.20	0.66	0.79	0.27, 2.29
Hispanic compared to African American	1.75	0.19	2.15	0.69, 6.70
Hispanic compared to Biracial/Other	0.07	0.79	1.2	0.32, 4.50
Total family income	0.015	0.90	0.99	0.81, 1.20
Parent education	0.62	0.43	0.89	0.67, 1.19
Parent health status (No dx of comorbid condition or overweight/obesity compared to Yes)	0.14	0.71	1.21	0.45, 3.30

*For continuous variables: odds ratio based on a 1.0 unit change; for categorical variables: odds ratio based on the change from lowest through highest categories within the variable.

OR = Odds Ratio; CI = Confidence Interval

Table 4-4. Weight status variables: Youth with MetS compared to youth without MetS

	MetS-1	MetS-0
BMI z-score*	2.21 (0.35)	2.08 (0.42)
Bodyfat %**	40.27 (7.24)	38.04 (8.27)

*$p < 0.05$
**$0.05 < p < 0.10$
MetS-1 = Youth with MetS; MetS-0= Youth without MetS; M = Mean; SD = Standard Deviation

Table 4-5. Weight status variables: Logistic regression analysis summary for the odds of meeting MetS criteria based on weight status

Weight Status Variable	Wald χ^2	p	OR*	95% CI
BMI z-score	5.18	0.02	2.44	1.13, 5.25
Bodyfat percentage	3.69	0.055	1.039	0.999, 1.08

*Odds ratio based on a 1.0 unit change

OR = Odds Ratio; CI = Confidence Interval

Table 4-6. Lifestyle variables: Youth with MetS compared to youth without MetS

	MetS-1	MetS-0
PF: Total laps	8.17 (3.08)	8.53 (3.14)
PA: Energy Expenditure	2298.59 (483.65)	2278.48(531/36)
PA: METS	1.57 (0.21)	1.61 (0.23)
Diet quality: % calories from fat	32.87 (5.43)	33.39 (5.49)

*$p < 0.05$
**$0.05 < p < 0.10$
MetS-1 = Youth with MetS; MetS-0= Youth without MetS; PF = Physical fitness; PA = Physical activity; M = Mean; SD = Standard Deviation

Table 4-7. Lifestyle variables: Logistic regression analysis summary for the odds of meeting MetS criteria based on lifestyle variables

Lifestyle Variable	Wald χ^2	p	OR*	95% CI
Physical fitness (total laps)	0.78	0.38	1.04	0.95, 1.15
PA- Energy expenditure	0.45	0.50	1.00	0.999, 1.001
PA- METS	0.20	0.65	0.67	0.11, 3.90
Diet quality	0.55	0.46	0.98	0.93, 1.03

*Odds ratio based on a 1.0 unit change

OR = Odds Ratio; CI = Confidence Interval; PA = Physical activity; METS= Metabolic equivalent of a task

Table 4-8. Psychosocial functioning variables: Youth with MetS compared to youth without MetS

	MetS-1	MetS-0
Parent report: Psychosocial QOL	71.43 (15.21)	72.93(15.35)
Parent report: Physical QOL	72.61 (19.73)	75.30(20.10)
Child report: Psychosocial QOL	74.28 (16.30)	75.31 (14.29)
Child report: Physical QOL	78.55 (15.43)	79.67 (15.78)
Peer victimization**	20.85 (8.79)	18.56 (7.45)
Global family functioning	20.30 (4.70)	21.21(4.90)
Internalizing behavior problems	57.14 (9.89)	56.49 (10.00)
Externalizing behavior problems	52.75 (11.24)	52.13 (9.84)

*$p < 0.05$
**$0.05 < p < 0.10$
MetS-1 = Youth with MetS; MetS-0= Youth without MetS; PF = Physical fitness; PA = Physical activity; M = Mean; SD = Standard Deviation

Table 4-9. Psychosocial functioning variables: Logistic regression analysis summary for the odds of meeting MetS criteria based on psychosocial functioning

Psychosocial Functioning Variable	Wald χ^2	p	OR	95% CI
Psychosocial QOL-parent report	0.05	0.83	0.998	0.98, 1.02
Physical QOL-parent report	0.66	0.42	1.01	0.99, 1.02
Psychosocial QOL-child report	0.02	0.90	0.999	0.98, 1.02
Physical QOL- child report	0.01	0.94	1.001	0.98, 1.02
Peer victimization	3.52	0.06	1.03	0.99, 1.08
Global family functioning	1.36	0.24	0.96	0.90, 1.03
Internalizing behaviors	0.07	0.80	1.00	0.97, 1.04
Externalizing behaviors	0.20	0.66	1.01	0.98, 1.04

* Odds ratio based on a 1.0 unit change

OR = Odds Ratio; CI = Confidence Interval; PA = Physical activity; METS= Metabolic equivalent of a task

Table 4-10. Percentage of youth meeting MetS criteria by weight status

		MetS-1	MetS-0
BMI percentile	85th to 94th	38.5	61.5
	95th to 98th	50.5	49.5
	99th and above	66.7	33.3

MetS-1 = Youth with MetS; MetS-0= Youth without MetS

CHAPTER 5
DISCUSSION

Review of Findings

The current study is unique in that it examined metabolic syndrome and its relationship with lifestyle, demographic, and psychosocial variables, in an at-risk population. Children who meet criteria for overweight or obese weight status are at greater risk for medical comorbidities (e.g. Type 2 Diabetes and cardiovascular disease) across their lifespan compared to normal weight peers. Children with MetS appear to have an even greater risk (up to 15 fold) of experiencing these medical comorbidities, as many as 10 years after identification of MetS (Steinberger, Daniels, Eckel, Hayman, et al. 2009). The results of the current study highlight the importance of assessing for metabolic syndrome in overweight/obese treatment seeking, rural youth, given its high prevalence rate in our study sample (57.2%). This is one of the first studies to document rates of this magnitude in a school-age population, as similar rates are more typically reported in adolescents (e.g. Rossi Sukalich, Droz, Griffin, et al., 2008). While it is difficult to compare prevalence rates across studies, rates of metabolic syndrome in overweight and obese youth are seen to be as high as 60-70% in some studies (Saffari, Jalilolghadr, Esmailzadehha, Axinfar, 2012; Tailor, et al., 2009). It is important to understand however, that prevalence rates within the same sample may vary widely (up to 25%) based on the definition used (e.g. Olza, Gil-Campos, Leis, Bueno, et al., 2011; Saffari et al., 2012).

When examining extant literature using the definition proposed by Cook and colleagues in 2008, rates in the current study are similar to those reported in the literature (e.g. 44%, 55%, 60.6%, etc.) in overweight/obese children and adolescents

(Cook et al., 2008; El-Koofy, Anwar, El-Raziky, El-Hennawy, et al., 2012; Rossi, et al., 2008). However, the majority of these findings are from adolescent populations (Cook et al., 2008; Rossi et al., 2008). Rates of metabolic syndrome reported in literature using the definition proposed by Cook and colleagues in 2003 range more widely (9.4-58.1%), with lower rates typically reported in overweight or younger youth, and higher rates reported in obese or older youth (e.g. Kim, Lee, Nam, and Lee, 2011; Reinehr, Sousa, Toshke, Andler, 2007; Sangun, Dundar, Kosker, Pingon, Dundar, 2011; Seo, Lee, Lee, 2008; Shalbi & Goran, 2008).

In our sample, youth with higher body fat percentages or BMI z-scores were seen to be at increased odds to have more MetS symptoms or to be identified as meeting MetS criteria, respectively. Furthermore, having a BMI above the 99th percentile was associated with increased odds of meeting criteria for MetS compared to having a BMI in the 95th-98th percentile. Lifestyle, demographic, and psychosocial factors examined were not seen to differ significantly across youth with or without MetS. However, while higher rates of peer victimization were not associated with increased odds of meeting MetS criteria, the differences approached significance. The overall directionality of the majority of current findings, as well as extant literature, indicates a need for further investigation in these domains.

Weight Status

Current significant findings indicate that being of increased weight status is a primary factor which increases ones odds of meeting MetS criteria. Child BMI accounted for 11% of the variance in MetS symptoms. Youth who met criteria for Metabolic Syndrome in our study had an average BMI z-score of 2.21, whereas youth who did not meet criteria had an average BMI z-score of 2.08. This difference of 0.13 in

BMI z-score is consistent with findings in extant literature which show that BMI z-score decreases of similar amounts positively impact metabolic syndrome components. For example, Kirk and colleagues reported that a decrease of 0.15 in BMI z-score sufficiently impacted blood pressure, cholesterol, triglycerides, and insulin in overweight/obese youth (2005). Others have suggested that BMI z-score decreases of 0.18 to 0.25 may be necessary to impact MetS status (e.g. Pedrosa et al., 2011), while still others have indicated that BMI z-score decreases of 0.50 can be comparable to pharmacological treatment in impacting MetS (e.g. Reinehr et al., 2009).

It is important to note that the findings from the extant literature noted above come from examined changes in BMI, and their impact on MetS status, as opposed to examining the baseline differences in weight status within overweight children with or without MetS. Here, consistent with our findings, it has been noted that MetS syndrome risk increases with increased BMI (e.g. Pedrosa et al., 2011, Pratt et al., 2009). One study reported that each unit increase of BMI z-score in an overweight sample is associated with a 2.4 factor increase in the odds of meeting MetS criteria (Patino-Fernandez, Delamater, Sanders, Brito, Goldberg, 2008). Our findings closely replicated these results, with each zBMI increase associated with a 2.44 greater odds of metabolic syndrome. An additional study found that among participants in the top 5% of weight status there was an 11% increase in the prevalence of MetS between moderately obese (38.7%) and severely obese youth (49.7%) (Weiss, et al., 2004). In the current study, 48.5% of the population was at or above the 99^{th} percentile for BMI. Of these participants, 66.7% met criteria for metabolic syndrome. This can be compared to

38.5% of youth with a BMI between the 85^{th}-94^{th} percentile and 50.5% of youth with a BMI between the 95^{th}-98^{th} percentile who met MetS criteria (Table 4-10).

Demographics

In previous research with children and adolescents, being of increased age, male gender, low SES, of Caucasian or Hispanic descent, and having a parent with increased weight status or a comorbid health condition are typically associated with greater risk for MetS (e.g. Cruz et al., 2004; Johnson et al., 2009; Lehman et al., 2005; Pan & Pratt, 2008; Sumner, 2009). While the directionality of demographic differences between youth who did or did not meet criteria for MetS generally were consistent with extant research, current findings were non-significant. This may be due to the homogeneity of the present sample (8-12 years old, living in medically underserved rural communities, as part of a treatment seeking sample) as compared to general population samples (e.g. Pan & Pratt, 2008). For example, literature indicates that higher rates of MetS may be seen in adolescents, a group not examined in the current study. Similarly, the potential relationship between increased age and MetS may be confounded in a study which includes only overweight youth given the increased rates of overweight/obesity seen with increased age (Mirmiran, Sherafat-Kazemzadeh, & Farah, 2010; Ogden et al., 2010). Additionally, while significant racial/ethnic differences were not seen, it is important to examine such findings with caution, as ethnic-specific criteria do not exist for MetS symptoms such as blood pressure and triglycerides, whose norms are inherently different across groups (Moore et al., 2008; Sumner, 2009; Sumner 2012).

Lifestyle Factors

Existing literature clearly indicates the importance of examining lifestyle factors such as diet, physical activity, and physical fitness in youth with metabolic syndrome (e.g. Cassava et al., 2009; Eisenmann, 2007). However, there are inconsistencies with regards to the importance of diet overall versus specific dietary factors, and physical activity versus physical fitness in their associations with MetS (Aeberli et al 2009; Eisenmann, 2007). The results of the current study did not delineate significant differences in odds for meeting MetS criteria based on these variables. Interestingly, when examining diet quality, youth in our sample reported approximately 33% of calories coming from fat in their diets. This is consistent with both national guidelines for school age youth, as well as treatment recommendations for youth with metabolic syndrome (recommending 25%-35% of caloric intake from fats) (Steinberger et al., 2009; U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010). However, it is possible the dietary fat intake seen in the current sample was underreported. Based on joint parent and child-report, overall caloric intake was reported to average 1281.15 (675.99) calories per day. This is likely inaccurate, as dietary intake is often underreported due to self-report bias, with intake more severely underreported in overweight youth (Champagne, Fada, Baker, DeLaney, et al., 2003). Data from the NHANES III indicates that the average energy intake (based on 24-hour diet recalls) ranges from 1,897 calories per day to 2,218 calories per day in children and adolescents (McDowell, Briefel, Alaimo, Bischof, et al., 1994).

Moreover, it is important to note that the average caloric expenditure seen via accelerometry data in the current sample was approximately 2300 calories per day. Accelerometers may over or underestimate caloric expenditure by about 13% in youth; however, these estimates improve when providing anthropometric data such as height and weight to the formula used to calculate caloric expenditure, which was done in the current study (Dorminy, Choi, Akohue, Chen, & Buchowski, 2008; Liden, Wolowicz, Stivoric, Teller, et al., 2002). Therefore, if self-report of dietary intake and accelerometry data for caloric expenditure were both correct; our participants would have had a significant caloric deficit, which is typically associated with weight loss, not increased weight status (e.g. Steinberger et al., 2009). Thus, findings based on diet quality in the current study should be interpreted with extreme caution.

Similarly, findings for physical activity and physical fitness variables may need to be further explored. The average intensity of physical activity performed by our participants was 1.58 (0.22) METS, which is a lower intensity than that associated with light walking (Adams, Caparosa, Thompson, Norman, 2009). The youth in the current study completed an average of 8.15 (3.09) laps on the PACER physical fitness test. This represents roughly the equivalent of completing one level of the test, with the second level of the PACER beginning at lap 9. This average fell below the required minimum of 10 laps which are needed to calculate VO_2max using the PACER, limiting our ability to examine physical fitness using this construct (Cooper Institute for Aerobics Research, 1992). As the majority of youth in the current study presented with very low levels of physical activity and physical fitness, the restricted range impacts our ability to find significant differences between groups. However, these findings highlight the importance of increasing physical activity and fitness in high risk populations given the baseline levels of these variables.

Psychosocial Findings

While it was hypothesized that poorer psychosocial functioning would be associated with increased odds of meeting criteria for MetS in the current study, there were no statistically significant psychosocial findings (although peer victimization approached significance). The psychosocial functioning in the current sample was generally good across groups, which may have impacted our ability to find differences (Table 4-8). Findings in extant literature are mixed with regards to the relationship between psychosocial functioning and Metabolic Syndrome in youth, with consistent findings in adult literature indicating a positive relationship between poor psychosocial functioning and MetS (Goldbacher & Matthews, 2007; Mueller et al., 1998; Toledo-Corral & Goran, 2007). Some research has indicated that a relationship between psychosocial functioning and MetS may not exist, rather, these variables are associated with individual MetS symptoms (e.g. poor glucose tolerance) or with an increasing number of MetS symptoms (Raikkonen et al., 2003, Ravaja et al., 1995). In the current study, when psychosocial functioning was examined in relationship to the number of MetS symptoms on a continuum instead of as a syndrome via a yes/no dichotomous variable, findings from extant literature were not replicated.

When examining the impact of stress on obesity and related comorbidities there are consistent findings based on both physiological biomarkers and self-report data indicating that high levels of stress are positively associated with MetS (e.g. Holmes, et al., 2008; Sen, et al., 2008; Weigensber et al., 2008). Further research is needed to establish a relationship between peer victimization and perceived stress in this population. The current study is novel in that it is the first to examine peer victimization, a construct often associated with stress, in its relationship with MetS. Increased rates of victimization have been seen in overweight populations, and higher rates may be seen in youth with comorbid MetS given the correlation between metabolic syndrome and increased weight status (Fekkes, et al., 2005; Van Cleave & Davis, 2006). In the current study, higher levels of peer victimization were approaching significance in their association with MetS. However victimization levels on average were relatively low in our sample. Future research with a larger sample size, or in a population reporting higher baseline levels of peer victimization is warranted to expand upon current findings.

Strengths and Limitations

There are several limitations in this study that should be taken into account when interpreting its findings. The primary limitation is the lack of consistent diagnostic criteria for metabolic syndrome which can be applied to youth. This is a limitation across pediatric literature, with over 40 definitions of MetS currently in use (Morrison et al., 2008). Several consensus definitions exist (e.g. Cook et al., 2003; Cook et al., 2008, & IDF Task Force on Epidemiology and Prevention of Diabetes, 2007), however they have not been applied consistently in literature. This limits the ability for research findings to be compared, and results in difficulties when attempting to replicate or expand upon previous findings. The current study utilized the most up to date consensus definition from Cook and colleagues, with the criteria for glucose tolerance modified to allow for non-fasting blood analyses, using HBA_1C (2008). While this is a weakness in that it creates an additional definition for metabolic syndrome in the literature, the use of HBA_1C can also be seen as a strength. HBA_1C examines chronic glucose levels over time, which can identify up to 2/3 more adolescents as having Type 2 Diabetes Mellitus who may previously have gone un-identified (International Expert Committee, 2009; l'Allemand-Jander, 2010). The utility of HBA_1C is especially relevant in our sample, as these participants are at increased risk for the development of T2DM and other health conditions.

Limitations also exist specific to the study sample. Participants were part of a treatment seeking sample of youth living in medically underserved rural communities, limiting generalizability. However, participants were sampled from more than ten counties, increasing the variability of the population. The participants examined were between the ages of 8 and 12, and as such, caution should be taken when attempting to generalize or compare findings to younger school-age children or adolescents. In the current sample, 65.5% of the youth were Caucasian, with Hispanics (12.4%), African Americans (13.9%), and Biracial/Other participants (8.2%) making up the remainder of the group. No significant differences by racial/ethnic background were seen. Based on extant literature, one would expect that such differences may be found in a group with a higher representation of Hispanics. Additionally, the individual symptoms (e.g. glucose) examined in metabolic syndrome have norms which are inherently different across ethnicities. Thus, the relationship between these symptoms and later development of health conditions may also differ based on ethnicity (Moore et al., 2008; Ogden et al., 2012; Sumner, 2009; Sumner 2012). For example, African American's have higher rates of T2DM and cardiovascular disease than other ethnic groups, despite being diagnosed with metabolic syndrome less frequently (DeBoer, 2010). One study compared the use of the de Ferranti MetS criteria (2004) to ethnic-specific MetS criteria in African American children, and found that identification increased from 17% to 38%, with an 81% decrease in false negatives when using ethnic-specific cut points (Sharma, Lustig, Fleming, 2011). Given such findings, it may be necessary to develop consistent ethnic norms for MetS prior to investigating potential differences by race/ethnicity (Moore et al., 2008; Sumner, 2009).

Additional limitations exist specific to the study design. All of the psychosocial data, as well as the data on diet quality, was examined via self-report. Self-report measures have the potential of producing biased information. Social desirability factors often result in the underreporting of symptoms (as was most likely seen in our measure of diet quality). Given that the results on the majority of self-report measures of psychosocial functioning were in the sub-clinical range, such bias may have been demonstrated. Alternatively, these measures may not be adequate to capture the specific types of psychosocial difficulties seen in an overweight/obese population, whereas measures created for this population (e.g. “Sizing Me Up” and “Sizing Them Up”, obesity specific quality of life measures) may capture these difficulties (Modi & Zeller, 2008; Zeller & Modi, 2009). While self-report measures have some inherent weaknesses, they allow for an easy and low-cost assessment of information which may not be obtained through behavioral observation, and are of high utility when examining large samples across multiple domains.

An additional limitation was the cross-sectional design used in the current study. While cross-sectional designs can be useful when studying the prevalence of an outcome of interest, data is not provided over the long-term, which can be important when looking at variables which may fluctuate over time (Levin, 2006). Metabolic syndrome in childhood is shown to predict metabolic syndrome in adulthood; however, its overall stability across time points has been questioned (Gustafson, Yanoff, Easter, Brady, et al., 2009; Steinberger et al., 2009). This may be due to differences in diagnostic criteria used across age groups, the lack of sufficient age-normalized data for the individual MetS symptoms, or the inability to account for the impact of changes in pubertal status on physiological factors (Pedrosa et al., 2011). Additionally, the lack of longitudinal data does not allow us to examine potential predictive relationships, such as those which may exist between poor diet and physical activity/fitness, and later diagnosis of metabolic syndrome (Eisenmann, 2007).

It should be noted that the current study also has several strengths. While significant relationships were not seen between most demographic, lifestyle, and psychosocial variables and MetS, this is the first study of its kind to examine the breadth of these relationships in a sample of overweight and obese youth. Previous findings in these domains were primarily extrapolated from adult literature, general population studies, or studies in other chronic illness groups (e.g. Raikkonen, et al., 2003). Additionally, the current study used validated measurements of psychosocial functioning from multiple raters, expanding upon existing literature which relied upon data from single information sources, often using single-item measures. Finally, while the measure of physical fitness was limited in that it did not allow for the calculation of VO_2max, the use of objective measurements of physical activity/ fitness allowed for an examination of lifestyle variables without the weaknesses inherent to self-report assessments.

Future Directions and Clinical Implications

The current study examined demographics, lifestyle behaviors, and psychosocial functioning in their relationship with metabolic syndrome in an overweight/obese treatment seeking sample of rural youth. Future research would benefit from a study design allowing for an examination of these variables longitudinally, in both overweight/obese as well as healthy weight control groups. This would allow for the examination of potential predictive models accounting for the presentation and development of MetS in high-risk populations.

Given that the relationship between peer victimization and MetS in the current study approached significance, it would be interesting to examine both peer victimization as well as physiological markers of stress, to determine their collinearity, as well as their impact on MetS. It has been noted that stress hormones such as cortisol are related to increased visceral adiposity, often seen in patients with high waist circumferences. Additionally, animal models consistently indicate that cortisol plays a mediating role in insulin resistance and T2DM (Holmes at al., 2008; Steinberger et al., 2009). Further research is needed to understand the physiological impact of stress on the development of MetS. Assessments of other chronic and acute stressors (e.g. financial concerns, divorce) may better clarify the relationship between stress and MetS in children. If stress and associated hormones are mediating factors in the development of MetS, it is important to understand peer victimization and other stressful events in overweight/obese youth. Obesity specific measures in psychosocial functioning domains such as stress may further delineate these potential relationships.

The current study utilized an objective measure of physical fitness; however, the participants' poor performance made it difficult to examine this construct using VO_2max to represent cardiorespiratory fitness. Future research may benefit from the use of alternative assessment techniques more feasible for school-age, overweight populations. Unfortunately, other physical fitness assessment techniques which may be applicable in a school-age, overweight population (e.g. cycle ergometer or treadmill tests) typically cannot be administered in the field, and require additional equipment, limiting their feasibility (Ortega et al., 2008). Given the apparent under-reporting of caloric intake seen in the current study, the feasibility of alternative assessment techniques and their validity to examine diet quality (e.g. the gold standard multi-pass 24-hour food recall) should be explored in future research. The 24-hour food recall technique suffers from biases inherent to self-report however, and is less cost-effective than other methods. Extant literature has noted the importance of assessing physical activity/fitness and diet in treating MetS, thus it is imperative to assess these domains as accurately as possible. This may allow for the creation of a MetS phenotype including physiological and lifestyle/demographic components which can be examined over time (Steinberger et al., 2009).

Future research would also benefit from the inclusion of a wider age range of youth. As previously noted, increased rates of metabolic syndrome are typically seen to align with increased rates of obesity in adolescence (Monzavi et al., 2006; Pan & Pratt, 2008). Current prevalence rates for MetS were found to be close to 60%, which are similar to rates typically seen in adolescent populations (e.g. Cook et al., 2008). This is one of the first studies to document rates of this degree in school-age children, and without intervention, these youth may present with higher prevalence with increased age. While psychosocial and lifestyle differences were not seen in the current study when comparing youth with and without MetS, research including adolescents may result in differences more similar to those seen in adult populations due to increased functional disability with age, or the impact of being symptomatic and untreated for a longer period of time. Findings such as these could help to support and direct intervention efforts specific to overweight youth who present with medical comorbidities such as metabolic syndrome.

It will also be important to examine the impact of weight management interventions on metabolic syndrome in overweight youth. At this time literature appears mixed with regards to the impact of behavioral lifestyle interventions on obesity comorbidities. The degree of weight loss or BMI z-score change appears to be a relevant factor in whether these interventions are successful in targeting MetS status (Pedrosa et al., 2011; Reinehr et al., 2009). Alternatively, some research has indicated that behavioral lifestyle interventions can impact MetS status in the absence of, or independent of, a significant weight change (Monzavi et al., 2006; Steinberger et al., 2009). There is a need for further assessment of whether interventions designed to target weight status in youth are also appropriate for addressing medical comorbidities, or if additional or different interventions (e.g. medical management of health factors) are required.

At this time, a debate exists in literature as to the importance of identifying and treating the cluster of symptoms associated with metabolic syndrome together, versus examining and treating the factors individually (Jones, 2006). When identified, treatment for metabolic syndrome is typically similar to that recommended for treating increased weight status (specifically, increasing physical activity while decreasing caloric intake and sedentary behaviors), though treatment components specific to the individual health parameters may be added. For example, pharmacological therapy may be useful for youth presenting as above triglyceride, glucose, or blood pressure criteria to specifically target these symptoms (Steinberger et al., 2009). Additional dietary changes may be recommended specific to which MetS symptoms criteria a child is meeting, for example emphasizing a diet low in saturated and trans fats for youth presenting with high triglycerides (Steinberger et al., 2009). It is not necessary to categorize a child as meeting criteria for MetS to direct the treatment which individually targets health symptoms. However, without treatment as a whole, the MetS phenotype tends to persist and worsen (Pedrosa et al., 2011). It has been suggested that instead of using a dichotomous definition for metabolic syndrome, a more complex system weighing the magnitude of all the risk factors, their interactions, and individual patient characteristics may need to be created (Steinberger et al., 2009). Further research on the relationship between MetS and these factors, such as that done in the current study, is required to create the complex system suggested.

Given that there is not a current unified definition to identify MetS in children and adolescents, it is difficult to fully understand the differences which exist between overweight youth with and without this syndrome. The current study was not able to fully delineate the impact of differences in psychosocial functioning, lifestyle behaviors, or demographics between youth in our sample. Additional research is needed to further examine these differences. However, findings were significant in their confirmation that overweight and obese populations present with high rates of metabolic syndrome, especially in rural communities. Extant literature indicates that adverse effects on health and functioning increase exponentially with increasing numbers of MetS symptoms observed (Steinberger et al., 2009; Wickham, Stern, Evans, Bryan, et al., 2009). Thus, it is imperative to expand upon current and past research to better understand both baseline differences in, as well as the impact of interventions on, overweight and obese youth with or without metabolic syndrome. Such an understanding will allow for allied health professionals to assist these youth in decreasing the health and psychosocial risks seen to be associated with this syndrome in adulthood.

APPENDIX
ADDITIONAL MEASURES

Background Information Form

1. Child's Gender (please circle) _____**Boy** ______ **Girl**

2. Child's age: _______

3. Child's Date of Birth: ____/____/______

4. Child's grade in school: _______

5. Your Gender (please circle) ______ **Male** _____ **Female**

6. Your (parent/guardian's) age: ______________

7. You are the child's (Please check one)….

Mother	_____	Father	_____
Step-Mother	_____	Step-Father	_____
Grandparent	_____	Other Legal Guardian	_____

8. Including yourself, how many adults live in your home: ________________

9. Including your child, how many children live in your home: ________________

10. Which of the following best describes your <u>education</u> through high school?

    _____ I left school before earning a high school diploma or GED →

    If this is your answer, how many years did you complete before leaving? ______Years

    _____ I earned a GED →

    If this is your answer, how many years did you complete before leaving and earning your GED? ______Years

_____ I completed high school and earned a high school diploma

11. Did you complete any schooling or training beyond high school/GED? _____Yes _____ No

If Yes:

11a. Which of the following best describes the highest level of schooling or training you completed beyond high school/GED?

____ Vocational or Trade School diploma or certificate

____ Some college classes but no college degree

____ Associate's degree/2-year college degree

____ Bachelor's degree/4-year college degree

____ Some college or professional school AFTER college graduation

____ Master's degree

____ Doctoral/Professional degree (such as Ph.D., M.D., J.D.)

12. What is your current job status? (Mark the one that best describes you. However, if more than one describes you, mark both).

_____ Not working _____ Employed full-time

_____ Retired _____ Employed part-time

_____ Homemaker, raising children, care for other _____ Disabled, unable to work

_____ Other (Specify): ______________________

13. Which of the statements below best describes your job? If you are not working now, which statement best describes your past job, that is, the job you held the longest? (If you are a homemaker, but works part-time, you should mark both).

_____ Homemaker, raising children, care of others

_____ Managerial, professional speciality

_____ Technical, sales, and administrative support

_____ Service

_____ Operators, fabricators, and laborers,

_____ Other (Specify): ________________________________

14. Which of the following best describes your partner's <u>education</u> through high school?

_____ My partner left school before earning a high school diploma or GED →

If this is your answer, how many years did your partner complete before leaving? ______Years

_____ My partner earned a GED →

If this is your answer, how many years did your partner complete before leaving and earning your GED? ______Years

_____ My partner completed high school and earned a high school diploma

15. Did <u>your partner</u> complete any schooling or training beyond high school/GED?
_____Yes _____ No

If Yes:
15a. Which of the following best describes the highest level of schooling or training <u>your partner</u> completed beyond high school/GED?

____ Vocational or Trade School diploma or certificate

____ Some college classes but no college degree

____ Associate's degree/2-year college degree

____ Bachelor's degree/4-year college degree

____ Some college or professional school AFTER college graduation

____ Master's degree

____ Doctoral/Professional degree (such as Ph.D., M.D., J.D.)

16. What is <u>your partner's current job status</u>? (Mark the one that best describes your partner. However, if more than one describes your partner, mark both).

_____ Not working

_____ Retired

_____ Homemaker, raising children, care for other

_____ Other (Specify): ______________________

_____ Employed full-time

_____ Employed part-time

_____ Disabled, unable to work

17. Which of the statements below best describes your partner's job? If your partner is not working now, which statement best describes your partner's past job, that is, the job your partner held the longest? (If your partner is a homemaker, but works part-time, you should mark both).

_____ Homemaker, raising children, care of others

_____ Managerial, professional speciality

_____ Technical, sales, and administrative support

_____ Service

_____ Operators, fabricators, and laborers,

_____ Other (Specify): _________________________________

18. What is your total family income falls into?

_____ Below $19,999

_____ $20,000 - $39,999

_____ $40,000 - $59,999

_____ $60,000 - $79,999

_____ $80,000 - $99,999

_____ Above $100,000

19. Do you consider your child to be Hispanic or Latino?

____ Yes – Hispanic or Latino *(A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race. The term "Spanish Origin" can be used in addition to "Hispanic" or "Latino")*

_____ No – Not Hispanic or Latino

_____ No Response

20. What race do you consider your child to be? You may choose more than one response.

_____ American Indian or Alaskan Native *(A person having origins in any of the original peoples of North, Central, or South America, and who maintains tribal affiliations or community attachment.)*

_____ Asian *(A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.)*

_____ Black or African American *(A person having origins in any of the black racial groups of Africa. Terms such as "Haitian" or "Negro" can be used in addition to "Black" or "African American.")*

_____ Native Hawaiian or Other Pacific Islander *(A person having origins in any of the original peoples of Hawaii, Guam, Somoa, or other Pacific Islands.)*

_____ White *(A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.)*

_____ Bi-Racial

_____ No Response

21. Do you consider <u>yourself</u> to be Hispanic or Latino?

____ Yes – Hispanic or Latino *(A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless* *of race. The term "Spanish Origin" can be used in addition to "Hispanic" or "Latino")*

_____ No – Not Hispanic or Latino

_____ No Response

22. What race do you consider yourself to be? You may choose more than one response.

_____ American Indian or Alaskan Native *(A person having origins in any of the original peoples of North, Central, or South America, and who maintains tribal affiliations or community attachment.)*

_____ Asian *(A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.)*

_____ Black or African American *(A person having origins in any of the black racial groups of Africa. Terms such as "Haitian" or "Negro" can be used in addition to "Black" or "African American.")*

_____ Native Hawaiian or Other Pacific Islander *(A person having origins in any of the original peoples of Hawaii, Guam, Somoa, or other Pacific Islands.)*

_____ White *(A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.)*

_____ Bi-Racial

_____ No Response

Parent Medical History Form

Parent's Medical History

1. Has a doctor ever told you that you have a heart condition and you should only do physical activity recommended by a physician?

Yes_____ No ______

If yes, please specify: ____

____

____

2. Did a doctor ever say that you had hypertension or high blood pressure? **(Not including high blood pressure only when you were pregnant.)**

Yes_____ No______

If yes, please answer the following:

a. Did you ever take pills for high blood pressure? Yes_____ No ______

b. Do you now take pills for high blood pressure? Yes_____ No ______

3. Did a doctor ever say that you had diabetes or high blood sugar? **(Not including diabetes only when you were pregnant.)**

Yes_____ No______

If yes, please answer the following:

a. Did you ever take pills or insulin for diabetes? Yes_____ No ______

b. Do you now take pills for diabetes? Yes_____ No ______

c. Do you now take insulin for diabetes? Yes_____ No ______

4. Are you currently participating in another weight control program?

Yes_____ No______

If yes, please list the name of the program (s) below:

____

5. Have you previously undergone bariatric surgery? Yes_____ No ______

6. If you are a female, please answer the following questions:

   a. Are you currently pregnant? Yes______ No______

   b. Do you plan on becoming pregnant within the next year? Yes______ No_______

7. Has you ever been diagnosed with a depression, bipolar disorder, an anxiety disorder, schizophrenia or mental illness?

   Yes_____ No_____

   a. If yes, please specify: ____

   ____

8. Did a doctor <u>ever</u> say that you have arthritis?

   Yes_____ No______

9. Did a doctor <u>ever</u> say that you have problems?

   Yes_____ No______

10. Did a doctor <u>ever</u> say that you have metabolic syndrome?

   Yes_____ No______

11. Did a doctor <u>ever</u> say that you have epilepsy or seizures?

   Yes_____ No______

12. Did a doctor <u>ever</u> say that your child has ulcerative colitis or Crohn's disease?

Yes_____ No______

13. Have you ever had a hip or knee replacement?

Yes_____ No______ If Yes, please provide the date: ____________________

14. Are you currently taking any medications?

Yes_____ No_____

a. If yes, please list the medications below:

____

____

____

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BIOGRAPHICAL SKETCH

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