FAT AND FIT? PHYSICAL ACTIVITY AND FITNESS AS PREDICTORS OF QUALITY OF LIFE IN OVERWEIGHT YOUTH

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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The rising rates of childhood overweight and obesity is of great health concern given the associated increased risk of hypertension, diabetes, CVD, and impaired Quality of Life (QOL) compared to normal-weight peers. Researchers have made a “fit and fat” argument, suggesting that obese adults who are more active and fit report higher QOL due to improved physical functioning and health compared to those who are less active or fit. Currently, there is mixed evidence about the role physical activity plays in predicting QOL in children and a dearth of research on physical fitness. The current study examined: (1) the relation between weight status, physical fitness and activity, (2) the relation between weight status and child-reported QOL, (3) the relation between physical activity and fitness with QOL, and (4) physical activity and fitness as moderators between weight status and QOL.

Participants were 96 overweight or obese youth, ages 8-12, participating in a multi-wave obesity intervention study. All data for this study is from baseline data collection. BMI z-score was not significantly associated with physical activity or total QOL. BMI z-score was positively associated with physical QOL, such that as weight status increased, physical QOL decreased. BMI z-scores had a unique relationship with

physical fitness, such that there was a linear decline in fitness as weight status increased and an accelerated decline in fitness for those children who were considered extremely obese. While this finding is significant given the positive association between fitness and both total QOL and physical QOL, fitness was no longer significant once controlling for BMI z-score. Physical activity did not have a significant association with either total or physical QOL. Physical activity and physical fitness did not serve as moderators of the BMI z-score and total QOL or physical QOL relationships.

This study suggests that future interventions for overweight youth may benefit from placing a dual focus on both improved weight status and physical fitness. Future longitudinal research should focus on further examining the current results in order to determine if improvements in weight status or fitness are predictive of improved QOL in overweight and obese children.

CHAPTER 1
INTRODUCTION

Childhood Obesity

Prevalence.

The increasing prevalence of childhood obesity in the United States are of great health concern. Among children and adolescents (ages 2 to 19 years old) from 2007-2008, 31.7% were overweight or obese (i.e., body mass index (BMI) above the 85^{th} percentile for age and gender), while 11.9% were considered obese (i.e., BMI above the 95^{th} percentile for age and gender; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Having one or both parents who are overweight or obese is predictive of childhood risk of obesity (Magarey, Daniels, Boulton, & Cockington, 2003; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). For instance, Magarey and colleagues (2003) found that children between the ages of 8 and 11 years had between a 4.1 and 12.2 higher relative risk of being overweight or obese if one parent was overweight, and between an 8.4 and 26.7 higher relative risk if both parents were overweight, compared to children with normal weight parents. Children who are obese also have a higher likelihood of adult obesity compared to non-obese children (Raitakari, Juonala, & Viikari, 2005; Whitaker et al., 1997). For overweight and obese children ages 8-12 years, the increased probability of overweight (54-86%) and obesity (14-59%) in adulthood is often dependent on age, gender, and BMI percentile in childhood (Guo, Chumlea, & Roche, 2002).

Etiology.

Given the increased prevalence of childhood overweight and obesity, it is important to consider the etiological factors contributing to childhood obesity. Pediatric obesity is due to a wide variety of factors. At the fundamental level, pediatric obesity is due to an imbalance in the energy equation, which suggests that excess body weight is a result of high energy intake that is disproportionate to an individual's energy expenditure (Goran, 2000). What ultimately plays an important role in childhood obesity are a number of environmental factors that influence dietary intake and energy expenditure, including increases in the availability of calorically dense and high-sugar and high-fat foods, increased food portion sizes, parental shaping and modeling of eating behaviors, and changes in technology and transportation that have decreased requirements for physical activity (Birch, 2006; Hill, 2006). It is also important to note that some individuals have different genetic vulnerabilities, acquired medical conditions, or take medication that can leave them at greater risk for obesity (Hill, 2006). The etiology and prevalence of childhood obesity is especially important given the negative health and psychosocial consequences associated with being overweight or obese.

Health Risks.

Researchers have consistently shown the health risks of obesity such as increased risk of hypertension (Freedman, Dietz, Srinivasan, & Berenson, 1999), diabetes mellitus (Wabitsch et al., 2004), hyperlipidemia (Dietz, 1998), insulin resistance (Srinivasan, Myers, & Berenson, 2002), and metabolic syndrome (Freedman et al., 1999; Wickham et al., 2009). Childhood obesity has also been linked to cardiovascular disease risk during adolescence and later life (Garnett, Baur, Srinivasan, Lee, & Cowell, 2007; Raitakari et al., 2005). Children who are overweight have a 2.4 to 12.6 higher likelihood of high cholesterol, triglycerides, or glucose levels compared to normal-weight children (Freedman et al., 1999). Eight-year-old children who are overweight are also seven times more likely than normal-weight peers to have several cardiovascular risk-factors in adolescence, such as having higher fasting glucose, cholesterol, triglycerides, hypertension, and insulin resistance (Garnett et al., 2007). This is particularly important given the increased risk of mortality later in life. Being overweight or obese in adolescence is associated with a 30 to 80% and 30 to 100% increased risk of death in adulthood compared to normal-weight peers for males and females, respectively, with higher risk being associated with higher weight status (Engeland, Bjørge, Søgaard, & Tverdal, 2003).

Psychosocial Risks.

Obese children and adolescents are also at an increased risk of experiencing various psychosocial difficulties. Overweight and obese children are particularly more likely to encounter problems such as peer victimization (Janicke et al., 2007; Janssen, Craig, Boyce, & Pickett, 2004), poorer self-esteem (McClure et al., 2010), body dissatisfaction (Davison, Markey, & Birch, 2003), and parental distress (Davis, Davies, & Priest, 2008), all of which are associated with significantly poorer child-self report and parent-proxy report of quality of life (Janicke et al., 2007).

Quality of Life

Weight Status and Quality of Life.

Given the negative health and psychological consequences associated with higher weight status, children and adolescents who are overweight or obese are more likely to report impaired quality of life than their normal-weight peers (Pinhas-Hamiel et al., 2006; Williams, Wake, Hesketh, Maher, & Waters, 2005). Health-related quality of life (QOL) is a concept referring to a multidimensional approach for assessing self-perceived well-being across several domains including overall, physical health, emotional, social, and school functioning (Varni, Burwinkle, Seid & Skarr, 2003).

Compared to normal weight peers, children and adolescents who are obese are between 2 and 5.5 times more likely to report poorer quality of life in both physical and psychosocial domains than their normal-weight peers, and report QOL similar to that of children with cancer (Friedlander, Larkin, Rosen, Palermo, & Redline, 2003; Schwimmer et al., 2003; Zhang et al., 2008). While the literature has demonstrated the association between weight status and QOL in large samples of both healthy individuals and those with chronic health conditions, the literature is less clear on differences in QOL within overweight and obese populations. Shoup and colleagues (2008) found that very obese children and adolescents (i.e., above the 95.6th percentile) reported significantly lower physical and psychosocial quality of life compared to those who were overweight.

Psychosocial Predictors of Quality of Life.

The literature suggests that there are a number of psychosocial variables that may be associated with poorer QOL in overweight and obese youth. Youth who are overweight or obese are more likely to report higher depressive symptoms (Zeller & Modi, 2006) and poorer self-esteem (Friedlander et al., 2003; Stern et al., 2007) than normal-weight peers. Increased weight-related teasing and peer victimization are associated with poorer self-esteem and poorer QOL (Stern et al., 2007). Higher parental stress is associated with lower parent-proxy reports of QOL in children (Guilfoyle, Zeller, & Modi, 2010), which is significant given that parent reports of child QOL are oftentimes utilized and can influence health care use and assessment (Guilfoyle et al., 2010).

Physical Activity and Physical Fitness

While there is often a focus of psychosocial predictors of QOL in overweight youth, health behaviors such as physical activity and physical fitness likely also play an important role not only in future health risk, but also self-reported QOL. Activity and fitness are at times used interchangeably; therefore, it is important to distinguish between the two. Physical activity refers to the engagement in body movement that result in increased energy expenditure, while physical fitness is an indicator of an individual's capacity to engage in prolonged vigorous physical activity (Ortega, Ruiz, Castillo, & Sjöström, 2008). Common methods for assessing physical activity in youth include retrospective self-report measures and the use of accelerometers, while assessment methods for physical fitness include a treadmill run test, muscle strength and flexibility, and the 20-meter shuttle run.

Weight Status, Physical Activity, and Physical Fitness.

Having a higher weight status in childhood is associated with low physical activity (Blair & Church, 2004; Dowda, Ainsworth, Addy, Saunders, Riner, 2001; Ortega et al., 2008; Soric & Misigoj-Durakovic, 2009) and poorer physical fitness (Ara, Moreno, Leiva, Gutin, & Gasajús, 2007; Eliakim et al., 2002; Suminski, Ryan, Poston, & Jackson, 2004) when compared to those children of lower weight status. Energy expenditure in overweight children is approximately 45% less than that of normal-weight peers, especially during the weekend (Soric & Misigoj-Durakovic, 2009). This is a significant concern as engagement in physical activity is an important predictor of long-term weight status in children. Specifically, children who engage in physical activities such as sports are significantly less likely to be overweight during adolescence than children who are less active (Dowda et al., 2001). In child populations, there is also a strong association between level of physical fitness and weight status. Even within an overweight and obese population, children who are more fit are more likely to have lower fatness levels than unfit children (Ara et al., 2007; Nassis, Psarra, & Sidossis, 2005). In longitudinal intervention programs, children who receive treatment aimed to increase fitness exhibit more improved weight status when compared to a control group (Eliakim et al., 2002).

Demographic Differences in Activity and Fitness.

Levels of physical activity and fitness in children appear to differ based on demographic factors, such as age and gender. Older children are significantly less likely to engage in physical activity compared to younger children (Nyberg, Nordenfelt, Ekelund, & Marcus, 2009; Trost, Pate, Freedson, Sallis, & Taylor, 2002). Researchers have also found sex differences in physical activity engagement, with boys participating in more physical activity than girls (Dowda et al., 2001; Nyberg et al., 2009; Soric & Misigoj-Durakovic, 2009). Some studies have found that boys are also more likely to be more physically fit than girls (Lindquist, Reynolds, & Goran, 1999; Suminski et al., 2004), with boys completing more laps and running faster than girls on a 20-meter shuttle run test. However, other researchers have found no significant sex differences in physical fitness (Manios, Kafatos, & Codrington, 1999) or have found smaller sex differences when using objective measures of physical activity (Trost et al., 2002). Also, sex differences in physical activity shrinks with age, as boys have a larger decline in physical activity as they get older than girls (Telama & Yang, 2000). Given the mixed findings for gender differences in fitness, further research is necessary to examine these differences. Some research indicates that ethnic and racial minority adolescents are less likely to be physically active than whites (Felton et al., 2002; Gordon-Larsen, McMurray, & Popkin, 1999); however, there are mixed findings on racial/ethnic differences in childhood. Some researchers found no differences (Lindquist et al., 1999; Pate et al., 1997; Troiano & Flegal, 1998), while other researchers found that some racial/ethnic minorities such as non-Hispanic Blacks (Anderson, Economos, & Must, 2008) and Hispanics (Sallis et al., 1993) engaged in less physical activity than whites.

Relationship of Activity and Fitness to Psychosocial and Health Risks.

Improvement in an individual's level of physical activity and fitness play a significant role in lowering the psychosocial and health risk factors that are associated with high weight status (Ortega et al., 2008). Specifically, researchers have suggested that increases in physical fitness can assist in improving an individual's levels of depression, anxiety, and general mood status (Ortega et al., 2008). Physical activity and fitness are also important in physical health in individuals, irrespective of weight status. Older adolescents who are less fit are 3 to 6 times more likely to develop diabetes, hypertension, and metabolic syndrome than those who are more fit (Carnethon et al., 2003). However, Blair and Church (2004) argued that physical activity is a "common denominator" for helping improve low fitness and high weight status in individuals, suggesting that physical activity is the important variable to target in interventions.

In adult populations, engagement in physical activity and being more physically fit is associated with a significantly lower risk of cardiovascular disease (Giannini, Mohn, & Chiarelli, 2006; Wessel et al., 2004). Being unfit is associated with higher relative risk of death in both normal weight (3.1 RR) and overweight (4.5 RR) individuals when compared to those who are fit and of normal weight, even after controlling for other cardiovascular risk factors (Wei et al., 1999). Interestingly, overweight and obese men who are fit have much lower risk for death compared to men who are of normal weight and unfit (Wei et al., 1999), suggesting that fitness is a more important predictor of negative health consequences than weight status. If physical activity and/or fitness are more important than weight status in health outcomes in children, they may also explain the QOL differences that we see in this population. However, currently there are inconsistent findings on QOL differences within overweight and obese samples of individuals. This study adds to the literature by examining the relationship between physical activity, physical fitness, and QOL more closely in a sample of overweight and obese children.

Physical Activity, Physical Fitness and Quality of Life

Given the positive physical benefits of being active and fit, activity and fitness may positively impact on an individual's mood (Ortega et al., 2008) and self-perceived well-being (i.e., quality of life) in overweight children and adolescents (Chen et al., 2005; Shoup et al., 2008). However, there is currently a dearth of research in the role that activity plays in childhood quality of life. The little research that does exist has mixed findings (Boyle, Jones, & Walters, 2010; Chen et al., 2005; Shoup et al., 2008). Boyle and colleagues (2010) found that while higher BMI was associated with significantly lower levels of average daily minutes of physical activity, activity was not a significant predictor across any of the domains of quality of life. Contrary to the previous study, Chen and colleagues (2005) found that less engagement in physical activity predicted poorer childhood quality of life, even after controlling for weight status. It is important to note that less than one quarter of the sample was overweight or obese in the Boyle et al. study (2010) and that while Chen and colleagues (2005) specified that they controlled for weight status, they did not report the BMI of children in their sample. Other researchers (Shoup et al., 2008) have found that within an obese sample of children, those who did not meet recommendations for 60 minutes of daily physical activity reported significantly lower physical quality of life than children who did.

Several methodological issues in the studies examining the role of physical activity should be considered when evaluating these findings. All of the studies were cross-sectional, limiting their ability to make causal statements or determine whether changes in physical activity predict QOL improvement (Boyle et al., 2010; Chen et al., 2005; Shoup et al., 2008). Only Shoup et al. used objective measures of physical activity (i.e., accelerometers), while the other studies used less-reliable self-report measures of physical activity frequency and/or duration (Boyle et al., 2010; Chen et al., 2005). However, the Shoup et al. study categorized the activity data, which removed sample variability in this measure. While two of the studies used a validated measure of QOL (i.e., PedsQL 4.0; Boyle et al., 2010; Shoup et al., 2008), Chen and colleagues (2005) used a measure of QOL that had low reliability and validity (i.e., with some kappa coefficients being at .50).

While there are several studies examining the role of physical activity in predicting childhood QOL, there is scant research examining the relationship between physical fitness and quality of life in child populations. Kriemler and colleagues (2010) found that after a school-based physical activity intervention for both overweight and non-overweight children, children displayed improved weight status, level of daily physical activity, and physical fitness; however, there were no significant changes in total or physical QOL. Due to the limited research or mixed findings in the literature, the impact of physical activity and fitness on the QOL in overweight and obese youth is still unclear. Bringing greater clarity to the role that activity and fitness play in health and QOL outcomes will help in determining which areas should receive greater focus in future interventions for overweight or obese youth.

Researchers on quality of life in adults have more consistent findings on the relationship between QOL and physical activity (Peterson et al., 2006; Ross et al., 2009). In the area of physical activity, some researchers have suggested that the positive association between activity and quality of life is dependent upon the intensity of the activity (Blacklock, Rhodes, & Brown, 2007). This suggests that engagement in physical activity will not help to maintain or increase quality of life unless individuals engage in moderate to vigorous activities.

There are similar findings in adult literature on the association between fitness and QOL. Researchers have suggested a “fit and fat” argument, which proposes that those who are overweight and physically fit would see less of a negative impact on their QOL than those who are less fit but of normal weight. In older adults, those who are more physically fit are more likely to report better mood and higher QOL than those who were less fit (Stewart et al., 2003). Other researchers have suggested that levels of physical fitness are more likely to impact physical health domains of QOL (Bennett et al., 2008; Ross et al., 2009). In longitudinal research, improvements in fitness predict significant increases in physical functioning in overweight adults, even after controlling for change in BMI (Ross et al., 2009). When examining health outcomes, researchers have found that obese adults who have high cardiovascular fitness have a lower likelihood of cardiovascular disease and death than those individuals who are of normal weight and unfit (Blair & Church, 2004; Wessel et al., 2004). These findings in the adult literature suggest that, even within an overweight and obese sample, the level of physical fitness plays a significant role in both physical health and QOL. Given the mixed findings and scarce amount of literature in this area in child overweight populations, there remain many unanswered questions.

Purpose and Summary

The purpose of the current study was to address the limitations within the existing literature on weight status, physical activity, and fitness as predictors of QOL in overweight and obese child populations. While researchers have found differences in QOL depending on weight status (Friedlander et al., 2003; Pinhas-Hamiel et al., 2006; Zhang et al., 2008), the association between weight status and QOL is currently less clear in populations of exclusively overweight or obese individuals (Pinhas-Hamiel et al., 2006; Shoup et al., 2008). Moreover, the literature is considerably scarce in the examination of physical activity and fitness as predictors of QOL in child overweight populations. The few studies that do exist have mixed findings or methodological issues, such as subjective reports of activity and less valid measures of QOL. This lack of research on physical activity and fitness is noteworthy given the role they play in long-term physical health and how informative they may be in child weight management interventions. Therefore, this study attempts to extend the literature by examining the relationship between QOL, physical activity, and physical fitness in a sample of overweight and obese youth by using objective measures of physical activity and physical fitness. Specifically, the aims and hypotheses are as follows:

Aim 1

The first aim of the study was to describe the relationship between weight status (i.e., as expressed by BMI z-score) and physical activity and physical fitness.

Hypothesis 1. It was hypothesized that in this overweight and obese sample, child weight status would be negatively associated with physical activity and physical fitness, such that children with a higher weight status would be less physically active and fit than their peers who were less obese.

Aim 2

The study's second aim was to examine the relationship between weight status and both total and physical QOL in treatment seeking overweight and obese youth.

Hypothesis 2. It was hypothesized that weight status would be negatively associated with child total and physical QOL, such that children with a higher weight status would report lower QOL than children of lower weight status.

Aim 3

The third aim was to examine the relationship between levels of physical activity and fitness with child-reported total and physical QOL.

Hypothesis 3. It was hypothesized that within this sample of overweight and obese children, those who participated in more physical activity and were more physically fit would report higher total and physical QOL that children who were less active and fit.

Aim 4

The last aim of the study was to determine whether physical activity and fitness served as moderators of the proposed relationship between BMI z-score and both total and physical QOL.

Hypothesis 4. It was hypothesized that physical activity and fitness would serve as protective factors of the negative impact that higher weight status had on total and physical QOL.

CHAPTER 2
METHODS

Participants

Participants were 96 overweight or obese children between the ages of 8 and 12 years old and their parent or legal guardian attending their baseline appointment as part of their participation in a behavioral weight management program for overweight and obese youth. A trained member of the research team measured each child's height and weight in order to verify weight status and eligibility for the study. Children were considered eligible for the current study if they were accompanied by their parent or legal guardian, resided in a rural Florida county, and if they were considered overweight or obese. In this study, overweight was classified as a child being at or above the 85^{th} percentile in Body Mass Index (BMI) for age and gender, while participants were considered obese if their BMI was at or above the 95^{th} percentile. Children who were identified as having severe developmental delays, taking medication for weight loss, or participating in another weight management program were excluded from participation.

Procedures

The current study uses data from a larger grant-funded intervention study, the Extension Family Lifestyle Intervention Project (E-FLIP for Kids). Recruitment for participants living in rural counties in north-central Florida was conducted through direct mailings to households and health-care providers, press releases to local radio stations, and through brochure distribution to local schools, churches, and community organizations and events. Interested families were able to contact the research office through a toll-free phone number in order to learn more about the study and complete the initial phone screening. Families who met the initial eligibility criteria were scheduled for an in-person initial screening visit, followed by a pre-study baseline assessment visit at their local Cooperative Extension office to complete the assessment measures.

At the initial in-person screening visit, trained study personnel provided families with information about the research study before obtaining written child assent and parent or legal guardian consent for themselves and their child. At the baseline visit, both parents and children completed a series of questionnaires and physical assessments. Time to complete the questionnaires and physical assessments during their baseline visit was approximately 75 minutes. The baseline visits occurred approximately 5 to 10 days before the start of the intervention.

Measures

Pediatric Quality of Life Inventory.

The Pediatric Quality of Life Inventory (PedsQL 4.0; Varni et al., 2003) is a 23-item general QOL instrument to assess self-perceived well-being across physical, social emotional, and school dimensions. Children rated how difficult specific situations or behaviors were for them in the previous month on a 4-point scale, ranging from “0” (Never) to “4” (Almost Always). An example statement is, “It is hard for me to walk more than one block.” The measure produces three summary scores: a total scale score, a physical health score, and psychosocial health score (i.e., social, emotional, and school). The focus of the current study was to examine physical health in overweight children and therefore utilized the total and physical health scores of the PedsQL. Higher scores indicated higher self-perceived quality of life in those domains. The PedsQL 4.0 has excellent reliability, clinical validity, and is practical to use in large community-based samples (Varni et al., 2003). It demonstrated adequate construct validity when distinguishing a healthy sample from acutely and chronically ill children, as well as acceptable internal consistency reliability for both the Total Score (alpha=0.91) and Physical Health Score (alpha=0.82) for child self-report for children ages 8 to 12 years (Varni et al., 2003).

Height and Weight.

A trained member of the medical staff measured the children's height to the nearest 0.1 centimeter using a Harpendon Stadiometer. Weight was measured to the nearest 0.1 kilogram using a digital scale. Height and weight were used to calculate child BMI. BMI z-scores were calculated for the children using the modified LMS method from the Center for Disease Control and Prevention (Kuczmarski et al., 2002). The LMS procedure provided parameter estimates of lambda (L), mu (M), and sigma (S) for each age (in months) for males and females, which allows for smoothing of the BMI curve in order to calculate BMI z-scores (Kim et al., 2005; Kuczmarski et al., 2002).

20-meter Shuttle Run.

Trained members of the research team measured children's current levels of physical fitness through a 20-meter shuttle run test. Children were asked to run in between two orange cones on a flat smooth surface, either outside or inside to music and beeps on a CD. The beeps on the CD indicated when the children should reach the next cone, with the frequency of beeps gradually increasing over time. In order to ensure understanding of instructions, a facilitator modeled one to two laps alongside the child. Children were asked if they had any questions or needed further practice prior to beginning the shuttle run test. Children ran to the pace of the beeps on the CD until they could no longer maintain the pace, as assessed by the children not reaching the cone in the required amount of time on two non-consecutive laps. The fitness test was not conducted if a child had a fever, an ankle or leg injury, or if their blood pressure was over 140/100. While $VO_{2\ peak}$ (i.e., also known as $VO_{2\ max}$) is considered the gold standard in fitness assessment, the 20-meter shuttle run is considered a reliable and valid estimate of $VO_{2\ peak}$ in children (Artero et al., 2010; Mahoney, 1992). The number of laps completed by each child was used as the measure of fitness for analysis in this study.

Accelerometer.

Children were instructed to wear a Sensewear Armband Accelerometer (Bodymedia, Inc., Pittsburgh, PA) for 24 hours per day for seven consecutive days at the start of treatment (i.e., prior to making behavioral changes), except when bathing or swimming. The Sensewear armband was worn on the back of their upper arm, opposite of the hand they write with. The accelerometer was an objective measure of the children's physical activity expenditure, has about a 90% accuracy in detecting energy expenditure (Liden et al., 2002), and is considered the "go to" device due to its high reliability and validity (Liden et al., 2001). While studies examining the validation of the armband have reported the mean BMI of their sample that include overweight children (e.g., Andreacci, Dixon, Dube, & McConnell, 2007), they often have not specified the number of overweight or obese children in the study and have not examined validation separately from normal-weight children.

For the analyses in the current study, average daily minutes of physical activity was used, which was assessed using time spent in activity that was more than 3 METs (i.e., metabolic equivalents for moderately intense activity). Data was obtained from the accelerometers using the SenseWear Professional Software, version 7.0. In order to include data in the study, children needed to wear the accelerometer for at least 3 weekdays and 1 weekend day for at least 16 hours of each of those days. This criteria is consistent with previous research and with suggestions to maintain reliability of at least 0.80 (Trost, Pate, Freedson, Sallis, & Taylor, 2000).

Parents or legal guardians completed the following measures:

Demographic Information.

Parents completed a questionnaire of background information at the time of their initial screening visit. Collected background demographic information that was used for the current study included child race and ethnicity, child age, and household income.

Data Analysis

In order to describe the sample, descriptive statistics (means, SDs) were calculated for demographic variables, child BMI z-scores, physical activity, physical fitness, and quality of life (i.e., total QOL and physical health summary score). Next, the primary variables were examined for normality using histograms and the Kolmogorov-Smirnov test. Physical fitness, total QOL, and physical QOL were found to be non-normal, so they were transformed and normalized prior to conducting the analyses. More specifically, total QOL, physical QOL, and physical fitness were square root transformed, while physical activity was log transformed. Once transformed, any individual cases in the regressions that had a standardized residual in excess of 3 were removed from the analyses. Removal was due to the possible distortion of the relationship between the independent and dependent variables.

Correlation analyses were used to determine if there were age or sex differences in the independent or dependent variables, and an analysis of variance (ANOVA) was used to determine if there were ethnic/racial differences. Any significant demographic differences were accounted for in later analyses. Subsequently, correlation analyses were used to examine the relationship between weight status (BMI z-score), physical activity, physical fitness, and child reported quality of life. Hierarchical regressions were conducted as follow-up analyses to significant correlations between independent and dependent variables in order to further examine the relationship between those variables. Any demographic variables that were significantly associated with total or physical QOL were entered into block 1, followed by the independent variables in block 2. In order to investigate whether physical fitness or physical activity served as moderators of the relationship between weight status and quality of life, a regression with centering approach was used for each moderator variable (Preacher, Curran, & Bauer, 2006).

CHAPTER 3
RESULTS

There were 171 children enrolled in the study that completed study questionnaires at baseline. However, 25 children dropped out of the study prior to the first treatment session and 6 children did not complete the fitness test. Of the remaining 140 children who were given an accelerometer during the first session of treatment, 44 of the children did not wear the armband for the required amount of time for useful data analysis. Thus, 96 participants were used in the analyses for the current study. There were no significant differences in demographics, physical fitness, total QOL, or physical QOL in those who did and did not have enough physical activity data to be included in the analyses.

The final sample consisted of 96 children (55 girls, 41 boys) between the ages of 8 and 12 years (M=10.55, SD=1.4). The sample was primarily obese, with the mean BMI being 28.38 kg/m^2 (SD=5.37) and the mean BMI z-score being 2.13 (SD=0.4). The sample consisted of 55 girls (57.3%) and 41 boys (42.7%). The majority of the sample was Caucasian (61.5%) and approximately 30% of the sample was African-American or Hispanic. The median family income ranged from $40,000 to 59,999. Demographic information for the sample is presented in Table 3-1.

Preliminary analyses for the study included examining possible significant demographic differences across either the independent (i.e., BMI z-score, physical activity, or physical fitness) or dependent variables (i.e., total and physical QOL). Child age was negatively correlated with physical activity (r= -0.22, $p<.01$), with increasing age being associated with less physical activity. There were no other significant demographic differences in the independent or dependent variables. Additional information of the variable intercorrelations is shown in Table 3-2 and the sample's means and standard deviations for the independent and dependent variables are displayed in Table 3-3.

The first aim of the study was to describe the relationship between BMI z-score and both physical activity and fitness. While BMI z-score was not significantly correlated with physical activity (r= -0.13, p >.05), it was negatively associated with physical fitness, such that children with higher weight status were significantly less physically fit (r= -0.42, p<.01). Follow-up regression analyses were conducted in order to further examine the relationship between BMI z-score and physical fitness. BMI z-score had both a significant linear (t(93)= -4.42, R^2=.172, p<.001) and quadratic (t(92)= -2.161, ΔR^2=.038, p=.033) relationship with fitness. This finding indicates that there is a linear decline in fitness as weight status increases, but for those who are considered extremely obese (i.e., BMI z-score > 2.0), there was an accelerated decline in fitness. Results can be seen in Table 3-4 and Figure 3-1.

The second aim of the study was to examine the relationship between weight status and both total and physical QOL. There was no significant association between weight status and total QOL (r= -0.14, p>.05) within this treatment seeking overweight and obese sample. However, having a higher BMI z-score was associated with significantly lower child reports of physical QOL (t(93)= -2.712, R^2=.073, p=.008). As weight status increased, there were significant declines in child-reported physical QOL (see Table 3-5).

The third aim of the study was to examine the association that physical activity and fitness had with total and physical QOL. Physical activity was not a significant correlate of either total (*r*= -.03, p >.05) or physical QOL (*r*=.05, p >.05). Fitness, on the other hand, was positively associated with both total QOL (*r*=0.21, *p*<.05) and physical QOL (*r*=0.21, *p*<.05). However, when controlling for child BMI z-score, fitness was no longer associated with either total ($t(92)=1.579$, $R^2=.026$, $p=.118$) or physical ($t(92)=.991$, $R^2=.01$, $p=.324$) QOL (see Tables 3-6 and 3-7).

The fourth aim of the study was to determine whether physical activity or fitness served as moderators of the relationship between weight status and both total and physical QOL. Neither physical activity nor fitness served as moderators in the current study. There were no centered main effects or interactions for any of the analyses, except for the centered main effect of BMI z-score in relation to physical QOL (see Tables 3-8 through 3-11).

Table 3-1. Demographic characteristics of sample.

	Mean	SD
Child Age	10.55	1.42
Child BMI	28.38	5.37
BMI z-score	2.13	0.40
		%
Gender		
	Boys	42.7
	Girls	57.3
Child Race/Ethnicity		
	Caucasian	61.5
	African-American	15.6
	Hispanic	14.6
	American Indian	1.0
	Biracial	7.3
Median Family Income		
	Below $19,999	16.3
	$20,000-$39,999	31.5
	$40,000-$59,999	22.8
	$60,000-79,999	16.3
	$80,000-$99,999	6.50
	Above $100,000	6.50

SD, Standard deviation

Table 3-2. Intercorrelations of predictor variables and QOL.

Measure	1	2	3	4	5	6	7	8	9
1. BMI z-score									
2. Child Age	-0.09								
3. Family income	-0.05	-0.06							
4. Gender	-0.10	-0.09	-0.36						
5. Race	-0.01	-0.21*	0.15	-0.04					
6. Physical activity	-0.13	-0.22*	0.20	-0.19	0.17				
7. Physical fitness	-0.42†	0.08	-0.02	-0.03	0.09	0.23*			
8. PedsQL total score	-0.14	0.16	0.07	-0.02	-0.05	-0.03	0.21*		
9. Physical summary score	-0.27†	0.08	0.07	-0.06	0.05	0.05	0.21*	0.80†	

PedsQL, Pediatric Quality of Life Inventory
*p<.05
† p<.01

Table 3-3. Mean QOL scores, physical activity, and physical fitness.

	Mean	SD	Range
Quality of Life			
PedsQL total score	73.89	14.58	30.43 to 96.74
Physical health summary score	77.64	15.10	37.50 to 100.0
Physical Activity (Avg min/day)	120.49	68.89	31.50 to 431.0
Physical Fitness (# laps completed)	7.99	3.31	1.00 to 17.00

PedsQL, Pediatric Quality of Life
SD, standard deviation

Table 3-4. BMI z-score in relation to child levels of physical fitness.

	B	SE B	β	ΔR^2
Constant	4.173	.292		
Linear BMI z-score	-.655	.135	-.451†	.203
Quadratic BMI z-score	-.544	.252	-.196†	.038

†*p*<.01

Table 3-5. Weight status in relation to child-reported physical quality of life.

	B	SE B	β	R^2
Constant	6.917	.925		
BMI z-score	-1.159	.427	-.271†	.073

†*p*<.01

Table 3-6. Physical fitness and child-reported total quality of life, controlling for weight status.

	B	SE B	B‡	R^2
Step 1				.022
Constant	5.793	.862		
BMI z-score	-.572	.398	-.148	
Step 2				.048
Constant	3.790	1.530		
BMI z-score	-.258	.442	-.066	
Fitness	.480	.304	.180	

‡*p*’s >.05

Table 3-7. Physical fitness and child-reported physical quality of life, controlling for weight status.

	B	SE B	β	R^2
Step 1				.073
Constant	6.917	.925		
BMI z-score	-1.159	.427	-.271†	
Step 2				.083
Constant	5.556	1.656		
BMI z-score	-.945	.479	-.221*	
Fitness	.326	.329	.111	

**p*=.051
†*p*<.01

Table 3-8. Physical activity as a moderator between weight status and total quality of life.

	B	SE B	β‡	R^2
Constant	4.579	.160		.025
BMIz (centered)	-.576	.402	-.149	
Activity (centered)	-.134	.316	-.044	
BMIz*Activity	.341	.822	.043	

‡ *p*-values >.05

Table 3-9. Physical activity as a moderator between weight status and physical quality of life.

	B	SE B	β‡	R^2
Constant	4.474	.171		.087
BMIz (centered)	-1.11	.429	-.260*	
Activity (centered)	.096	.337	.029	
BMIz*Activity	1.11	.877	.127	

**p*=.011

Table 3-10. Physical fitness as a moderator between weight status and total quality of life.

	B	SE B	β‡	R^2
Constant	4.588	.166		.050
BMIz (centered)	-.258	.432	-.067	
Fitness (centered)	.473	.290	.182	
BMIz*Fitness	.186	.567	.033	

‡ *p*-values >.05

Table 3-11. Physical fitness as a hypothesized moderator between weight status and physical quality of life.

	B	SE B	β	R^2
Constant	4.440	.180		.084
BMIz (centered)	-.919	.468	-.215*	
Fitness (centered)	.353	.314	.123	
BMIz*Fitness	-.045	.615	-.007	

*p=.053

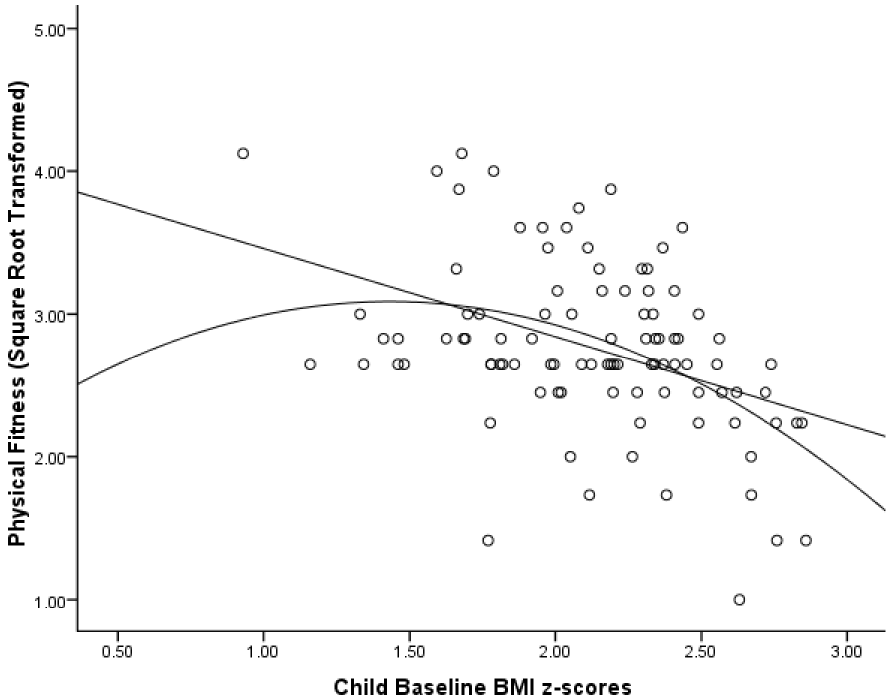

Figure 3-1. Linear and quadratic relationship between weight status and physical fitness.

CHAPTER 4
DISCUSSION

Childhood overweight and obesity is linked to significantly higher risk of health problems, adult mortality, and lower quality of life (QOL; Engeland et al., 2003; Freedman et al., 1999; Friedlander et al., 2003). Therefore, it is important to examine possible protective factors that could be a focus of current interventions. Being physically active and fit is predictive of a significantly lower risk of health difficulties associated with being overweight or obese (Carnethon et al., 2003; Garnett et al., 2007; Ortega et al., 2008). However, little research has been conducted on the impact that activity and fitness have on QOL in overweight or obese children (Boyle et al., 2010; Chen et al., 2005; Kriemler et al., 2010; Shoup et al., 2008). Given that childhood overweight is likely to extend into adulthood (Guo et al., 2002; Whitaker et al., 1997) and that fitness and activity impact health and QOL in adult populations (Hulens et al., 2002; Peterson et al., 2006; Ross et al., 2009; Stewart et al., 2003), it is essential that further research be conducted in this area for child populations. The current study extends the literature in this area by utilizing more objective measures of physical activity and fitness (i.e., through the use of accelerometers and 20-meter shuttle run, respectively) and examining the association they have with both overall (total) and physical health domains of QOL in a strictly overweight and obese treatment seeking sample of children.

The composition of the sample is an important consideration when interpreting the results of the study. Participants in the study were primarily obese, with approximately ninety percent of the sample being obese. Although there was a significant restriction of range in weight status, there was still excellent diversity in the remaining demographics in our sample. Slightly more than half the sample included girls and approximately 38% of the sample consisted of ethnic and racial minorities.

Even in this weight restricted sample of children, higher weight status was associated with lower physical QOL. This finding is important in further demonstrating the negative association between weight status and QOL in physical domains in an overweight and obese sample of children. Children in our sample reported lower total QOL (M=73.9, SD=14.6) when compared to a published normative study with healthy, acutely ill, and chronically ill samples of children (Varni, 2001), but lower physical QOL (M=77.6, SD=15.1) only when compared to the healthy sample of children. The fact that the overweight and obese children in our sample reported significant impairments in overall functioning compared to children with acute and chronic health conditions sheds further light onto the negative impact that weight status has on children's well-being.

There were less consistent findings when comparing this sample to other reports of QOL in published studies with overweight or obese children. Specifically, children in this study reported significantly higher total and physical QOL when compared to the findings of Schwimmer and colleagues (2003). While children in this study did not differ from children in other obese samples on total QOL (Janicke et al., 2007; Pinhas-Hamiel et al., 2006), there were mixed findings in the physical domain. Physical QOL in our study was not different from what was found in one study (i.e., Janicke et al., 2007), but was significantly higher than that of another (i.e., Pinhas-Hamiel et al., 2006). Thus, in samples of strictly overweight and obese children, there are less consistent findings of child-reported QOL, especially in the physical domain.

There are two important matters to consider when comparing our sample to the Schwimmer et al. (2003) and Pinhas-Hamiel et al. (2006) studies. First, the mean BMI z-score for our study was much lower than that of the Schwimmer study (i.e., M=2.14 and M=2.6, respectively). Therefore, it is likely that we found such significant differences in QOL between the two samples due to greater variability of weight status in our sample. Second, children participating in the Schwimmer study were physician referred, and a subset of the sample in the Pinhas-Hamiel study was recruited from hospital clinics. Therefore, the poorer QOL reported in those samples is likely a reflection of higher weight status and more health concerns than our sample.

Interestingly, BMI z-score had a unique relationship with physical fitness. As other studies have found (Ara et al., 2007; Nassis et al., 2005), there was a linear decline in fitness as weight status increased. However, a distinct finding in our study was the accelerated decline in fitness for those children who were considered extremely obese (i.e., z-score above approximately 2.0). To our knowledge, this is the first study to report on this unique relationship between child BMI z-score and physical fitness. This accelerated decline in fitness for those obese individuals has significant implications into the functional limitations these children may face. Functional limitations associated with childhood obesity suggest that both weight status and fitness are important targets for intervention. By addressing these markers of health, children will be better able to engage in basic everyday activities and improve upon their health.

For children in this study, having low fitness levels was associated with significantly lower total and physical QOL compared to those who were more fit. To date, there is only one previous study to examine the association between fitness and

QOL (Kriemler et al., 2010). In the adult literature, improvements in fitness are predictive of improved physical functioning, even after controlling for change in BMI (Ross et al., 2009). However, once controlling for child weight status in our sample, fitness was no longer significantly associated with either total or physical QOL. This is contrary to what Ross and colleagues (2009) found in adult populations, but similar to what was found in child populations (Kriemler et al., 2010). Given the dearth of research on this area in child populations, our study is unique and informative for future interventions. Certainly future research is needed before definitive conclusions can be drawn.

In the current sample, the overall fitness level of the children was poor. The median number of laps completed in the shuttle run test was seven, which is far below a age and gender-based normative sample. For instance, a 12-year-old female who is considered obese (i.e., 95% percentile in BMI) would need to run at least 46 laps (i.e., 9-minutes running) on the fitness test in order to fall in the “healthy fitness zone” (Cooper Institute, 2010). Because fitness levels were extremely low in our overweight and obese sample of children, future interventions may benefit from placing a dual focus on improved weight status and physical fitness, especially given that these are both important markers of health in adulthood (Giannini et al., 2006; Wei et al., 1999).

BMI z-score was not significantly associated with physical activity in our study. One possible explanation for the lack of a relationship found in our study is that the sample engaged in much more physical activity overall than expected. Children in the sample averaged approximately 2 hours of daily physical activity, which is more than the recommended 60 minutes of daily physical activity for children (Centers for Disease

Control [CDC], 2010). While it appears that the children are obtaining adequate levels of activity, these activity levels consisted primarily of moderate physical activity (i.e., 3 to 6 METs). The CDC (2010) currently recommends that children engage in vigorous physical activity (i.e., > 6 METs) 3 days per week as part of the daily activity recommendations. Children in the current study engaged in an average of 5.35 minutes of vigorous activity per day (i.e., after excluding a single outlier of 67.25 average minutes), which was consistent with the poor fitness levels of this sample. This finding is significant given that vigorous activity is also an integral component of physical health and activity recommendations in children. Researchers in adult literature have suggested that the positive impact of physical activity might be more likely to be found when individuals engage in more vigorous levels of activity (Blacklock et al., 2007). This has significant clinical implications for weight management interventions for children. The current study suggests that future interventions for overweight youth may benefit from placing more of a focus on increasing vigorous physical activity and improved fitness.

Older children in our study were less likely to be physically active than younger children, which was consistent with previous research (Nyberg et al., 2009; Trost et al., 2002). These age-related differences in physical activity may be due to increased time spent with peers as children get older. Physical activity and physical fitness did not serve as moderators of the BMI z-score and QOL relationship in our study. Therefore, neither activity nor fitness explained the relationship between higher weight status and QOL in our study.

There are several strengths and limitations to the current study. Strengths of the study include the use of objective assessments of physical activity and fitness, as well as the use of a validated measure of child QOL. The main limitation of the study is the cross-sectional design that limits our ability to make causal statements in our results. A second limitation of our study is that given the low mean number of laps completed, we could not validly estimate $VO_{2\ peak}$ for a majority of the children, as at least ten completed laps are needed to calculate $VO_{2\ peak}$ (Cooper Institute, 2010). Therefore, the number of laps completed was used in the analyses of our study, which was not ideal compared estimating the "gold standard" VO_{2max}. A third limitation of the study was the use of 1-minute sampling intervals for the accelerometers to obtain activity data. Previous researchers have argued that the utilization of 1-minute intervals to estimate energy expenditure instead of 10-second intervals tends to underestimate vigorous activity in children (Rowlands, 2007). Clinically, this suggests that use of 1-minute epochs may underestimate any changes in vigorous activity in intervention studies. Also, this suggests that examination of the association between the intensity of physical activity and QOL is less reliable with the use of 1-minute epochs. Therefore, it is important to use the more reliable 10-second interval to estimate energy expenditure in treatment studies targeting physical activity and when examining QOL outcomes. A final and significant limitation in our study is the number of participants (i.e., N=44) that were excluded due to the lack of adequate physical activity data. While this suggests that there were possible biases impacting the findings of the study, there were no significant differences between those who did and did not have enough activity data.

Future research should focus on strengthening the results of the current study. More specifically, research would benefit from further examining the intervals used in accelerometer measurement and whether samples of overweight children continue to display inadequate levels of vigorous physical activity when 10-second intervals are used. Given the increasing rates of obesity and the decreasing levels of physical activity and fitness in children, research would also benefit from the validation of the 20-meter shuttle run for individuals running less than 10 laps in order to enable researchers to reliably estimate VO_{2max}. Also, future weight management studies would benefit from examining changes in weight status, physical activity, and physical fitness in order to determine if improvements are predictive of improved QOL in overweight and obese children. This next step in research could inform future interventions and shed light on whether changes in physical activity and fitness are more important methods for improving physical and psychosocial health in overweight and obese children.

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BIOGRAPHICAL SKETCH

Danielle is a second year graduate student in the Clinical and Health Psychology Program at the University of Florida, with a concentration in pediatric psychology. She completed her bachelor's degree in psychology at the University of Missouri in 2009. During her undergraduate education, she worked with several faculty members on research projects including cognitive aging in older adults and the relationship between family functioning and juvenile delinquency. Danielle is currently involved in working on a family-based weight management program for overweight children residing in rural counties in Florida. She is also working on a study examining the association between disease severity, behavior health factors, psychosocial functioning, and quality of life of adolescents with inflammatory bowel disease.