

Physical activity, quality of life, and weight status in overweight children

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Abstract

Purpose This cross-sectional study aimed to investigate the relationship between health quality of life, physical activity, and overweight status in children aged 8–12 years old.

Study participants Participants ($n = 177$ overweight boys and girls) completed a validated quality of life (QOL) inventory and wore an accelerometer to objectively measure physical activity for 1 week.

Methods Centers for Disease Control and Prevention's standardized growth charts were used to categorize participants as overweight ($M_{\text{BMI}\%} = 95.6$) or obese status ($M_{\text{BMI}\%} = 99.0$) while accelerometer data was used to categorize participants as meeting or not meeting the recommended guidelines for physical activity.

Results Psychosocial, physical, and total QOL (all $P < 0.05$) were significantly lower for obese when compared to overweight participants. Less physically active children, irrespective of weight status, had significantly lower psychosocial and total QOL (all $P < 0.05$).

Conclusion Physical activity promotion in overweight and obese children may have additional benefits to weight management that include improving QOL.

Keywords Child obesity · Quality of life · Exercise

Abbreviations

QOL	Quality of life
KPCO	Kaiser Permanente Colorado
BMI	Body mass index
PEDS QL	The pediatric quality of life inventory 4.0
MET	Metabolic equivalent
ANOVA	Analyses of variance

Introduction

The physical and psychological health outcomes associated with being overweight as a child are well known. Being overweight increases a child's risk of developing type 2 diabetes, hyperlipidemia, elevated blood pressure, sleep apnea, and asthma [1]. Many of these diseases—previously considered to be adult onset diseases—are now appearing in young adults and children [2]. Contributing to the burden of overweight in children are the psychosocial aspects associated with overweight such as self-esteem, peer interactions, social interactions, depression, shame, and decreased self-confidence [3]. Childhood obesity does not singularly affect the overweight child; its impacts are globally seen in the social, economic, and psychological environment surrounding the child [3, 4].

An important aspect of childhood that may be greatly impacted by the state and outcomes of being overweight is a child's quality of life. Quality of life (QOL) can be defined as a multidimensional construct that reflects one's self-perceptions of enjoyment and satisfaction with life [5]. Assessing childhood QOL can provide insights into a child's self-rating of physical, psychosocial, and overall functioning [6, 7]. In addition, overweight children report significantly lower quality of life than their healthy-weight counterparts [6–9].

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For example, Freidlander et al. [8] found that overweight children had significantly lower scores on psychosocial, physical functioning, and global health-related quality of life when compared to healthy-weight children. Similar findings from another study concluded that overweight children were over five times more likely to report poor quality of life scores when compared to healthy-weight children [6]. Finally, a recent study of severely overweight children demonstrated significantly lower quality of life related to physical functioning and social domains [9].

While there has been a consistent relationship between being an overweight child and lower perceptions of quality of life, much less is known about quality of life and physical activity in the context of overweight children. Regular physical activity has a positive influence on a number of quality of life domains in adults [10–12]. In fact, regular physical activity may buffer the negative impact of obesity or other health conditions have on quality of life in adults [13, 14]. There is some support that children who participate in regular physical activity are more likely to rate their QOL positively than children who never participated in physical activity [15].

Unfortunately, research to date has been associated with crude assessments of both physical activity and QOL outcomes. Specifically, no study has combined the use of a validated and multidimensional conceptualization of QOL and an objective and validated assessment of physical activity. In addition, there is a paucity of research that examines the extent of overweight, its relationship with QOL, and the potential benefit of physical activity. That is, as children are more overweight does QOL continue to decline and does meeting the recommended guidelines for physical activity influence that relationship? The primary purpose of this cross-sectional study was to explore the relationships between objectively assessed physical activity, weight status, and QOL, as measured by the PEDs QL for overweight boys and girls between the ages of 8 and 12 years old. We hypothesized that QOL across psychosocial and physical domains would be rated more favorably by overweight boys and girls who participated in the recommended amount of physical activity for 60 min [16] or more each day as compared to those who did not meet physical activity recommendations.

Method

Design and procedures

The data collected for this study reflect the baseline assessments for participants enrolled in a larger randomized controlled trial conducted to determine the efficacy of alternative strategies which support healthful weight

management for overweight children. All assessments were completed prior to randomization or application of intervention content. Kaiser Permanente Colorado (KPCO) Institutional Review Board Approval was obtained for this study and all study participants signed the appropriate forms including parental consent, child assent, and authorization for use of medical records. Potential participants were identified via an electronic medical record or pediatrician referral. Referrals could be made to any child with a body mass index (BMI) ranking for age and gender at or above the 85th percentile (the current Centers for Disease Control and Prevention classification of overweight), while the electronic medical record was used to identify children at or above the 95th percentile (the current Centers for Disease Control and Prevention classification of obese). The participants completed a brief survey, were measured for height and weight, and given an accelerometer (i.e., an objective measurement tool to assess daily physical activity) to wear for 7 days. Families were instructed to have the child wear the accelerometer upon awaking and continuously wear it until going to bed at night, unless they were bathing, swimming, or participating in other water sports.

Participants

Two hundred and twenty KPCO child members between 8 and 12 years of age with a BMI at or above the 85th percentile for their age began the larger study. As physical activity was not a primary outcome for the larger study, children were able to opt out of the accelerometer component of the study; as a result 177 children with complete physical activity and QOL data participated in the study. There were no differences between the children who agreed and those who declined to wear the accelerometer on weight, BMI, self-reported physical activity, quality of life or the majority of sociodemographic variables (e.g., race, gender). The only significant difference was that those who declined to wear the accelerometer were slightly older (11.2 versus 10.6 years).

Measures

Demographic information was obtained through medical chart information and parent reports. The child's age and sex were retrieved from their medical charts and verified by parents. Race and ethnicity information was completed by the participants' parents.

Quality of life

The Pediatric Quality of Life Inventory 4.0 (PEDS QL), a 23-item questionnaire for children, was used to assess

QOL. The PEDS QL measures health-related QOL with three major composite assessments—psychosocial, physical, and total QOL. In repeated reliability and validity tests, the PEDS QL has consistently had high reliability scores ($\alpha = 0.71 - 0.89$) and has also been able to distinguish between healthy children and those with chronic diseases [5]. This measure was scored using a five-point scale (0 = never; 1 = almost never; 2 = sometimes; 3 = often; 4 = always). These items were then reverse scored on a scale of 1–100 (i.e., 0 = 100, 1 = 75, 2 = 50, 3 = 25, and 4 = 0). A mean score was computed for psychosocial and physical QOL. These dimensions were averaged to provide a total QOL score.

Physical activity

Accelerometers (model 7164; Actigraph LLC, Pensacola, FL) were used to objectively assess moderate to vigorous intensity physical activity. Participants wore the accelerometer for 7 days. Based on recommendations associated with using accelerometers in children [17], all children in this study wore the accelerometer for at least 4 days of 8 or more hours each (on average children wore the accelerometer for 6 days). This model of accelerometer has demonstrated validity and inter-rater reliability for various activities [18]. The metabolic equivalent (MET) calculation used for children between the ages of 6 and 18 is as follows: $METs = 2.757 + (0.0015 \times \text{counts/min}) - (0.0896 \times \text{age}) - (0.000038 \times \text{counts/min} \times \text{age})$, where moderate physical activity is defined as $4 \leq MET < 6$ and vigorous physical activity is defined as $6 \leq MET$. The MET calculation by Trost and colleagues, which calculates moderate and vigorous energy expenditure counts in children based upon their age, was used to determine average daily minutes of physical activity [19]. Because there are significant benefits that are achieved by children meeting recommended guidelines for physical activity, the data were reduced to reflect children that were either meeting recommended guidelines for physical activity (i.e., >60 of moderate to vigorous activity daily) [20] or not.

Body mass index

Height was measured to the nearest 1/8 inch using a stadiometer, and weight was measured to the nearest 1/4 pound using a medical scale, calibrated regularly with a 25-pound calibration weight. Standardized BMI scores were calculated based on the value of the 50th percentile BMI ranking and the standard deviation attributable to appropriate age and gender samples from the Centers for Disease Control and Prevention growth charts [21]. Using a

statistical program available through the Centers for Disease Control and Prevention to allow for more precision in BMI in children, we calculated the BMI percentage attributable to each individual participant. In addition, international standards based on BMI data from six industrialized nations suggest that there may be a clinical differences between children who are overweight and those who are obese [22]. However, specific cut points to distinguish overweight from obese children are not yet available for a US sample. Children were categorized into overweight or obese status using a median split on BMI percentile ranking. This split resulted in an overweight group (average BMI 24.1 kg/m² and 95.6 percentile) and obese group (average 30.3 kg/m² and 99%) that approximate the BMI characteristics of overweight and obese adults.

Statistical analyses

For the primary analyses, physical activity and weight status were used as independent variables while physical, psychosocial, and total QOL scores were used as dependent variables. We used SPSS version 14.0 (Chicago, IL) for the analysis. Children were categorized as either meeting or not meeting the recommended guidelines for physical activity based on accelerometer data (i.e., at least 60 min of moderate to vigorous physical activity daily) [23]. In addition, children were categorized into overweight or obese status. Frequencies were calculated by weight status for gender, race, and ethnicity. Similarly, mean and standard deviation scores were calculated for age, BMI percentile ranking for age and gender, minutes of moderate to vigorous activity, and QOL scores for physical functioning, psychosocial functioning, and total QOL scores. Univariate analyses of variance (ANOVA) were used to test for main and interactive effects of physical activity and weight status on QOL dimensions. Finally, a series of regression analyses were completed to determine the potential differential role of moderate versus vigorous physical activity.

Results

Just over half of the recruited children were boys (55%) and the average age of the participants was 10.6 (± 1.4) years old. Two-thirds of the participants were white (65%) and approximately one-quarter of the participants were Latino (24%). The sample had an average BMI percentile ranking for age and gender falling at 97.2 (± 2.4).

In addition, approximately 40% of the participants were meeting the recommended guidelines for physical activity.

Table 1 includes descriptive statistics of the study variables based on the entire sample and by categorizations of physical activity and weight status.

Children who were categorized as overweight or obese did not significantly differ from one another in age, ethnicity, or gender. However, chi-square analyses demonstrated that girls were less likely than boys to meet the recommended guidelines for physical activity ($\chi^2 = 5.75$; $P < 0.05$), whereas younger children were more likely to meet these guidelines than older children ($F(1, 176) = 50.25$; $P < 0.01$). Hispanic and non-Hispanic children did not differ in terms of level of physical activity.

Table 2 shows the mean scores for each QOL domain in each weight and physical activity categorization. Participants in the obese category had significantly lower psychosocial QOL than those in the overweight category ($F(3, 173) = 6.5$, $P < 0.05$). Similarly, participants who were not meeting the recommended guidelines for physical activity reported significantly lower psychosocial QOL than those who were meeting recommended guidelines ($F(3, 173) = 9.19$, $P < 0.05$). However there was no interaction between the relationships of weight and physical activity status with psychosocial QOL.

Physical QOL was also lower for participants in the obese category when compared to those in the overweight category ($F(3, 173) = 15.0$, $P < 0.05$) and for the participants not meeting the recommended physical activity guidelines when compared to participants who were ($F(3, 173) = 9.0$, $P < 0.05$). The interaction between weight and physical activity status approached significance ($F(3, 173) = 3.7$, $P = 0.057$), suggesting that children who were overweight demonstrated higher physical QOL if they were meeting the recommended guidelines, while those who did not demonstrated lower physical QOL. In contrast, obese children did not seem to demonstrate the same benefit of whether they achieved the recommended guidelines or not.

When total QOL was used as the dependent variable, the pattern of results was nearly identical to that found for psychosocial QOL. Specifically, participants in the obese category had significantly lower total QOL than those in

Table 2 Mean scores of QOL domains by physical activity and weight status

	QOL domain		
	Psychosocial	Physical	Total
Met physical activity recommendations			
Overweight ($n = 35$)	81.1 (11.8)	88.4 (12.0) ^a	82.9 (11.2)
Obese ($n = 34$)	74.3 (13.0)	74.5 (17.2)	74.4 (13.4)
Did not meet physical activity recommendations			
Overweight ($n = 57$)	73.2 (17.4)	76.5 (16.2)	74.0 (15.7)
Obese ($n = 51$)	67.9 (16.2)	71.8 (16.2) ^b	68.9 (14.9)

Values shown are mean (SD)

a > b, $P < 0.05$

the overweight category ($F(3, 173) = 9.7$, $P < 0.05$). Participants who were not meeting the recommended guidelines for physical activity reported significantly lower total QOL when compared to those who were meeting recommended guidelines ($F(3, 173) = 10.6$, $P < 0.05$). There were no interactions between weight status and physical activity in relation to total QOL.

Linear regression analyses that examined the relationships between the number of weekly minutes of moderate and vigorous physical activity with quality of life were not significant regardless of physical activity intensity.

Discussion

This is the first examination of the relationships between a multidimensional and validated conceptualization of QOL, weight status in overweight and obese children, and objectively assessed physical activity. In general, we found support for national trends similar to healthy-weight children, in that overweight and obese boys were more active than girls, and that the proportion of children meeting the recommended guidelines for physical activity decreased with age [24].

The findings also extend the previous literature examining QOL in overweight and obese children in two general

Table 1 Descriptive statistics for study variables across physical activity and weight status categories

	Total sample	Not meeting PA Rec.	Meeting PA Rec.	<i>P</i> value	Overweight	Obese	<i>P</i> value
<i>N</i>	177	108	69		92	85	
BMI percentile ranking	97.2 (2.4)	97.2 (2.1)	97.2 (2.8)	NS	95.6 (2.4)	99.0 (0.5)	<0.05
Daily minutes moderate & vigorous PA	56.0 (26.1)	35.3 (12.7)	77.4 (19.4)	<0.05	58.6 (29.6)	53.7 (22.2)	NS
Psychosocial quality of life	73.4 (15.8)	70.7 (16.9)	77.7 (12.8)	<0.05	76.2 (15.9)	70.5 (15.2)	<0.05
Physical quality of life	77.1 (16.6)	74.3 (16.2)	81.5 (16.3)	<0.05	81.1 (15.8)	72.9 (16.5)	<0.05
Total quality of life	74.4 (14.9)	71.6 (15.5)	78.7 (13.0)	<0.05	77.4 (14.8)	71.1 (14.5)	<0.05

Values shown are mean (SD); PA rec. = physical activity recommendations; NS = not significant

ways. First, a number of previous studies have documented lower QOL in overweight children when compared to healthy-weight children [6, 9]. Our findings suggest that there are even disparities in QOL for children who vary in the degree to which they are considered overweight (i.e., overweight versus obese). Second, meeting the recommended guidelines for physical activity seems to be positively associated with QOL in children ages 8–12 years, confirming other studies in adults [10–12] and children [15]. Regardless of the degree of overweight in a child, perceptions of physical, psychosocial, and total QOL were higher for children who were meeting physical activity recommendations when compared to those who were not. Interestingly, meeting the recommended guidelines seems important for this relationship to occur as there was a lack of linear relationship between physical activity (regardless of intensity) and QOL.

It is of note that approximately 40% of the participants in this study were meeting the 60 min of daily moderate to vigorous intensity physical activity guidelines. Although this level of physical activity may seem high in comparison to national data [24], it is lower than the prevalence within Colorado (where the study was conducted), where 54% of children under 14 years of age meet physical activity recommendations [25]. As such, it may be expected that the rate of physical activity recommendation achievement is lower in a sample of overweight and obese children when compared to the prevalence across the local population.

There are a number of strengths and limitations of this study. The strengths include the use of objective physical activity assessment, a validated multidimensional assessment of QOL for children, and objectively assessed height and weight. In addition, the study is the first to examine the variance of QOL for overweight compared to obese children and the interplay between weight status and physical activity when considering QOL outcomes. The primary limitation of the study is a cross-sectional design that does not allow for determining the causality of these relationships or the temporality of the relationship between QOL, physical activity, and weight status.

There are also a number of paths for future research in the area of physical activity, weight status, and QOL. Of primary interest is the causality of the relationships detected in this study. The examination of changes in weight and physical activity status as predictors of changes in QOL would be a logical next step in this research. There is also an emerging body of literature demonstrating the need for more comprehensive theory related to QOL in adults [26], which could also be generalized to a need for theory development in children. In particular, understanding QOL from a social ecological perspective that includes personal psychological, physical, and behavioral predictors

of QOL as well as social and physical environmental factors is another fruitful area of investigation.

Related to this point, it is clear that within the US definition of overweight, there are differential QOL perceptions for children with a high BMI (i.e., 30) when compared to those with a lower BMI (i.e., 24). This adds to the body of literature that suggests there are additional, and appropriate, clinical categories of overweight and obese children that may not be captured using the current system of percentile rankings as the cut points for unhealthy childhood weight [22]. This study seems to support that basing distinctions of the extent children are overweight by age-specific BMI ratings has some validity when considering QOL.

In summary, this study provides evidence that physical activity can have a positive relationship with psychosocial and total QOL in overweight and obese children. Conversely, obese children may not receive the physical QOL benefits achieved in overweight children. We conclude that physical activity promotion in overweight children can be used not only as a modality of reducing body weight, but also as an exploratory hypothesis in future prospective trials in testing its rigor for improving QOL.

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