

Physical Activity, Physical Fitness, and Health-Related Quality of Life in School aged Children

Bhagyajyoti. Meti

Abstract

This study examined the association between physical activity (PA), physical fitness, and health-related quality of life (HRQOL) among school-aged children. Methods: Participants were 201 children (91 boys, 110 girls; Mage = 9.82) enrolled in one school in the Karnataka. Students' PA (self-reported PA, pedometer-based PA) and physical fitness (cardio respiratory fitness, muscular fitness, flexibility, and body composition) were assessed in the fall. The PedsQL4.0 (Varni et al., 2001) was used to assess participants' HRQOL (physical and mental function) in the spring. Results: PA and four components of physical fitness were positively associated with physical and mental function. Path analyses suggested physical fitness mediated the relationship between self-reported PA and HRQOL (95% CI: 53, 1.48), as well as between pedometer-based PA and HRQOL (95% CI: [.54, 1.53]). Discussion: Results support the conclusion that enhancing children's physical fitness can facilitate positive outcomes including improved health related quality of life.

Keywords: BMI, VO₂max, muscular fitness, elementary students, mental health

Introduction

Obesity has reached an epidemic level in the pediatric population, which conveys an increased risk of obesity later in life (Fogelholm, 2010). Over the past half century researchers have provided evidence that being physically inactive or unfit has major negative health consequences throughout the lifespan (Ortega, Ruiz, Castillo, & Sjörström, 2008; Sallis et al., 2012). Health professions recommend that school-aged children should accumulate at least 60 min of daily moderate-to vigorous physical activity or achieve a certain number of steps per day (15,000 steps for boys and 12,000 steps for girls; Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009; U.S. Department of Health and Human Services [USDHHS], 2008). Although the physical and mental health benefits of regular physical activity (PA) participation have been well documented (Janssen & LeBlanc, 2010; Ströhle, 2009), it is estimated only 23% of school-aged children meet minimum recommended activity levels, and children's PA actually declines with age (Tremblay et al., 2014).

Increasing PA and physical fitness is often proposed as a critical way to prevent childhood obesity and is effective in enhancing individuals' mental health (Morales et al., 2013; Ströhle, 2009). PA and physical fitness are closely related in that physical fitness is mainly determined by PA patterns over weeks or months. Physical fitness in children and adolescents is considered an important indicator of health-related outcomes (Ortega, Ruiz, Castillo, & Snowstorm, 2008) and is conceptualized as an integrated measure of cardio respiratory fitness, muscular fitness, flexibility, and body composition. Furthermore, low levels of physical fitness during childhood track into adulthood and are a threat to both the short- and long-term health of young adults (Ruiz et al., 2009; USDHHS, 2008). A systematic review (Fogelholm, 2010) provided evidence that individuals with high body mass index (i.e., BMI ³30) and good aerobic fitness had lower risk for all-cause and cardiovascular mortality, compared with individuals with normal BMI and poor fitness, suggesting that aerobic fitness is a more important influence than BMI. In contrast, individuals who

are physically active with high BMI exhibit a greater risk for cardiovascular disease and diabetes, compared with individuals who have normal BMI with low physical activity. However, an early study reported that fitness interacted with PA habits such that highly fit individuals who do not regularly participate in PA have a poorer mental health status than all others (Thirlaway & Benton, 1992). To date, a few studies have considered the concomitant influences of both PA and physical fitness concurrently on children's mental health (Morales et al., 2013). There is a growing use of health-related quality of life (HRQOL) as a measure of individual physical and mental health over time, including physical, emotional, social, and school functioning (Varni, Seid, & Kurtin, 2001). HRQOL is a subset of quality of life used to measure an individual's perception of health. This is an important element in determining the health benefits of various interventions for clinicians, researchers, and patients. Research on PA and HRQOL has primarily focused on elderly populations with chronic conditions such as cardiovascular disease, arthritis, and cancer (Chyun et al., 2006; Smith & McFall, 2005), and on general adult populations without health impairments (see reviews, Bize, Johnson, & Plotnikoff, 2007). Those studies showed that individuals with lower levels of PA are more likely to have a lower quality of life. In recent years, some pediatric studies were designed to examine the HRQOL of overweight and obese children and adolescents (Dalton, Schetzina, Pfortmiller, Slawson, & Frye, 2011; Swallen, Reither, Haas, & Meier, 2005; Tsiros et al., 2009). Researchers found that BMI is negatively associated with HRQOL, and HRQOL is frequently worse for females than for males (Bisegger, Cloetta, Von Rueden, Abel, & Ravens, 2005; Swallen et al., 2005). When examining BMI and PA in combination, a recent study indicated that PA emerges as the important correlate of HRQOL among adults, regardless of weight status (Herman, Hopman, Vandekerckhof, & Rosenberg, 2012). Recently, researchers also suggested that both PA and physical fitness may have a combined and accumulative effect on the improvement of HRQOL among older adults (Brovold, Skelton, Sylliaas, Mowe, & Bergland, 2014). The effect of PA and all components of physical fitness including body composition, cardiorespiratory fitness, muscular fitness, and flexibility on HRQOL in children, however, has received significantly less attention as compared with adults (Morales et al., 2013; Padilla-Moledo et al., 2012). Morales and colleagues (2013) provided the primary evidence of the relationship between fitness and HRQOL in children, and found the association between excessive body composition and HRQOL almost disappears when controlling for cardiorespiratory and musculoskeletal fitness. To date, only one study has examined HRQOL among school-aged children with normal weight in relation to their PA measured objectively with accelerometers. Gu and colleagues (2014) found PA was positively associated with physical, emotional, and social functioning of HRQOL in middle school students. Conversely, Morgan and colleagues (2008) found that there was no relationship between PA and HRQOL among obese children aged 5–9 years. To our knowledge, very few studies have examined the relationship between PA, physical fitness, and HRQOL among healthy school-aged children. Researchers also highlighted that identifying the role of PA and physical

Fitness on school-aged children's physical and mental health has important public health implications (Blair, Cheng, & Holder, 2001; Fogelholm, 2010). Schools provide a unique avenue for nearly 56 million youth in the U.S. to be involved in daily physical activities and develop appropriate levels of health-related fitness (Sallis, McKenzie, Beets, Beighle, Erwin, & Lee, 2012). An important goal of school physical education (PE) is to develop physically literate children who have the skills, knowledge, positive attitudes, and confidence to enjoy a physically active lifestyle (National Association for Sport and Physical Education [NASPE], 2013; Sallis et al., 2012). Therefore, improving PA and HRQOL are identified as major priorities for school PE and are also major goals of Healthy People 2020 (USDHHS, 2011). Despite growing concerns regarding increasing overweight and physical inactivity and their likely effects on health-related outcomes, students' PA opportunities during school have been decreased or eliminated, including PE classes, recesses,

and other PA breaks (Lee, Burgeson, Fulton, & Spain, 2007; Sallis et al., 2012). Over the past several decades, physical fitness test batteries have been developed and administered in schoolaged children and these measures serve as PE-related outcomes. The test protocols have historically included four components: body composition, cardio respiratory fitness, muscular fitness, and flexibility. To emphasize the importance of offering PE in school, an increasing body of research has attempted to connect PA and physical fitness with academic performance (Howie & Pate, 2012; Judge & Jahns, 2007; Shephard & Trudeau, 2013) and has examined the relationship between child obesity and mental health (Dalton et al., 2011; Halfon, Larson, & Slusser, 2013; Morales et al., 2013). Currently researchers are seeking a better understanding of how those behavioral factors interact together to influence the health outcomes such as HRQOL among school-aged children (Gu, Solmon, & Zhang, 2014). An early review (Blair, Cheng, & Holder, 2001) indicated that PA is the principal determinant of cardio respiratory fitness, although there is a genetic component. Blair and colleagues (2001) proposed a potential mechanism related to the interrelationship between PA, physical fitness components (i.e., muscular component and cardio respiratory component) and health outcomes. According to this proposed mechanism, the physical fitness components serve as the mediator in the relationship between PA and health outcomes. In their review, Blair et al. (2001) concluded there was evidence to suggest that physical fitness components may be more important than PA in relation to health outcomes. Specifically, when PA and physical fitness are included in a multivariate model, fitness remains strongly associated with health, and the association between PA and health is no longer significant. This notion was also supported in another systematic review by Fogelholm (2010), who indicated that physical fitness (i.e., BMI and cardio respiratory fitness) was more protective than PA toward health outcomes. However, this proposed mechanism by Blair and colleagues (2001) has not been fully tested, especially among school-aged children. It is very important to identify the extent to which PA (in and outside of PE) or physical fitness can counterbalance health risks associated with physical and mental health among school-aged children (Blair, Cheng, & Holder, 2001; Fogelholm, 2010). Knowledge of the association between PA, physical fitness, and HRQOL could provide important information for understanding variations in the development of young children and their mental health status in their early school years. Approximately 20% of school-aged children have a diagnosable mental health disorder, and those individuals are more likely to be classified as overweight or obese (Fedewa & Ahn, 2011; Halfon et al., 2013). Improvements in physical and mental health in childhood could have farreaching positive consequences for youth as they age and may provide a means for better screening of young children for intervention programs. It was of interest in our study to examine how PA participation in different settings (in and outside of PE) is related to HRQOL, especially among school-aged children. Including both self-reported PA and objectively measured PA in PE classes may provide a more global picture for us to understand school-aged children's HRQOL, which also could provide a basis for the future intervention programs in this population. Although no formula exists for promoting sustained physical and mental health throughout the lifespan, identifying underlying mechanisms among PA, physical fitness, and children's health-related well-being such as HRQOL is a crucial step toward developing strategies to promote and maintain a healthy lifestyle in school-aged children (Cummins, 2005). The first purpose of this study was to examine the association between self-reported PA, pedometer-based PA (steps/minute during PE classes), four components of physical fitness (BMI, cardio respiratory fitness, muscular fitness, and flexibility) and two dimensions of HRQOL (physical and mental functioning) among elementary children. The second purpose was to test whether physical fitness mediates the relationship between self-reported PA and HRQOL, as well as between pedometer-based PA and HRQOL.

Method

Participants

Participants were 201 (91 boys; 110 girls) elementary school students (97 fourth graders; 104 fifth graders) and their PE teachers recruited from one public school in the Karnataka States. The majority of the participants were Caucasian (85.8%), and their ages ranged from 9–11 years (M age = 9.83, SD = .70). The three PE teachers involved in the study were females with master's degrees, each of whom had more than 10 years of teaching experience. Two of them had earned a national board certification. They collaborated to design and implement a cohesive high quality PE curriculum across the elementary grades. The curriculum is based on state-mandated grade level expectations for public schools while developing physically literate children who have the skills, knowledge, and motivation to enjoy a physically active lifestyle (NASPE, 2013). Students attended a 30-min PE class every school-day and each class had 20–25 students. Approval to conduct the study was received from the University Institutional Review Board, and permission to collect data were granted by the school district, the school principal, and the PE teachers before the start of the study. The exclusion criteria were: (a) students who did not provide assent and/or their guardians' consent for participating in the study and (b) students who failed to complete 20% or more of the items on the measurements.

Research Design and Procedures

The correlation research design was used across one academic school year. In the middle of the fall semester during a regularly scheduled PE class, students completed a questionnaire measuring their physical activity (self reported PA). One-week after the self-reported PA data were collected, three days were scheduled to assess students' in-class PA measured by pedometers (pedometer based PA) during regular PE classes. To facilitate the pedometer data collection, two trained research assistants completed the following protocol: (a) placed numbered sheets with each student's name on it on a bleacher or bench in the activity area for easy access; (b) put up a numbered pedometer on the same number sheet; (c) reset all pedometers to 0; (d) posted a class list with students' names and assigned pedometer numbers. Students then picked up and attached the reassigned pedometers immediately before PE class as instructed by their teachers from the station they were assigned. The research assistants helped students attach the pedometers to their waist belts and made sure the students wore their individually assigned pedometers. Immediately following the end of the class period, participants were instructed to remove their pedometers and return them to the assigned station. Between classes, the researcher recorded step counts from each pedometer on a data sheet. Each pedometer was then reset to zero and returned to the station for the next class on the following day. At the end of the fall semester, the FITNESSGRAM test battery (Cooper Institute, 2010) was administered by the PE teachers in accordance with state requirements. Researchers observed fitness testing to ensure that the procedures were followed and the testing was reliable. In addition, the FITNESSGRAM test battery is a standard part of schools' PE curriculum and students were familiar with the tests. Students completed the self-reported HRQOL survey in the second semester of their academic school year. Survey-based instructions were briefly explained before students filled out the questionnaires. Questionnaires were distributed to all students under the supervision of the researchers with the assistance of the PE teachers. To ensure that students had smooth and equivalent test experiences, the lead researcher read each item to the students and answered their questions to ensure their understanding of the items. All students were informed that their teachers would not have access to their responses on the questionnaires. Students were encouraged to answer truthfully and assured that their responses would be anonymous and not affect their grades.

Measures

Measures Demographic Variables.

Self-reported information on grade, age, gender, and race were obtained from the questionnaires to characterize the participants.

- **Self-Reported Physical Activity.** The PA Questionnaire for Older Children (PAQ-C; Kowalski, Crocker, & Faulkner, 1997) was used to assess students' levels of PA. The PAQ-C is a reliable and valid measure of PA for students older than 8 (Kowalski, Crocker, & Faulkner, 1997). It is a 7-day recall questionnaire intended to assess students' moderate and vigorous PA, such as recreational activities, sports, and other types of exercise in the previous week. Other PA behaviors related to the students' PE class, free time, recess, extracurricular sports, weekend activities, and evening activities are also addressed within this questionnaire. There is a value from 1 to 5 for each of the 9 items used in the physical activity composite score. The final PAQ-C activity summary score is the mean of these 9 items as an indicator of the self-reported PA level for the student. A score of 1 indicates low PA, whereas a score of 5 indicates high PA.
- **Pedometer-Based Physical Activity (steps/min).** Pedometers were used to measure students' in-class PA during three PE classes on consecutive days (ACCUSPLIT pedometers, Accusplit, Inc., Livermore, CA). Each 30-min PE class was monitored by one or more of the researchers to be sure students were not opening pedometer cases or shaking pedometers. In addition, the actual activity time (i.e., any games or activity time excluding the instructional time) was recorded. The pedometer based PA was calculated as steps/min, a simple ratio, created by dividing the total steps taken for a monitored period by the duration of that period (total actual activity time) recorded by researchers. Pedometers have been established as a reliable and valid tool for measuring PA in children (i.e., ICC range = .69 to .91; Tudor-Locke et al., 2009).
- **Physical Fitness.** Physical fitness was represented by four components: cardio respiratory fitness, muscular fitness, flexibility, and BMI, all measured by the FITNESSGRAM test battery (Cooper Institute, 2010). Specifically, the Progressive Aerobic Cardiovascular Endurance Run (PACER) was measured, which is the total number of successful "laps" the students completed. A digital scale (SECA 880) was used to measure children's height and weight (without shoes). BMI was calculated by dividing weight by height squared. Then, each student's VO₂max was predicted based on age, gender, BMI, and PACER scores according to the proposed equation (Mahar, Guerieri, Hanna, & Kemble, 2011). The VO₂max represents students' cardio respiratory fitness. Muscular fitness was measured using two tests: curl-ups, representing the abdominal muscular strength and endurance, and push-ups, representing the upper body muscular strength and endurance. Lastly, participants performed the trunk lift as a measure of flexibility. Each test score was translated to a standard z-score and physical fitness index (total fitness score) was developed by summing four standard scores for each participant. The FITNESSGRAM manual (Cooper Institute, 2010) indicates that these tests used in the current study are reliable and valid representations of each component of health-related physical fitness.
- **Health-Related Quality of Life (HRQOL).** The PedsQL is a 23-item self-report survey that assesses individuals' HRQOL (PedsQL 4.0; Varni et al., 2001), including physical functioning (8 items) and mental functioning (15 items). The PedsQL items use a 5-point Likert-type scale to assess frequency (0 = never a problem; 1 = almost never a problem; 2 = sometimes a problem; 3 = often a problem; 4 = almost always a problem). Example items include: "It is hard for me to do sports activity or exercise" (physical functioning); "I feel sad or blue" (mental functioning); and "other kids

do not want to be my friend” (mental functioning). The items were reverse coded and then transformed to a linear scale (0–100; 0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), with 100 indicating highest and 0 lowest possible HRQOL. Scale scores were created by dividing the sum of the responses by the number of items answered (e.g., the highest HRQOL score: $2300/23 = 100$). Varni and colleagues (2001) demonstrated adequate reliability and validity of the PedsQL 4.0 in healthy school children (Cronbach alpha coefficient; physical functioning =.80 and mental functioning =.83). The Cronbach alpha coefficient for physical functioning was .74 and .85 for mental functioning in this study.

Data Analyses

Several steps were taken to analyze the data by using IBM SPSS 22. First, Cronbach’s alpha coefficients were used to examine the internal consistencies of the self-reported measures. Intra-class correlation (ICC) was used to test the relative reliability of the three-day pedometer measurement, which provides estimates of systematic and error variance (Thomas, Nelson, & Silverman, 2010). Then, vicariate correlation among the study variables (self-reported PA, steps/min, four components of physical fitness, and physical and mental functioning of HRQOL) were performed. Four multiple regressions were conducted to examine the predictive utilities of PA (self-report PA and steps/min) and four components of physical fitness on physical and mental functioning of HRQOL, respectively. It was previously suggested (Morales et al., 2013) that fitness components including BMI, cardio respiratory fitness, muscular fitness, and flexibility (independent variables) can be entered into the model at the same time to examine the independent effect of each fitness variable on HRQOL (dependent variables: physical and mental functioning). In addition, case wise diagnostic analysis (setting the standard deviation at 2 units) were also conducted, and standardized residuals, leverage values, Debates, and Cook’s distance were used to detect the presence of outliers and influential observations. Path analyses (MacKinnon, Fairchild, & Fritz, 2007) using IBM SPSS Amos 20 were conducted to evaluate the potential mediational relationships among PA (independent variables: self-reported PA and steps/min), physical fitness (mediator: physical fitness index), and HRQOL,

Table 1 Descriptive Statistics (N = 201)

Variables	Mean	SD
Physical Function	88.71	10.66
Mental Function	83.96	12.76
Total HRQOL	85.61	10.95
BMI (kg/m ²)	18.51	3.75
VO ₂ max (ml/kg/min)	43.13	5.21
Curl Up (#)	26.13	15.56
Push Up (#)	12.57	8.28

Trunk Lift (inches)	10.61	1.58
Self-reported PA	3.33	81
steps)	95.65	19.05
		teps/min (#

Note. M = Mean; SD = Standard Deviation; HRQOL = Health-related Quality of Life; PA = Physical Activity; Steps/min = Pedometer determined PA.

(dependent variable: total HRQOL score). We used the physical fitness index calculated by summing the z scores of the fitness measures in the mediation analysis. An alpha level of .05 was used for all statistical analyses.

Results

The descriptive data and correlation coefficients for all variables are presented in Tables 1 and 2. The reliability coefficients indicated that all of the instruments demonstrated acceptable internal consistency. Simple correlations and Cronbach’s alpha coefficients showed that both self-reported PA and pedometer-based PA (steps/min) were positively associated with physical and mental functioning of HRQOL (r’s ranging from .15 to .34, p < .05). All components of physical fitness including cardio respiratory fitness, muscular fitness, and BMI were significantly related to physical and mental functioning of HRQOL, except flexibility. The examination of linear relationship among the independent variables suggested that the assumption of no multi co linearity was met; the VIF and Tolerance statistics for the independent variables involved were all close to 1 and greater than .20, respectively. Case wise diagnostics for the four multiple regression models tested showed that the absolute values of Debates for the predictors did not exceed 1; no more than 5% cases of the standardized residuals had absolute values greater than 2 (4%, 3%, 4%, and 4% for regression models 1, 2, 3, and 4, respectively); no cases of Cook’s distance were greater than 1; and no cases of the leverage values exceeded 3 times the average leverage. Multiple regressions confirmed that both self-reported PA and steps/min were significant predictors of physical functioning and mental functioning of HRQOL (ES = .15 and .09; See Table 3). Both cardio respiratory and muscular fitness.

Table 2 Correlations among the Study Variables (N = 201)

Measure	1	2	3	4	5	6	7	8	9	10 Physical functioning (.74)
Mental function	.60**									(.85)
z-BMI	-.14*	-.18**								
Z-Cardio respiratory	.28**	.24**	-.54**							
Z-Muscular fitness	.27**	.30**	-.25**	.29**						
Z-Flexibility	.04	-.04	.06	.09	.05					
Self-report PA	.34**	.24**	.12	.08	.13	.16*				(.79)
Steps/min	.15*	.18**	-.17*	.28**	.29**	-.09	.06			(.83)
Total Fitness	.33**	.27**	-.35**	.55**	.71**	.39**	.16*	.22**		

Total HRQOL .79** .96** -.19** .28** .32** -.02 .30** .19** .32**

Table 3 Multiple Regressions of PA and Physical Fitness on HRQOL

Dependent Variables	Independent Variables	B	SE	Model t R ²	β	t
Physical Activity Physical Functioning (model 1)	Constant	67.07	4.56	13%	.33	14.68**
	Self-report PA	4.33	.88			4.94**
	Steps/min	.08	.04		.13	1.99*
Mental Functioning (model 2)	Constant	60.45	5.60	8.8%		10.79**
Physical Fitness Physical Functioning (model 3)	Constant	88.66	.74	11.8%		120.43**
	BMI	.14	.91		.01	.149
	Cardiorespiratory	2.46	.90		.22	3.09**
	Muscular fitness	1.40	.49		.20	2.84**
	Flexibility	.22	.75		.02	.313
Mental Functioning (model 4)	Constant	83.79	.87	11.4%		96.06**
	BMI	-.37	1.06		-.03	-.361
	Cardiorespiratory	2.25	1.08		.18	2.45*
	Muscular fitness	1.95	.59		.24	3.39**
	Flexibility	-.78	.89		-.06	-.874

Note. B values are under standardized regression coefficients; SE values are standard errors; β values are standardized regression coefficients. All values come from the final stage of the regression analysis. * $p < .05$. ** $p < .01$.

Emerged as significant predictors of physical and mental functioning of HRQOL regardless of BMI (ES = .13; see Table 3). In addition, the total score of HRQOL was also positively associated with self-reported PA ($r = .30, p < .001$), and steps/min ($r = .19, p < .01$), and physical fitness index ($r = .32, p < .001$). In the analysis of mediation model 1 (Figure 1), self reported PA significantly affected both physical fitness ($\beta_a = .15, p < .05$; a Path) and HRQOL ($\beta_c = .29, p < .01$; c Path), respectively. When self-reported PA and physical fitness were included as predictors of HRQOL in the model, both PA ($\beta_{c'} = .25, p < .01$; c' path) and physical fitness ($\beta_b = .28, p < .01$; b path) remained significant predictors of HRQOL and accounted for 16.5% of the variance in HRQOL ($R^2 = .165$; Table 4). The effects of the self-reported PA on HRQOL were decreased from .29 to .25 (standardized regression weights) after controlling for physical fitness, suggesting a partial mediated effect of self-reported PA on HRQOL through physical fitness. The 95% CI supported the significant indirect effect through physical fitness, 95% CI: [.53, 1.48]. In the mediation context, the relationship is reduced because the mediator (physical fitness) is in the causal path between the independent variable (PA) and dependent variable (HRQOL) and explains part of the relationship between PA and HRQOL (Mackinnon et al., 2000). Thus, our data support the conclusion that physical fitness serves as a mediator in the relationship between self-reported

PA and HRQOL and indicated the existence of a partial mediation. In mediation model 2 (Figure 1), results indicated full mediation effects through physical fitness on the relationship between pedometer-based PA (steps/min) and HRQOL. Specifically, steps/min emerged as the significant predictor of both physical fitness ($\beta_a = .23, p < .01$; a path) and HRQOL ($\beta_c = .19, p < .01$; c path), respectively. When steps/min and physical fitness were included as predictors of HRQOL in the model, steps/min became non significant ($\beta_{c'} = .12, p > .05$; c' path), and physical fitness ($\beta_b = .29, p < .001$; b path) remained significant, explaining 11.9% of variance in HRQOL ($R^2 = .119$; Table 4). Consequently, the apparent effects of steps/min on HRQOL are mediated by physical fitness, leading to the inference of full mediation. The 95% CI also supported the significant indirect effect through physical fitness (95% CI: [.54, 1.53]).

Discussion

This is the first study to investigate the relationships between PA and physical fitness with HRQOL in elementary school-aged children, as well as to explore the underlying mechanism related to physical and mental health in this population. Our results provide evidence of the positive association between PA, physical fitness, and

Table 4 Estimates of Standardized Effect on HRQOS

Path	Direct	Indirect	Total	ES
Self-reported PA → Fitness 0.28**	0.15*	–	–	– Fitness → HRQOL
Self-reported PA → HRQOL Fitness 0.23**	0.25**	0.04*	0.29*	0.165 Steps/min →
Fitness →HRQOL 0.12	0.29**	–	–	– Steps/min →HRQOL
	0.07**	0.19*	0.119	

Note. HRQOL= healthy-related quality of life; PA = physical activity; Steps/min = pedometer-determined PA; ES = (model) effect size. * $p < .05$. ** $p < .01$.

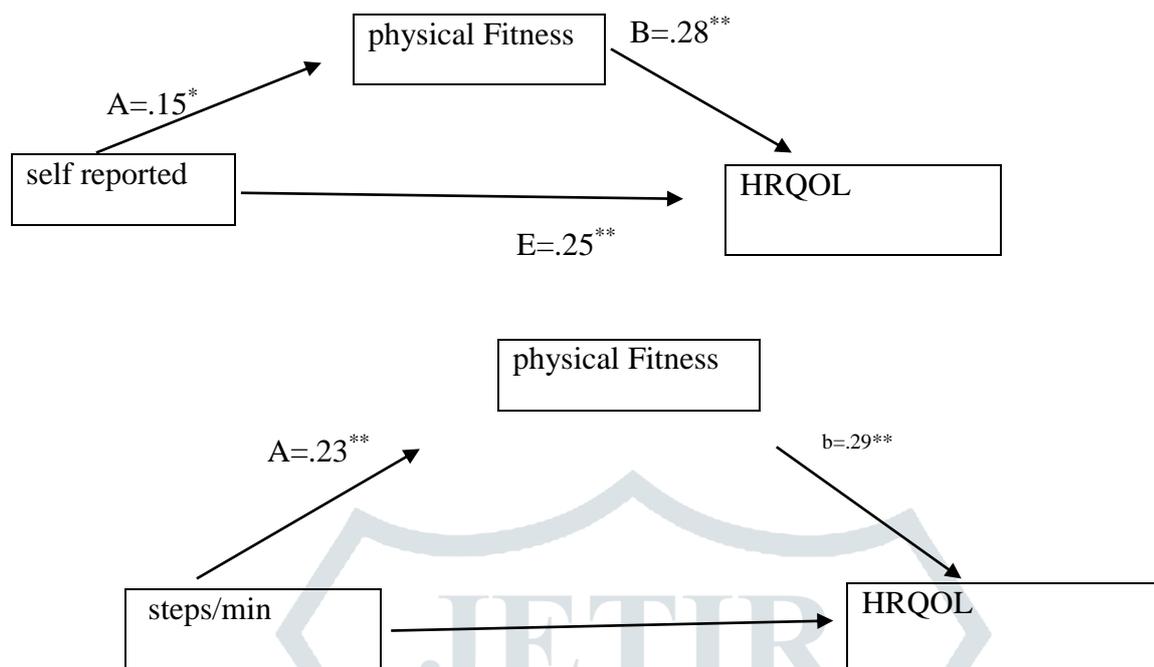


Figure 1 — Mediation Analyses. Path Model 1 Path Coefficients of Self-reported PA on HRQOL through Physical Fitness. Path Model 2 Path Coefficients of Steps/min on HRQOL through Physical Fitness.

HRQOL. Results showed that both physical fitness and PA (self-reported PA and steps/min) were significantly related to physical and mental functioning of HRQOL, which extends current research evidence in adult populations (Gaspar & Matos, 2009; Klavestrand & Vingard, 2009; Tsiros et al., 2009). This suggests that promotion of PA and physical fitness may help school-aged children achieve desired health benefits and these benefits may, in turn, motivate them to become more physically active. Such information is central to developing and implementing effective health promotion programs in elementary schools and to promote children's physical and mental health well-being.

PA and HRQOL

Consistent with studies of adults and adolescent populations (Bize et al., 2007; Dalton et al., 2011; Gu, Solmon, & Zhang, 2014), positive associations among PA and mental functioning of HRQOL in healthy children were found in the current study. Building on previous studies, this study provides additional evidence by using pedometers as an objective measure of PA. Self-report measures provide a reasonable snapshot of population levels of PA, but combining self-report measures with objective measures is recommended in investigating individuals' HRQOL (Klavestrand & Vingard, 2009). In addition, we found a small but significant relationship between steps/min and HRQOL which suggests that the school PE program could be an important setting for addressing/ preventing children's mental health problems. Using multiple measures can provide a more accurate assessment of students' current levels of PA, but the valid and reliable measurement of children's PA remains challenging. There was no correlation between self-reported PA and steps/min in this study. This is consistent with some research evidence indicating that self-reports compared with objective measures (motion sensors: accelerometers and pedometers) show only fair to poor agreement (coefficients range from 0.2–0.4; see reviews: Bauman, Phongsavan, Schoeppe, & Owen,

2006). This does not necessarily mean that self-reported PA has poor validity, as the PAC-Q measures different dimensions of behavior including PA within and beyond the PE class, compared with the movement-related aspects of PA measured by pedometers specifically during PE classes. Another possible explanation is that the class content and teachers' behavior may have contributed to the incongruence between students' self-reported activity level and pedometer counts (steps/min) within the limited time in PE (McKenzie, Marshall, Sallis, & Conway, 2000). Researchers observed classes and recognized some of the variation in step counts could be attributed to elements in the instructional environment such as task design, availability of equipment, and space. For example, Gu and Solmon (2015) suggested that a performance motivational climate could be associated with lower step counts in PE classes. We monitored and recorded students' actual activity time to more closely represent students' real PA levels in their allotted PE time. Health-related quality of life (HRQOL) encompasses physical and mental domains of health and has gradually become a more important emphasis in health care practice and research (Klavestrand & Vingard, 2009). The positive relationship between PA and HRQOL reported in this study has important practical implications for those involved in the promotion of physical and mental health in youth. Accordingly, health practitioners and pediatricians should be made aware that children who are physically inactive may be more likely to perceive themselves in a negative manner relative to impaired physical and mental functions incorporated in HRQOL. More specifically, the findings suggest that we should target health-related outcomes such as HRQOL among school-aged children by enhancing motivation and PA participation (Gu et al., 2014).

Mediational Effects of the Physical Fitness on PA and HRQOL

It has been well documented in the pediatric literature that overweight and obese (higher BMI) children and adolescents report lower HRQOL, primarily in physical functioning (Sato, Nakamura, & Sasaki, 2008; Shimmer, Burwinkle, & Varni, 2003; Swallen et al., 2005; Tsiros et al., 2009). Our findings expanded this area of investigation by demonstrating that both cardio respiratory fitness and muscular fitness predicted physical and mental well-being as measured by HRQOL among elementary school children. Earlier studies of the relationship between HRQOL and BMI have demonstrated a negative relationship between BMI and HRQOL in children and adolescents (Dalton et al. 2011; Swallen et al. 2005, Tsiros et al. 2009). We analyzed the concurrent effects of the four components of fitness and provided evidence that cardio respiratory fitness and muscular fitness contributed significantly more to the variance to HRQOL than BMI. This suggests that maintaining and enhancing cardio respiratory and muscular fitness in elementary children has the potential of yielding physical and mental health benefits. The evidence on the association between physical fitness and mental health in children is still scarce (Ortega et al., 2008) and longitudinal are needed. Given that different components of physical fitness are associated with different health-related outcomes (Ortega et al., 2008), PA programs and school PE should be designed to improve both cardio respiratory fitness and muscular fitness. The primary contribution of this study was testing whether physical fitness serves as a mediator between PA and HRQOL. The scope of the study is not sufficient to determine whether this mediational relationship is different for different health outcomes or age groups based on current literature among school-aged children (Cummins, 2005; Klavestrand & Vingard, 2009). Two earlier reviews proposed that physical fitness may be more important than PA in defining health outcomes among adults (Blair et al., 2001). Rejeski and Mihalko (2001) suggested that PA could lead to improved physical fitness and mental health in older adults. Consistent with the model proposed by Blair and colleagues (2001), our study supported that physical fitness remains significantly associated with health outcomes such as HRQOL when PA and physical fitness are both included in the model.

Thus, our data provided the initial evidence that physical fitness served as a mediator in the relationship between children's PA and HRQOL; however, it is not possible to determine whether fitness is more important than PA as a predictor of HRQOL and why due to the nature of the study. A possible explanation for the mediation role of fitness in this study is that the measures for PA were less precise and likely included more error than the assessments of physical fitness (Bauman et al., 2006). Blair and colleagues (2001) also supported the assertion that data from observational studies will likely demonstrate a higher association between physical fitness and health outcomes than for PA and health outcomes. The association between PA and physical fitness and HRQOL was recently reported in elderly populations (Brovold et al., 2014; Hebestreit et al., 2014) but the role of physical fitness as a mediator was not examined. There has been little research that has examined how PA and physical fitness interact together to influence individuals' physical and mental well-being of HRQOL, especially among school-aged children. It has been suggested that there is a need to assess theory-based mediators and health outcomes among school-aged children (Ryan, Patrick, Deci, & Williams, 2008). The significant mediation or indirect effects of PA on HRQOL through physical fitness found in our study provide further support for the tenets of two previous reviews (Blair et al., 2001; Rejeski & Mihalko, 2001), and the effects may extend to the prediction of PA on mental health in relation to HRQOL in school-aged children. It is promising that PA participation is associated with students' physical fitness levels during the elementary school years and ultimately impacts children's mental health development later in life. Furthermore, the support of mediation effects reinforces the notions that (1) increases in PA contribute to increases in health-related outcomes such as physical fitness and HRQOL, and (2) health promotion programs and recommendations should not only emphasize "increasing activity participation" but also "becoming physically fit," which may have implications for general perceptions of health among school-aged children (Blair et al., 2001). This study provides the initial evidence on the directional relationship of PA, physical fitness, and HRQOL. Although this is encouraging, additional studies are needed to refute or replicate our findings. A critical goal of national health promotion efforts is to assess trends in health risk factors and their antecedents and correlates. PE programs can play an important role in working to achieve that goal, although it is important to acknowledge that the goals of quality PE programs include skill and social development and are not limited to the promotion of physical activity. Research exploring children's HRQOL in elementary school PE provides important information for understanding variations in children's development and their health-related wellbeing in their early school years. We suggest that PE programs should provide sufficient opportunities/time for students to be active, striving to reduce time spent on management and lengthy instructional episodes, while maximizing the use of equipment and space to actively involve children in activities. This can ultimately increase class time PA participation, which may influence their physical fitness and quality of life. Knowledge of the association between PA, physical fitness, and HRQOL could help target interventions and direct resources to individuals and communities, addressing health issues prevalent in school physical education. From an applied perspective, PA and exercise intervention programs within or after school aimed at enhancing children's physical fitness are highly recommended. Links between PA, physical fitness, and mental health in school-aged children, however, are less well-substantiated and certainly constitute a promising area of future investigation. Specific areas for future investigation are the examination of a dose-response relationship between PA and HRQOL after controlling for the fitness level and whether the mediational relationship among PA, fitness, and HRQOL may differ in terms of skill level.

References

- Bauman, A., Phongsavan, P., Schoeppe, S., & Owen, N. (2006). Physical activity measurement—a primer for health promotion. *Promotion & Education*, 13(2), 93–103. doi:10.1177/10253823060130020103

- Bisegger, C., Cloetta, B., Von Rueden, U., Abel, T., & Ravens, S. (2005). Health-related quality of life: Gender differences in childhood and adolescence. *Preventive Medicine*, 50(5), 281–291. doi:10.1007/s00038-005-4094-2
- Bize, R., Johnson, J.A., & Plotnikoff, R.C. (2007). Physical activity level and health-related quality of life in general adult population: A systematic review. *Preventive Medicine*, 45(6), 401–415. doi:10.1016/j.ypmed.2007.07.017
- Blair, S.N., Cheng, Y., & Holder, J.S. (2001). Is physical activity or physical fitness more important in defining health benefits? *Medicine and Science in Sports and Exercise*, 33(Supplement), 379–399. doi:10.1097/00005768200106001-00007
- Brovold, T., Skelton, D.A., Sylliaas, H., Mowe, M., & Bergland, A. (2014). Association between health-related quality of life, physical fitness, and physical activity in older adults recently discharged from hospital. *Journal of Aging and Physical Activity*, 22(3), 405–413. doi:10.1123/JAPA.2012-0315
- Chyun, D.A., Melkus, G.D., Katten, D.M., Price, W.J., Davey, J.A., Grey, N., . . . Frans, J.T. (2006). The association of psychological factors, physical activity, neuropathy, and quality of life in type 2 diabetes. *Biological Research for Nursing*, 7(4), 279–288. doi:10.1177/1099800405285748
- Cooper Institute. (2010). *FITNESSGRAM/ACTIVITYGRAM: Test administration manual*. Champaign, IL: Human Kinetics.
- Cummins, R.A. (2005). Moving from the quality of life concept to a theory. *Journal of Intellectual Disability Research*, 49(10), 699–706. doi:10.1111/j.1365-2788.2005.00738.x
- Dalton, W.T., Schetzina, K.E., Pfortmiller, D.T., Slawson, D.L., & Frye, W.S. (2011). Health behaviors and healthrelated quality of life among middle school children in Southern Appalachia: Data from the winning with wellness project. *Journal of Pediatric Psychology*, 36(6), 677–686. doi:10.1093/jpepsy/jsq108
- Fedewa, A.L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children’s achievement and cognitive outcomes: A meta-analysis. *Research Quarterly for Exercise and Sport*, 82(3), 521–535. doi:10.1080/027 01367.2011.10599785
- Fogelholm, M. (2010). Physical activity, fitness and fatness: Relations to mortality, morbidity and disease risk factors. A systematic review. *Obesity Reviews*, 11(3), 202–221. doi:10.1111/j.1467-789X.2009.00653.
- Gaspar, T., & Matos, M.G.D. (2009). Health related quality of life in children and adolescents and associated factors. *Journal of Cognitive and Behavioral Psychotherapies*, 1, 33–48.
- Gu, X., & Solmon, M. A. (2015). Motivational processes of children’s physical activity and quality of life. *Physical Education and Sport Pedagogy*, (ahead-of-print), 1–18. DOI: 10.1080/17408989.2015.1017456
- Gu, X., Solmon, M.A., & Zhang, T. (2014). Understanding middle school students’ physical activity and healthrelated quality of life: an expectancy-value perspective. *Applied Research in Quality of Life*, 9(4), 1041–1054. doi:10.1007/s11482-013-9287-
- Halfon, N., Larson, K., & Slusser, W. (2013). Associations between obesity and comorbid mental health, developmental, and physical health conditions in a nationally representative sample of US children aged 10 to 17. *Academic Pediatrics*, 13(1), 6–13. doi:10.1016/j. acap.2012.10.007
- Hebestreit, H., Schmid, K., Kieser, S., Junge, S., Ballmann, M., Roth, K., . . . Kriemler, S. (2014). Quality of life is associated with physical activity and fitness in cystic fibrosis. *BMC Pulmonary Medicine*, 14(1), 26. doi:10.1186/1471-2466-14-26

- Herman, K.M., Hopman, W.M., Vandekerkhof, E.G., & Rosenberg, M.W. (2012). Physical activity, body mass index, and health-related quality of life in Canadian adults. *Medicine and Science in Sports and Exercise*, 44(4), 625–636. doi:10.1249/MSS.0b013e31823a90ae
- Howie, E.K., & Pate, R.R. (2012). Physical activity and academic achievement in children: A historical perspective. *Journal of Sport and Health Science*, 1(3), 160–169. doi:10.1016/j.jshs.2012.09.003
- Judge, S., & Jahns, L. (2007). Association of overweight with academic performance and social and behavioral problems: An update from the early childhood longitudinal study. *The Journal of School Health*, 77(10), 672–678. doi:10.1111/j.1746-1561.2007.00250.x
- Janssen, I., & LeBlanc, G.A. (2010). Systematic review of the health benefits of physical activity and fitness in schoolaged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity*, 7(1), 1–16. doi:10.1186/1479-5868-7-40

