

# Effects of Modifying Physical Activity and Sedentary Behavior on Psychosocial Adjustment in Overweight/Obese Children

Gary S. Goldfield,<sup>1,2,3,4</sup> PhD, Risa Mallory,<sup>1</sup> MEd, Torrey Parker,<sup>2</sup> MSc, Terrell Cunningham,<sup>4</sup> BA, Christine Legg,<sup>4</sup> BA, Andrew Lumb,<sup>4</sup> BA, Kasey Parker,<sup>2</sup> Denis Prud'homme,<sup>2</sup> MD, MSc, and Kristi B. Adamo,<sup>2,3,5</sup> PhD

<sup>1</sup>Mental Health Research, Children's Hospital of Eastern Ontario Research Institute, <sup>2</sup>School of Human Kinetics, University of Ottawa, <sup>3</sup>Department of Paediatrics, University of Ottawa, <sup>4</sup>Department of Psychology, Carleton University, and <sup>5</sup>Chalmers Research Group, Children's Hospital of Eastern Ontario Research Institute

**Objectives** To evaluate the relationship between changes in physical activity (PA), sedentary behavior, and physical self-perceptions and global self-worth in 30, 8–12 years old, overweight/obese children (13 boys, 17 girls). **Methods** Secondary analyses from a randomized controlled trial designed to increase PA and reduce sedentary behavior. PA was measured by accelerometers worn by participants every day for 8 weeks. Sedentary behavior, defined as minutes per day spent in television viewing, was assessed by self-report.

**Results** Increases in PA were associated with increases in perceived physical conditioning ( $r = .54, p < .01$ ), body satisfaction ( $r = .55, p < .01$ ), and overall physical self-worth ( $r = .44, p < .05$ ) independent of changes in body mass index (BMI). Reductions in TV viewing were also related to increased physical and global self-worth. **Conclusions** Increases in PA are associated with improvements in physical self-perceptions but not global self-worth, while reductions in TV viewing are associated with increased physical and global self-worth, and these psychosocial benefits appear to be independent of changes in adiposity.

**Key words** children; obesity; overweight; physical activity; sedentary behavior; self-esteem; self-perceptions; TV; youth.

Child obesity is increasingly being recognized as a global epidemic (Tremblay & Willms, 2000; World Health Organization, 2002) and represents a serious public health concern given its associated health complications (Dietz, 1998; Janssen et al., 2005b). In addition to adverse medical effects, there is a growing body of evidence indicating deleterious psychosocial sequelae of obesity in youth (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993). This includes, but is not limited to, depression (Goodman & Whitaker, 2002), weight-based teasing (Eisenberg, Neumark-Sztainer, & Story, 2003), and social isolation and discrimination (Latner & Stunkard, 2003), all of which have been shown to have negative effects on self-esteem in overweight youth (Eisenberg et al., 2003; Pierce & Wardle, 1997).

Although many clinical (Zeller, Saelens, Roehrig, Kirk, & Daniels, 2004) and epidemiological (French, Perry, Leon, & Fulkerson, 1996) studies support the notion that body mass index (BMI) is inversely related to self-esteem in youth, comprehensive review papers have not consistently shown obese youth to have lower global self-esteem than nonobese peers (French, Story, & Perry, 1995; Wardle & Cooke, 2005). However, the relationship appears much stronger when obese and nonobese children are compared on self-esteem related to physical self-perceptions (Braet, Mervielde, & Vandereycken, 1997) and physical quality of life (Swallen, Reither, Haas, & Meier, 2005). Perceived deficits in physical self-perceptions are often associated with real deficits (Raudsepp & Liblik, 2002), both of which may act as

All correspondence concerning this article should be addressed to Gary S. Goldfield, PhD, C. Psych, Senior Investigator, Children's Hospital of Eastern Ontario Research Institute, Mental Health Research, 401 Smyth Rd., Ottawa, ON Canada K1H 8L1. E-mail: ggoldfield@cheo.on.ca.

*Journal of Pediatric Psychology* 32(7) pp. 783–793, 2007

doi:10.1093/jpepsy/jsm017

Advance Access publication April 19, 2007

*Journal of Pediatric Psychology* vol. 32 no. 7 © The Author 2007. Published by Oxford University Press on behalf of the Society of Pediatric Psychology. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

barriers to participating in physically active games or sports. Thus, it is not surprising that low scores on perceived physical competence are consistently associated with reduced PA, and high scores on perceived physical competence are predictive of more regular and frequent physical activity (PA) in children (Crocker, Eklund, & Kowalski, 2000; Norman, Schmid, Sallis, Calfas, & Patrick, 2005). These physical self-perceptions have also been shown to be important indicators of motivation to be physically active (Biddle & Mutrie, 2001), making them critical components in the context of identifying modifiable variables that may lead to, or result from, more sustained PA participation in overweight children.

One of the most reliable psychological correlates relating to physical self-perceptions in obese children is body dissatisfaction or physical appearance esteem. Mounting evidence from systematic reviews indicates that overweight/obese children, especially girls, exhibit greater dissatisfaction than normal-weight peers in clinical and community-based samples (Ricciardelli & McCabe, 2001; Wardle & Cooke, 2005). This is clinically significant because body dissatisfaction is not only a consequence of obesity; it is directly related to unhealthy restrictive dieting behaviors that are cross-sectionally and prospectively related to weight gain in youth (Field et al., 2003) and adults (French et al., 1994). Thus, lifestyle intervention that enhances body image and other physical self-perceptions should not only provide psychological benefits, but these benefits may translate to more sustained PA and improved eating behavior needed to induce negative energy balance and weight loss. Increasing PA and reducing sedentary behavior in overweight/obese youth may be one method of achieving these aims (Biddle, Sallis, & Cavill, 1998).

Obese children are a group who may particularly benefit from increased energy expenditure from physical activity given that they are less physically active (Bar-Or et al., 1998; Sallis et al., 1992) and less fit (Johnson et al., 2000; Mamalakis, Kafatos, Manios, Anagnostopoulou, & Apostolaki, 2000) than nonobese children, and because obesity and sedentary lifestyles track from childhood to adulthood (Stark, Atkins, Wolff, & Douglas, 1981). In addition, TV watching is a sedentary behavior that consumes a large part of children's leisure time (Gortmaker et al., 1996; Olds, Ridley, Dolman, 2006), and is cross-sectionally (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Hancox & Poulton, 2006) and prospectively related to the development of obesity in children (Gortmaker et al., 1996) and adults (Viner & Cole, 2005), and negatively correlated with physical activity

(Andersen et al., 1998; Janssen et al., 2005a) and fitness (Durant, Baranowski, Johnson, & Thompson, 1994). Moreover, physically active children report greater body satisfaction, self-esteem, and physical self-perceptions than sedentary peers (Biddle et al., 1998), and increasing PA and exercise improves global self-esteem in youth (Ekeland, Heian, Hagen, Abbott, & Nordheim, 2004). Importantly, there is evidence that the psychological benefits of increased PA in youth are often independent of changes in body mass (Ekeland et al., 2004), but this issue needs further study.

Using sedentary behavior to reinforce physical activity, a behavior modification technique known as the premack principle (Premack, 1959), increases PA and reduces sedentary behavior in normal-weight and obese children in the laboratory (Goldfield, Kalakanis, Ernst, & Epstein, 2000; Saelens & Epstein, 1998), as well as adiposity in obese children in the natural environment (Faith et al., 2001; Goldfield et al., 2006). Very few clinical trials have examined the effects of modifying PA and sedentary behavior on psychological well-being in overweight/obese children, as most of this research has utilized cross-sectional samples or epidemiological cohorts rather than randomized controlled trial designs. Thus, the aim of this study was to examine the effects of an intervention designed to increase PA while reducing TV viewing (Goldfield et al., 2006) on changes in physical self-perceptions and global self-worth in overweight/obese children, and evaluate the degree to which this relationship is influenced by changes in body composition. We predicted that increases in PA rather than reductions in sedentary behavior would predict improvements in body image and other physical self-perceptions and global self-esteem, and this relationship would exist independent of body composition change. It was also of interest to examine the degree to which changes in intensity of PA related to changes in psychosocial adjustment.

## Methods

The criteria to define overweight and obesity used in this study are based on the International Obesity Task Force guidelines ([www.who.int](http://www.who.int)), which differ from the Center for Disease Control definition stating that BMI above the 85th percentile for age and sex is considered "at risk of overweight" and BMI above the 95th BMI is "overweight" ([www.cdc.gov](http://www.cdc.gov)). Forty-six children were screened for eligibility. Thirty, 8–12 years old overweight/obese children who participated with their parents in an 8-week PA randomized control trial met the following inclusion

**Table I.** Mean ( $\pm$  SD) Characteristics of the Sample at Baseline

Variable	Intervention ( <i>n</i> = 14)	Control ( <i>n</i> = 16)	<i>P</i>
Gender (M/F) <sup>a</sup>	6/8	7/9	.961
Age	10.0 (.90)	10.7 (1.4)	.133
Height (cm)	145.0 (8.7)	151.8 (11.6)	.090
Weight (kg)	61.5 (16.9)	65.6 (13.9)	.473
BMI (kg/m <sup>2</sup> )	28.9 (6.2)	28.2 (3.0)	.691
Combined parental income <sup>a</sup>			
Below \$50,000	2 (14.3%)	4 (25%)	.272
Between \$50,000–75,000	5 (36%)	6 (38%)	.891
Above \$75,000	7 (50%)	6 (38%)	.650
Physical activity (counts/day)	247.0 (131.2)	206.8 (119.0)	.386
MVPA (min/day)	14.4 (7.8)	12.0 (11.3)	.513
VPA (min/day)	3.7 (4.9)	1.2 (1.6)	.091
Targeted sedentary behavior (min/day)	160.5 (93.7)	152.1 (86.5)	.799
Nontargeted sedentary behavior (min/day)	34.0 (17.5)	41.5 (41.7)	.530

MVPA, Moderate to vigorous physical activity; VPA, vigorous physical activity.

<sup>a</sup>Group differences in gender and parental income were determined by chi-square test. Differences in other variables determined by independent *t*-tests.

criteria: (a) 8–12 years old children with a BMI of 85th–95th BMI percentile (overweight) or greater than 95th BMI percentile (obese) for age and sex (Kuczmarski, Ogden, Guo, et al, 2002); (b) watching 15 h of self-reported TV per week or more, including VCR/DVD use and video game playing; (c) engaging in <60 min of self-reported moderate to vigorous PA per day (Pate et al., 1995); (d) without conditions that would limit PA; (e) both child and parent agreed not to participate in any other exercise or weight control program during the course of the study; (f) no regular participation in swimming or strength training (activities that cannot be measured properly by accelerometry); (g) willingness of the parents to enforce or maintain the contingencies or lack of, as reflected by their assigned study group; (h) parent providing signed informed consent, and child providing signed informed assent. Subjects were reimbursed for the parking and transportation costs associated with attending the baseline and posttreatment assessments as well as the bi-weekly meetings. Baseline characteristics of participants in each study group are shown in Table I. The sample was predominantly Caucasian (28 of 30). This study was approved by the Research Ethics Board at the Children's Hospital of Eastern Ontario.

### Design and Procedures

The randomized controlled trial was conducted at the Children's Hospital of Eastern Ontario from September

2003 to June 2004. Thirty families were randomized to PA monitoring and feedback plus reinforcement (TV access) (open-loop feedback + reinforcement, *n* = 14) versus PA monitoring and feedback only (open-loop feedback alone, *n* = 16). None of the participants dropped out of the study. Children in both groups were provided objective feedback on their PA by wearing a PA monitor (BioTrainer; Individual Monitoring Systems, Baltimore, MD, USA). However, children in the open-loop feedback plus reinforcement group were rewarded with access to television based on the amount of PA accumulated, whereby 400 activity counts on the activity monitors, equivalent to about 1 h of moderate to vigorous PA (MVPA; Goldfield et al., 2006), provided 1 h of access to TV/VCR/DVD and TV-based computer games. TV access was controlled by a Token TV<sup>TM</sup> electronic device (Stokes Corporation, St. Mazomanie, WI, USA). Participants were required to install these electronic devices on each TV in the house and if they encountered any difficulties with installation, a research assistant was sent to the house to provide assistance. Each token provided 30 min of TV access followed by immediate shut off and the TV would not restart unless more tokens were inserted. At least one participating parent in the intervention group was subjected to the same contingencies as targeted children, but siblings and nonparticipating parent were given unlimited tokens so they could watch as much TV as desired. Families in the intervention group were instructed not to allow targeted children to watch TV on other family members' tokens. Children were free to accumulate physical activity counts by engaging in any and all types of activities they desired, except swimming since the accelerometers were not waterproof.

Children in the open-loop feedback control group were provided feedback on PA but did not have the token TV devices, hence had free access to TV. These children were required to visit the laboratory for activity monitor downloading according to the same schedule as the intervention group. Families in this group were not given any activity goals to avoid confounding goals with the effects of the feedback from activity monitors. More specific information of the trial methodology and procedures are reported elsewhere (Goldfield et al., 2006).

### Measurement

Demographics were evaluated by self-report and socioeconomic status was assessed by the sum of parental income. Medical history and current medical problems or

physical conditions that contraindicate PA were evaluated by self-report and clinical interview.

### Body Composition

Child weight was assessed to the nearest 0.1 kg with subjects wearing light clothing without shoes using a calibrated balance beam scale. Height was assessed using a Health-O-Meter stadiometer. Height and body weight were measured at baseline and 8-week follow-up assessment and used to determine BMI defined as weight in kg over height in m<sup>2</sup> (kg/m<sup>2</sup>). We chose to use BMI rather than z-BMI in light of new research indicating that traditional BMI is more sensitive to change over time than z-BMI (Cole, Faith, Pietrobelli, & Heo, 2005), making it more suitable to evaluate intervention effects.

### Measurement of Daily PA

PA was objectively measured by the BioTrainer<sup>®</sup> (IM Systems, Baltimore, MD, USA), a small, unobtrusive accelerometer validated under laboratory and field conditions (Welk, Blair, Wood, Jones, & Thompson, 2000), that has detected significant increases in PA in clinical outcome research (Andersen et al., 1999). The BioTrainer<sup>®</sup> provides minute-by-minute measures of PA, and thus can provide information on when children are active and not active, and the intensity of activity performed. Total activity counts, average daily activity counts, time spent in MVPA (3–5.9 METS), and vigorous physical activity (VPA  $\geq$  6 METS) (Pate et al., 1995) were calculated from data downloaded from the BioTrainer<sup>®</sup> at 7-day baseline, bi-weekly during the intervention, and 8-week posttreatment.

### Self-reported Behaviors

The Past Day Physical Activity recall (PD-PAR), a valid self-report measure of PA in children (Weston, Petosa, & Pate, 1997), including obese children, was used in combination with the BioTrainer<sup>®</sup> to indicate what children were doing when they were active and sedentary. Participants were asked to use the PD-PAR daily to record all targeted and nontargeted forms of sedentary behaviors, as well as physical activities throughout each day of the week during baseline and posttreatment assessment periods, as well as daily during the intervention. The PD-PAR was also used with interviews at screening to assess eligibility. Children self-reported the amount of time they wore the activity monitor by writing the time of day they put the monitor on and when they took it off, using a self-report form prepared by the investigative team. The self-reported activity was compared with the objective activity monitors to verify accuracy of reporting when activity monitors were worn,

and discrepancies between self-report and activity monitors were addressed with families in the bi-weekly meetings.

### Physical Self-perceptions

Physical self-perceptions were assessed using the Physical Self-Perception Profile for Children (PSPP-C; Fox & Corbin, 1989; Eklund, 1997). This 36-item inventory is designed to measure children's perceived competence in five domains of functioning: Sport, Physical Conditioning, Body Appearance, Strength, and a higher order construct—the Physical Self-Worth scale. The Harter Global Self-Esteem subscale (Harter, 1985) was added to evaluate the extent to which the child likes himself/herself as a person and is happy with the way he/she is. As such, this dimension constitutes a global dimension of one's self-worth as a person, rather than domain-specific competency or adequacy. These domains were discriminated from each other through factor analytic procedures (Fox & Corbin, 1989). The PSPP-C adopts a response format that includes both positively and negatively worded phrases to control for socially desirable responses. Each response has two components whereby children first choose the direction and then the intensity of their response. For example, they would first circle one of the following two statements that is most true of themselves: "some kids are often unhappy with themselves" BUT "other kids are pretty pleased with themselves." The second step in completing responses would be to rate whether the statement circled is "sort of true for me" or "really true for me." Items are scored on a 4-point rating scale (1–4), with higher numbers reflecting greater competence and self-esteem.

### Analytic Plan

The relationship between changes in overall PA and self-perceptions and the degree to which this relationship is influenced by changes in body composition were evaluated in two ways. First, between-group changes on the six domains of physical and global self-perceptions were evaluated using an intention to treat approach with a mixed analysis of variance and covariance models. The ANOVA/ANCOVA consisted of a between-subjects factor of group (open-loop feedback + reinforcements vs. open-loop feedback only), as well as a repeated measures factor of Time (Baseline vs. Posttreatment), with the six domains of physical self-perceptions serving as the dependent measures, and baseline BMI as a covariate. A significant Group  $\times$  Time interaction and post hoc tests using Fisher's exact tests were used to determine if the intervention provided psychosocial benefits independent of BMI. Two, pre–post change scores were created, and the



magnitude of correlation between the changes in overall PA (total counts per day), minutes per day in MVPA, minutes per day in VPA, targeted sedentary behavior, and self-perceptions were evaluated by Pearson Product Moment correlations with and without partialing out changes in BMI. In addition, correlations between changes in BMI and physical self-perceptions were also conducted. In all analyses, we used two-tailed alpha values set at 0.05.

**Table II.** Adjusted Means (and SDs) of Changes in Physical Self-perceptions<sup>a</sup>

Variable and assessment period	Intervention (n = 14)	Control (n = 16)	Group × Time p-value
<b>Sport</b>			
Baseline	15.5 (2.6)	15.9 (2.8)	
Postintervention	17.1 (3.4)	16.8 (3.1)	.478
Change (post minus pre)	1.6 (3.4)	0.9 (2.5)	
<b>Physical Conditioning</b>			
Baseline	14.4 (2.1)	14.2 (3.1)	
Postintervention	17.3 (2.7)	15.0 (2.5)	.043
Change (post minus pre)	2.9 (2.7)	0.8 (2.0)	
<b>Body Appearance</b>			
Baseline	12.4 (4.7)	12.2 (3.8)	
Postintervention	15.3 (3.4)	11.8 (3.6)	.050
Change (post minus pre)	2.9 (4.7)	-0.4 (3.8)	
<b>Strength</b>			
Baseline	18.4 (3.8)	16.6 (4.2)	
Postintervention	18.8 (3.9)	18.6 (3.6)	.251
Change (post minus pre)	0.4 (3.6)	2.0 (3.6)	
<b>Physical Self-Worth</b>			
Baseline	14.2 (3.4)	13.8 (4.2)	
Postintervention	16.9 (2.5)	14.1 (4.8)	.037
Change (post minus pre)	2.7 (2.9)	0.3 (3.1)	
<b>Global Self-Worth</b>			
Baseline	16.2 (4.5)	15.6 (4.2)	
Postintervention	17.1 (3.6)	16.2 (4.9)	.741
Change (post minus pre)	0.9 (2.6)	0.6 (4.5)	

<sup>a</sup>Scores adjusted for baseline BMI using ANCOVA.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS 13.0).

## Results

Demographic and anthropometric characteristics of the sample are reported in Table I. No group differences emerged on these variables.

ANOVAs yielded significant Group × Time interactions indicating that, compared with controls, the intervention group demonstrated significantly greater changes in total physical activity counts [ $F(3, 84) = 3.79, p < .05$ ], and time spent in MVPA [ $F(3, 84) = 2.8, p < .05$ ]. The Group × Time interaction for VPA was not significant.

There was a significant Group × Time interaction on several dependent measures. Controlling for BMI at baseline, the intervention group exhibited significantly greater improvements in perceived Physical Conditioning [ $F(1, 27) = 4.5, p = .036$ ], Body Appearance [ $F(1, 27) = 4.0, p = .04$ ], and Physical Self-Worth [ $F(1, 27) = 4.8, p = .02$ ] compared with controls. Between-group differences on the Sport, Strength, and Global Self-Esteem were not statistically significant. The results of analyses of physical self-perception scales are shown in Table II. Neither the main effects of time nor group were significant for any of the dependent measures when controlled for BMI.

Correlational analyses indicated that increases in PA were associated with increases in Body Appearance ( $r = .43, p = .017$ ), Condition ( $r = .38, p = .04$ ), and Physical Self-Worth ( $r = .44, p = .01$ ). As shown in Table III, these relationships remained significant after controlling for changes in BMI. Changes in PA were not associated with changes in Strength, or Global self-Esteem. Changes in targeted sedentary behavior (i.e., TV viewing) were not related to changes in physical self-perceptions when BMI

**Table III.** Pearson's Correlations between Changes in Physical Activity Level, Intensity, TV, and Self-Perceptions

Δ Self-perceptions	Uncontrolled				BMI controlled			
	ΔPA	ΔMVPA	ΔVPA	ΔTV	ΔPA	ΔMVPA	ΔVPA	ΔTV
Sport	.18	.15	.12	-.17	.16	.09	.12	-.14
Conditioning	.54**	.41*	.26	-.16	.54**	.42*	.26	-.24
Body Appearance	.53**	.36*	.23	-.13	.55**	.38*	.27	-.22
Strength	.22	-.12	.10	-.14	-.22	-.12	.10	-.11
Physical Self-Worth	.44*	.24	.07	-.24	.44*	.23	.07	-.38*
Global Self-Worth	-.13	-.15	-.14	-.13	-.11	-.13	-.14	-.36*

Δ Self-perceptions, post minus baseline change scores on self-perception subscales; ΔPA, changes from baseline through intervention of total physical activity pedometer counts per day; ΔMVPA, changes from baseline through intervention of minutes per day spent in moderate to vigorous physical activity; ΔVPA, changes from baseline through intervention of minutes per day spent in vigorous physical activity; ΔTV, changes from baseline through intervention of minutes per day spent watching television.

\* $p < .05$ , \*\* $p < .01$ .

**Table IV.** Pearson's Correlations between Changes in BMI and Changes in Self-Perceptions

$\Delta$ Self-perceptions	$\Delta$ BMI
Sport	.10
Conditioning	.01
Body Appearance	.10
Strength	.08
Physical Self-Worth	.05
Global Self-Worth	.18

$\Delta$ Self-perceptions, post minus baseline change scores on self-perception subscales;  $\Delta$ BMI, post minus baseline change scores on BMI.

was not controlled for, but were inversely related to Physical Self-Worth ( $r = -.38$ ,  $p = .05$ ) and Global Self-Esteem ( $r = -.36$ ,  $p = .05$ ) when BMI was statistically controlled for. The improvements in self-perceptions were more strongly correlated with overall volume (total counts) of PA rather than intensity, as shown in Table III.

A significant Group  $\times$  Time interaction emerged for BMI [ $F(1, 28) = 3.9$ ,  $p < .05$ ] indicating greater improvements for intervention group (pre:  $28.9 \pm 6.2$ ; post:  $28.3 \pm 6.6$ ) compared with control (pre:  $28.2 \pm 3.0$ ; post:  $28.5 \pm 3.1$ ). Changes in BMI were not related to changes in physical self-perceptions (Table IV).

## Discussion

To our knowledge, this is the first study to examine the effects of open-loop feedback to increase PA on psychosocial adjustment in overweight/obese children. Data from the current study indicate that increases in overall PA are associated with improvements in Body Satisfaction, perceived Physical Conditioning, and perceived Physical Self-Worth, and these psychological benefits were independent of reductions in BMI.

Despite the study intervention not resulting in "visible" change in BMI (Goldfield et al., 2006), there remained a relationship between increased PA and improved body appearance esteem. This finding, previously reported in youth (Kirkcaldy, Shephard, & Siefen, 2002), has important clinical implications. Many overweight children experience weight-based teasing (Puhl & Brownell, 2001), which likely serves to exacerbate body dissatisfaction that is already prevalent in this population (Wardle & Cooke, 2005). It is interesting to note that while one may expect self-esteem to increase in association with improved body satisfaction, our data indicate that increased PA was only associated with improved physical, but not global, self-worth, highlighting that the correlation between body esteem and self-esteem is not linear or symmetrical in overweight/obese children

(Wardle & Cooke, 2005). The fact that PA was associated with increased body image and several other domains of self-perception, but not global self-esteem, is inconsistent with systematic review findings indicating PA increases self-esteem and emotional well-being in children (Ekeland et al., 2004; Gruber, 1986). Perhaps this discrepancy in findings is due, in part, to the fact that most trials included in these reviews were not based on clinical samples of obese children. It appears that the current sample of overweight/obese children may be evaluating their global self-worth on many domains that extend well beyond merely PA and body image. This self-perception may provide psychological advantages given that over investment in body weight and shape is associated with increased risk of engaging in unhealthy eating and weight control practices, and full-blown eating disorders (American Psychiatric Association, 1994). Given that many obese children presenting for treatment have difficulty losing weight and maintaining the losses, it is encouraging to note that body image and physical self-worth can be enhanced, independent of weight loss simply by getting overweight children more physically active. Moreover, given that body dissatisfaction often elicits restrained eating or dieting for weight loss in overweight children (Casper & Offer, 1990; Field et al., 1999), combined with evidence that dieting leads to weight gain in youth (Field et al., 2003; Shunk & Birch, 2004), future research is needed to determine whether improved body image resulting from increased PA in overweight children translates to healthier eating behavior and weight management.

Our findings indicating that increases in PA were associated with increases in physical self-perceptions, independent of BMI, is consistent with previous research in mainly normal-weight children (Crocker et al., 2000) and adolescents (Crocker et al., 2003), and provides evidence that PA interventions can be empowering in the context of perceived competence in physical abilities in overweight/obese children. This finding is important knowing that physical self-worth is predictive of subsequent PA and sport participation (Biddle et al., 2001), which may provide greater opportunity to increase energy expenditure needed for weight loss or weight maintenance throughout growth in this patient population.

Today's children spend more time watching TV and playing video games than any other activity besides sleeping (The Annenberg Public Policy Center of the University of Pennsylvania, 1997), and obese children, in particular, spend more time in these sedentary activities

(Dietz & Gortmaker, 1985). Interestingly, reductions in TV viewing were associated with improvements in physical and global self-worth, but only when changes in BMI were statistically controlled. To the best of our knowledge, we are the first to document a relationship between reduced TV viewing and increased global self-worth in this population. One possible explanation for this finding may be that successfully reducing TV viewing may have enhanced feelings of self-discipline or self-control that psychologically empowered children to feel better about themselves. Additionally, children and youth are particularly vulnerable to the messages conveyed through TV, which have been shown to adversely influence their self-image and aggressive behaviors (American Academy of Pediatrics, 2001). Therefore, a reduction in viewing time may increase self-esteem by reducing exposure to unhealthy messages and unrealistic body images displayed on TV. Alternatively, reductions in TV viewing may conceivably lead to improved physical and global self-worth by increasing PA (Epstein, Roemmich, Paluch, & Raynor, 2005). However, our data indicate that improved global self-worth was not related to changes in PA; thus, given the multidimensional nature of self-esteem, increasing PA alone may not be sufficient to increase global self-esteem in overweight and obese children.

Regardless of the mechanism, the finding that reducing TV is predictive of improved self-esteem is important because good self-esteem is a predictor of physical health (Rhee, Holditch-Davis, & Miles, 2005) and is also a well-accepted measure of psychosocial health in youth (Rotenberg et al., 2004). Moreover, self-esteem has reliably been shown to predispose to, or buffer against, the development of numerous psychiatric disorders, including eating disorders (Fairburn, Welch, Doll, Davies, & O'Connor, 1997). Future research is needed to replicate and further understand how reductions in TV viewing are associated with enhanced self-esteem in overweight children.

The relationship between changes in intensity of PA and physical self-perceptions and global self-esteem in overweight/obese children has not been well studied. Our data indicate that overall volume (total counts) of PA was more closely associated with improvements in physical self-worth than MVPA, and in fact, there was virtually no relationship between changes in VPA and self-perceptions. Research suggests that obese children find it more difficult to sustain bouts of higher intensity PA than normal-weight children (Dishman, 1991; therefore, attempting to be active at these intensities may be

disempowering and affect adherence resulting in reduced physical self-perceptions. Conversely, increasing volume of PA at lower intensities may provide a sense of mastery and empowerment in relation to physical competencies. This finding, if replicated, has clinical relevance in that overall volume of PA in youth may be more important for providing psychosocial health benefits than higher intensity PA designed to improve fitness (Rowland & Freedson, 1994). In addition, encouraging overweight/obese children to engage in higher volume, lighter intensity PA may be a more realistic goal that would likely yield better adherence and may contribute to weight control (Rowlands, Eston, & Ingledeu, 1997).

This study has several limitations. Although novel research questions were posed, the small sample size makes it difficult to evaluate how generalizable these results are to preadolescent overweight/obese children. The sample size of primarily Caucasian children also precludes a meaningful evaluation of how gender or ethnicity influence the relationship between activity changes and psychosocial adjustment. Although changes in relationships were evaluated longitudinally, the study period was only 8-weeks and long-term follow up with multiple evaluations are needed to better determine how changes in volume and intensity of PA performed predict changes in physical and global self-worth in this population, and whether these changes are maintained after the intervention is stopped.

In summary, data from the current study indicate that increases in overall volume (total counts) of PA are associated with improvements in perceived physical conditioning, body satisfaction, and overall physical self-worth, and these improvements in psychosocial adjustment were not due to changes in body composition. Improvements in physical self-perceptions were more closely related to overall volume (total activity counts) of PA than intensity of PA, but this finding needs replication with larger samples and less sedentary children who engage in greater amounts of MVPA and VPA. Reductions in TV viewing were associated with increases in physical and global self-worth, independent of changes in BMI, thereby identifying additional psychological health benefits of reducing reinforcing sedentary behavior. Collectively, our findings indicate that behavioral interventions that increase PA and reduce TV viewing may be effective in improving weight control, and may also provide concomitant psychosocial benefits to a pediatric population in need. Future research incorporating longitudinal designs with multiple follow-ups are needed to

more accurately determine whether changes in activity provide psychosocial benefits, or whether improvements in psychosocial functioning lead to increased PA and reduced sedentary behavior, or both.

## Acknowledgments

This research is supported, in part, by a New Investigator Award and clinical trial grant from the Canadian Institutes of Health Research (CIHR) awarded to Dr Gary Goldfield. The authors would like to thank Dr Hollie Raynor, and Paula Cloutier for providing constructive feedback on previous versions of this manuscript.

*Conflict of interest:* None declared.

Received May 31, 2006; revisions received February 20, 2007; accepted February 20, 2007

## References

- American Academy of Pediatrics. (2001). Children, adolescents, and television. *Pediatrics*, *107*, 423–426.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.
- Andersen, R. E., Crespo, C. J., Bartlett, S. J., Cheskin, L. J., & Pratt, M. (1998). Relationship of physical activity and television watching with body weight and level of fatness among children: Results from the Third National Health and Nutrition Examination Survey. *Journal of the American Medical Association*, *279*, 938–942.
- Andersen, R. E., Wadden, T. A., Bartlett, S. J., Zemel, B., Verde, T. J., & Franckowiak, S. C. (1999). Effects of lifestyle activity vs structured aerobic exercise in obese women: a randomized trial. *Journal of the American Medical Association*, *281*, 335–340.
- Bar-Or, O., Foreyt, J., Bouchard, C., Brownell, K. D., Dietz, W. H., Ravussin, E., et al. (1998). Physical activity, genetic, and nutritional considerations in childhood weight management. *Medicine & Science in Sports & Exercise*, *30*, 2–10.
- Biddle, S. J. H., & Mutrie, N. (2001). *Psychology of physical activity: Determinants, well-being, and interventions*. London: Routledge.
- Biddle, S. J. H., Sallis, J., & Cavill, N. (1998). *Young and active? Young people and health-enhancing physical activity: Evidence and implications*. London: Health Education Authority.
- Braet, C., Mervielde, I., & Vandereycken, W. (1997). Psychological aspects of childhood obesity: A controlled study in a clinical and nonclinical sample. *Journal of Pediatric Psychology*, *22*, 59–71.
- Casper, R. C., & Offer, D. (1990). Weight and dieting concerns in adolescents, fashion or symptom? *Pediatrics*, *86*, 384–390.
- Cole, T. J., Faith, M. S., Pietrobelli, A., & Heo, M. (2005). What is the best measure of adiposity change in growing children: BMI, BMI%, BMI z-score or BMI centile? *European Journal of Clinical Nutrition*, *59*, 419–425.
- Crocker, P. R., Eklund, R. C., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Sciences*, *18*, 383–394.
- Crocker, P., Sabiston, C., Forrester, S., Kowalski, N., Kowalski, K., & McDonough, M. (2003). Predicting change in physical activity, dietary restraint, and physique anxiety in adolescent girls: Examining covariance in physical self-perceptions. *Canadian Journal of Public Health*, *94*, 332–337.
- Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics*, *101*, 518–525.
- Dietz, W. H., & Gortmaker, S. L. (1985). Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics*, *75*, 807–812.
- Dishman, R. K. (1991). Increasing and maintaining exercise and physical activity. *Behavior Therapy*, *22*, 345–378.
- Durant, R. H., Baranowski, T., Johnson, M., & Thompson, W. O. (1994). The relationship among television watching, physical activity, and body composition of young children. *Pediatrics*, *94*, 449–455.
- Eisenberg, M. E., Neumark-Sztainer, D., & Story, M. (2003). Associations of weight-based teasing and emotional well-being among adolescents. *Archives of Pediatrics & Adolescent Medicine*, *157*, 733–738.
- Ekeland, E., Heian, F., Hagen, K. B., Abbott, J., & Nordheim, L. (2004). Exercise to improve self-esteem in children and young people (Cochrane Review) *The Cochrane Library*. (pp. 1–30). Chichester, UK: John Wiley and Sons, Ltd.
- Eklund, R. C., Whitehead, J. R., & Welk, G. J. (1997). Validity of children and youth physical self-perception profile: A confirmatory factor analysis. *Research Quarterly for Exercise and Sport*, *68*, 249–256.



- Epstein, L. H., Roemmich, J. N., Paluch, R. A., & Raynor, H. A. (2005). Physical Activity as a substitute for sedentary behavior in youth. *Annals of Behavioral Medicine, 29*, 200–209.
- Fairburn, C. G., Welch, S. L., Doll, H. A., Davies, B. A., & O'Connor, M. E. (1997). Risk factors for bulimia nervosa. A community-based case-control study. *Archives of General Psychiatry, 54*, 509–517.
- Faith, M. S., Berman, N., Heo, M., Pietrobelli, A., Gallagher, D., Epstein, L. H., et al. (2001). Effects of contingent television on physical activity and television viewing in obese children. *Pediatrics, 107*, 1043–1048.
- Field, A. E., Austin, S. B., Taylor, C. B., Malspeis, S., Rosner, B., Rockett, H. R., et al. (2003). Relation between dieting and weight change among preadolescents and adolescents. *Pediatrics, 112*, 900–906.
- Field, A. E., Camargo, C. A. Jr, Taylor, C. B., Berkey, C. S., Frazier, A. L., Gillman, M. W., et al. (1999). Overweight, weight concerns, and bulimic behaviors among girls and boys. *Journal of the American Academy of Child & Adolescent Psychiatry, 38*, 754–760.
- Fox, K. R., & Corbin, C. B. (1989). The Physical Self-Perception Profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*, 408–430.
- French, S. A., Jeffery, R. W., Forster, J. L., McGovern, P. G., Kelder, S. H., & Baxter, J. E. (1994). Predictors of weight change over two years among a population of working adults: The Healthy Worker Project. *International Journal of Obesity & Related Metabolic Disorders, 18*, 145–154.
- French, S. A., Perry, C. L., Leon, G. R., & Fulkerson, J. A. (1996). Self-esteem and change in body mass index over 3 years in a cohort of adolescents. *Obesity Research, 4*, 27–33.
- French, S. A., Story, M., & Perry, C. L. (1995). Self-esteem and obesity in children and adolescents: A literature review. *Obesity Research, 3*, 479–490.
- Goldfield, G. S., Kalakanis, L. E., Ernst, M. M., & Epstein, L. H. (2000). Open-loop feedback to increase physical activity in obese children. *International Journal of Obesity & Related Metabolic Disorders, 24*, 888–892.
- Goldfield, G. S., Mallory, R., Parker, T., Cunningham, T., Legg, C., Lumb, A., et al. (2006). Effects of open-loop feedback on physical activity and television viewing in overweight and obese children: A randomized controlled trial. *Pediatrics, 118*, e157–e166.
- Goodman, E., & Whitaker, R. C. (2002). A prospective study of the role of depression in the development and persistence of adolescent obesity. *Pediatrics, 110*, 497–504.
- Gortmaker, S. L., Must, A., Perrin, J. M., Sobol, A. M., & Dietz, W. H. (1993). Social and economic consequences of overweight in adolescence and young adulthood. *New England Journal of Medicine, 329*, 1008–1012.
- Gortmaker, S. L., Must, A., Sobol, A. M., Peterson, K., Colditz, G. A., & Dietz, W. H. (1996). Television watching as a cause of increasing obesity among children in the United States, 1986–1990. *Archives of Pediatrics and Adolescent Medicine, 150*, 356–362.
- Gruber, J. (1986). Physical activity and self-esteem development in children: A meta-analysis. In G. Stull, & H. Eckern (Eds), *Effects of physical activity on children* (pp. 330–348). Champaign, IL: Human Kinetics.
- Hancox, R. J., & Poulton, R. (2006). Watching television is associated with childhood obesity: But is it clinically important? *International Journal of Obesity, 30*, 171–175.
- Harter, S. (1985). *Manual for the self-perception profile for children*. Denver: University of Denver.
- Janssen, I., Katzmarzyk, P. T., Boyce, W. F., Vereecken, C., Mulvihill, C., Roberts, C., et al. (2005a). Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obesity Reviews, 6*, 123–132.
- Janssen, I., Katzmarzyk, P. T., Srinivasan, S. R., Chen, W., Malina, R. M., Bouchard, C., et al. (2005b). Utility of childhood BMI in the prediction of adulthood disease: Comparison of national and international references. *Obesity Research, 13*, 1106–1115.
- Johnson, M. S., Figueroa-Colon, R., Herd, S. L., Fields, D. A., Sun, M., Hunter, G. R., et al. (2000). Aerobic fitness, not energy expenditure, influences subsequent increase in adiposity in black and white children. *Pediatrics, 106*, E50–E56.
- Kirkcaldy, B. D., Shephard, R. J., & Siefen, R. G. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents.

- Social Psychiatry & Psychiatric Epidemiology*, 37, 544–550.
- Kuczmarski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., Wei, R., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2002). 2000 CDC growth charts for the United States: Methods and development. *Vital Health Statistics*, 246, 1–190.
- Latner, J. D., & Stunkard, A. J. (2003). Getting worse: The stigmatization of obese children. *Obesity Research*, 11, 452–456.
- Mamalakis, G., Kafatos, A., Manios, Y., Anagnostopoulou, T., & Apostolaki, I. (2000). Obesity indices in a cohort of primary school children in Crete: A six year prospective study. *International Journal of Obesity & Related Metabolic Disorders*, 24, 765–771.
- Norman, G. J., Schmid, B. A., Sallis, J. F., Calfas, K. J., & Patrick, K. (2005). Psychosocial and environmental correlates of adolescent sedentary behaviors. *Pediatrics*, 116, 908–916.
- Olds, T., Ridley, K., & Dollman, J. (2006). Screenieboppers and extreme screenies: The place of screen time in the time budgets of 10–13 year old Australian children. *Australian and New Zealand Journal of Public Health*, 30, 137–142.
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., et al. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, 273, 402–407.
- Pierce, J. W., & Wardle, J. (1997). Cause and effect beliefs and self-esteem of overweight children. *Journal of Child Psychology & Psychiatry & Allied Disciplines*, 38, 645–650.
- Premack, D. (1959). Toward empirical behavioral laws: 1. Positive reinforcement. *Psychological Review*, 66, 219–233.
- Puhl, R., & Brownell, K. D. (2001). Bias, discrimination, and obesity. *Obesity Research*, 9, 788–805.
- Raudsepp, L., & Liblik, R. (2002). Relationship of perceived and actual motor competence in children. *Perceptual & Motor Skills*, 94, 1059–1070.
- Rhee, H., Holditch-Davis, D., & Miles, M. S. (2005). Patterns of physical symptoms and relationships with psychosocial factors in adolescents. *Psychosomatic Medicine*, 67, 1006–1012.
- Ricciardelli, L. A., & McCabe, M. P. (2001). Children's body image concerns and eating disturbance: A review of the literature. *Clinical Psychology Review*, 21, 325–344.
- Rotenberg, K. J., McDougall, P., Boulton, M. J., Vaillancourt, T., Fox, C., & Hymel, S. (2004). Cross-sectional and longitudinal relations among peer-reported trustworthiness, social relationships, and psychological adjustment in children and early adolescents from the United Kingdom and Canada. *Journal of Experimental Child Psychology*, 88, 46–67.
- Rowland, T. W., & Freedson, P. S. (1994). Physical activity, fitness and health in children: A closer look. *Pediatrics*, 93, 669–672.
- Rowlands, A. V., Eston, R. G., & Ingledew, D. K. (1997). Measurement of physical activity in children with particular reference to the use of heart rate and pedometry. *Sports Medicine*, 24, 258–272.
- Saelens, B. E., & Epstein, L. H. (1998). Behavioral engineering of activity choice in obese children. *International Journal of Obesity*, 22, 275–277.
- Sallis, J. F., Simons-Morton, B. G., Stone, E. J., Corbin, C. B., Epstein, L. H., Faucette, N., et al. (1992). Determinants of physical activity and interventions in youth. *Medicine and Science in Sports and Exercise*, 24, S248–S257.
- Shunk, J. A., & Birch, L. L. (2004). Girls at risk for overweight at age 5 are at risk for dietary restraint, disinhibited overeating, weight concerns, and greater weight gain from 5 to 9 years. *Journal of the American Dietetic Association*, 104, 1120–1126.
- Stark, O., Atkins, E., Wolff, O. H., & Douglas, J. W. B. (1981). Twenty-four hour energy expenditure and resting metabolic rate in obese, moderately obese, and control subjects. *American Journal of Clinical Nutrition*, 35, 566–573.
- Swallen, K. C., Reither, E. N., Haas, S. A., & Meier, A. M. (2005). Overweight, obesity, and health-related quality of life among adolescents: The National Longitudinal Study of Adolescent Health. *Pediatrics*, 115, 340–347.
- The Annenberg Public Policy Center of the University of Pennsylvania. (1997). *Television in the home: The 1997 Survey of Parents and Children*. Philadelphia: University of Pennsylvania.
- Tremblay, M. S., & Willms, J. D. (2000). Secular trends in the body mass index of Canadian children. *CMAJ*, 163, 1429–1433.

- Viner, R. M., & Cole, T. J. (2005). Television viewing in early childhood predicts adult body mass index. *Journal of Pediatrics*, *147*, 429–435.
- Wardle, J., & Cooke, L. (2005). The impact of obesity on psychological well-being. *Best Practice & Research Clinical Endocrinology & Metabolism*, *19*, 421–440.
- Welk, G., Blair, S., Wood, K., Jones, S., & Thompson, R. (2000). A comparative evaluation of three accelerometry-based physical activity monitors. *Medicine and Science in Sports and Exercise*, *32* (9 Suppl), S489–S497.
- Weston, A. T., Petosa, R., & Pate, R. R. (1997). Validation of an instrument for measurement of physical activity in youth. *Medicine and Science in Sports and Exercise*, *29*, 138–143.
- World Health Organization (2002). Controlling the global obesity epidemic. <http://www.who.int/nut/obs.html>.
- Zeller, M. H., Saelens, B. E., Roehrig, H., Kirk, S., & Daniels, S. R. (2004). Psychological adjustment of obese youth presenting for weight management treatment. *Obesity Research*, *12*, 1576–1586.