A Reciprocal Effects Model of Children's Body Fat Self-Concept: Relations with Physical Self-Concept and Physical Activity

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Abstract

This study investigated a reciprocal effects model (REM) of children's body fat self-concept, physical self-concept, and objectively measured school physical activity at different intensities. Grade four students (*N*= 376; *M* age= 9.07, *SD*= .61; 55% boys) from the Midwest region of the United States completed measures of physical self-concept, body fat self-concept, and wore accelerometers for three consecutive school days at the beginning and end of one school year. Findings from structural equation modeling analyses did not support reciprocal effects. However, children's body fat self-concept predicted future physical self-concept and moderate-to-vigorous physical activity (MVPA). Multigroup analyses explored the moderating role of weight status, sex, ethnicity, and sex*ethnicity within the REM. Findings supported invariance, suggesting that the observed relations were generalizable for these children across demographic groups. Links between body fat self-concept and future physical self-concept and MVPA highlight self-enhancing effects that can promote children's health and well-being.

Keywords: body image; self-concept; objective physical activity; self-enhancement

Positive self-perceptions of one's body and overall physical self has been shown to have potentially powerful effects on health. For example, positive physical self-appraisals can reduce the risk for depression (Blashill & Wilhelm, 2013), are associated with health-related fitness (Marsh & Redmayne, 1994) and promote health-enhancing behaviors such as physical activity (PA) (Lindwall, Asci, & Crocker, 2014; Marsh, Papaioannou, & Theodorakis, 2006). Craven and Marsh (2008) report that a positive physical self-concept has the potential to enhance body image, simulate greater enjoyment of PA, and attenuate sedentary behavioral patterns. Of central importance to this study is advancing our understanding of children's physical self-perceptions in relation to body fat self-concept and objectively measured PA during the school day. We draw on longitudinal data collected during one school year with a group of ethnically diverse primary school students from six different schools. An overview of the physical self-concept construct, synthesis of physical self-concept research, and explanation of how the current study fills specific gaps within the literature is provided below.

Physical Self-Concept

Shavelson, Hubner, and Stanton (1976) initially conceptualized a hierarchical and multidimensional model of self-concept, which set the stage for sport and exercise psychology researchers to systematically investigate physical self-concept (Fox & Corbin, 1989; Marsh, 1997; Marsh, Martin, & Jackson, 2010; Marsh, Morin, & Parker, 2015; Marsh et al., 2006). Global self-esteem resides at the top of the self-concept model and is defined as an individual's positive feelings about her/his self. Global self-concept is considered a product of domain-specific self-concepts pertaining to academic/intellectual, physical, social, and emotional perceptions of the self, which are located below global self-esteem in the second level of the hierarchical model (Marsh, 1997). Physical self-concept, defined as feeling positive about one's physical self, is considered an important mental health outcome and facilitator of both PA and health-related fitness (Harter, 2012; Marsh et al., 2010; Marsh et al., 2006; Marsh & Peart, 1988; Marsh & Redmayne, 1994). Marsh and colleagues propose a multidimensional framework of physical self-concept that includes nine subdomains of physical self-concept including: (a) activity; (b) appearance, (c) body fat, (d) coordination; (e) endurance, (f) flexibility; (g) health, (h) sport, and (i) strength. Body fat self-concept is a particularly salient self-concept dimension given its visibility. For instance, young children are routinely teased about being fat (Puhl,& Luedicke, 2012). Additionally, body fat (and body fat self-perceptions) are strongly associated with indices of both mental and physical health (Freedman, Dietz, Srinivasan, & Berenson, 1999). For example, in young children weight concerns are positively related to depressive symptoms after controlling for BMI (Erickson, Robinson, Haydel, & Killen, 2000). For the above reasons, the current study focuses on the physical and body fat self-concepts.

Self-concept research generally assumes that subdomains of physical self-concept most relevant to a specific context, personal characteristic, or behavior will generate the greatest predictive utility (Marsh, 1997; Marsh & Redmayne, 1994; O'Mara et al., 2006). For example, one would expect strength self-concept to be the most responsive self-concept facet to improvements on a strength task (Marsh & Redmayne, 1994). The use of self-concept measures less germane to the strength task (e.g., flexibility self-concept) or global measures (e.g., self-esteem) are theorized to lead to an underestimation of true relations between self-concepts and other constructs. However, so far, studies anchored in Marsh's physical self-concept framework have generally focused on physical self-conceptions in adolescent populations (Garn, McCaughtry, Martin, Shen, & Fahlman, 2012; Marsh et al., 2015; Marsh et al., 2006; Standage, Gillison, Ntoumanis, & Treasure, 2012). Physical self-concept subdomains have received more limited attention in these investigations (see Lindwall et al., 2014 for an exception), particuklarly in children populations. Examination of both physical self-concept and strategically targeted subdomains (O'Mara et al., 2006) may provide a more efficient approach for creating health-enhancing interventions specifically focused at specific physical subdomains such as fitness enhancement or weight/body fat reductions (Kavanaugh, Moore, Hibbett, & Kaczynski, 2014; Lindwall et al., 2014; Marsh & Peart, 1988).

Body fat self-concept may be especially important to understanding health-related behaviors and long-term health in youth (Blashill & Wilhelm, 2013; Morin, Maiano, Marsh, Janosz, & Nagengast, 2011), particularly in light of the increasing rates of obesity reported in young populations and the dire health-related consequences associated with this public health challenge (Center for Disease Control and Prevention [CDC], 2015; World Health Organization [WHO], 2012). Body fat self-concept is defined as feeling that one is not overweight or fat. There is currently a dearth of research exploring how body fat self-concept relates to a variety of health-enhancing behaviors. Marsh's body fat self-concept items ask individuals to make direct assessments of their weight and body fat, which may tap into a specific motive for engaging in health-enhancing behaviors (Teixeira, Silva, Mata, Palmeira, & Markland, 2012). Likewise, engagement in health-enhancing behaviors may help improve fitness and manage weight and fat, thereby producing a more positive body fat self-concept. Exploring potential reciprocal effects of body fat self-concept and PA thus appears warranted.

Reciprocal Effects Model

Marsh and colleagues articulate the historical debate about whether self-concepts are best positioned as antecedents of future achievement and behaviors (i.e., self-enhancement hypothesis), outcomes of previous achievement and behaviors (i.e., skill development hypothesis), or if bi-directional relations between self-concepts and achievements/behaviors exist (reciprocal effects model; REM). From a self-enhancement perspective, higher physical self-concepts are expected to produce increased future levels of physical activity. The self-enhancement hypothesis assumes that positive self-concepts are central to maximizing human potential (Craven & Marsh, 2008) and stimulate future achievement (e.g., school achievement, Green, Nelson, Martin, & Marsh, 2006) and adaptive health and behavior (e.g., mental health, Marsh, Parada, & Ayotte, 2004). From a skill development perspective, physical activity engagement is expected to result in increases in physical self-concepts. Marsh et al. (2006) revealed positive reciprocal effects between physical self-concept and self-reported exercise behaviors in a large sample of Greek adolescents enrolled in physical education classes. Similarly, Lindwall et al. (2014) revealed reciprocal effects between physical self-worth and self-reported PA with adolescent girls using cross-lagged analyses.

The current study contributes to previous REM research by using objective measures of children's PA at different intensities (i.e., moderate-to-vigorous; light) assessed via accelerometers, rather than self-report measures (Lindwall et al., 2014; Marsh et al., 2006), which may overestimate covariance with physical self-perceptions (Kavanaugh et al., 2014). Unlike other REM studies, our focus is on children's school-based PA. Public health agencies such as the WHO and CDC recommend that children accumulate 60 minutes of PA per day and identify the important role that schools play in enabling children to meet this recommendation. The CDC advocates for schools to take a comprehensive approach to PA, allowing children to acquire large quantities of PA in the school context. Comprehensive school PA programs emphasize quality physical education programs, recess, PA breaks during the school day, before and after school PA opportunities, teacher/school staff involvement, and parental/community partnerships (CDC, 2013). There is currently limited understanding on how effective comprehensive school programs are at engaging young people in school-related PA, although recent studies are promising (Castelli, Centeio, Beighle, Carson, & Nicksic, 2014). Comprehensive school PA programs may also create an environment that enhances students' physical self-concept (Martin, Garn, Shen, McCaughtry, & Nash, 2014), yet more confirming evidence using diverse research designs including REMs is needed.

Furthermore, this study includes both physical self-concept and body fat self-concept in the REM, which allows for interesting comparisons between domain and subdomain constructs of physical self-concept. Specifically, top-down (going from global constructs to specific constructs), bottom-up (going from specific constructs to global constructs), reciprocal (going both ways) and horizontal (construct-specific) relations can be investigated (Lindwall et al., 2014; Marsh & Yeung, 1998). In the context of this study, top-down relations are supported if prior physical self-concept predicts future body fat self-concept after controlling for previous body fat self-concept. Bottom-up relations are supported if prior body fat self-concept predicts future physical self-concept after controlling for previous physical self-concept. Reciprocal relations are supported if prior body fat self-concept predicts future physical self-concept and prior physical self-concept predicts future body fat self-concept, after controlling for previous levels on both constructs. Horizontal relations are supported if only autoregressive associations between each construct and itself at a later time point are present.

Developmental Issues, Sex, Ethnicity, and Weight Status

Adolescence is a developmental period when physical self-concept and body-related self-perceptions are typically investigated (Lindwall et al., 2014; Marsh et al., 2015; Marsh et al., 2006; Morin et al., 2011). It is common for adolescents to experience substantial physical changes associated with puberty (Morin et al., 2011). Previously, researchers have noted that children generally report positive self-concepts, which subsequently decrease during the adolescent transition, and stabilize during young adulthood (Harter, 2012; Marsh, Craven, & Debus, 1998). Marsh et al. (1998) suggest common developmental changes associated with cognition and greater experiences help explain self-concept development. With the increased prevalence and potential implications of childhood obesity on physical self-concept and body fat self-concept, however, there is a clear need to examine REMs in younger populations (Crocker et al., 2003). Maintaining a high level of body fat self-concept may be especially salient as many overweight children experience weight and fat related biases (Li & Rukavina, 2012).

The influence of sex and ethnicity on physical self-concept has been a noteworthy area of investigation (Harter, 2012; Lindwall et al., 2014; Marsh et al., 2015; Morin et al., 2011). Boys typically have higher physical self-concepts and body-related self-concepts compared to girls (Marsh et al., 2015; Morin et al., 2011). Sex differences appear to be accentuated during adolescence. Differences may be less prevalent for children prior to puberty for a variety of reasons including minimized physical differences between boys and girls, and over-inflated views of self-concept in younger populations (see Harter, 2012; Marsh et al., 1998). With the proliferation of technology and screen time, boys and girls may also experience greater amounts of body socialization and develop body awareness earlier than previous generations (CDC, 2015). Similarly, ethnic background also appears to be linked to body image and physical self-concept (Botta, 2000; Morin et al., 2011). Historically, body image research has oversampled

Caucasian girls and women, leaving boys and men, as well as Black/African American girls and women, underrepresented. Individuals from Black/African American backgrounds appear to report a more positive body image and greater acceptance of larger bodies than other ethnicities (DiGioacchino, Sargent, & Topping, 2001). Morin and colleagues revealed a complex interaction between sex and ethnicity on body image whereby Caucasian girls report a more negative body image compared to other demographic groups. More investigation is needed, however, in child populations to determine when and if these issues occur prior to adolescence.

Weight status also appears to be closely intertwined with differences in physical self-concept (Paeratakul, White, Williamson, Ryan, & Bray, 2002) and activity patterns (Hamer et al., 2013) in adult populations. Research in this area suggests that physical self-concepts and PA levels tend to be lower for individuals with a body mass index (BMI) corresponding to overweight or obesity compared with those with a BMI corresponding to normal weight. However, relations between physical self-perceptions and PA appear to be more complex, especially in younger populations (Morano, Colella, Robazza, Bortoli, & Capranica, 2011). For example, it is unclear whether weight status may changes the relationship between physical self-concept and PA (Does being obese/overweight suppress the association? Does it reinforce it?).

The Present Study

The purpose of this study is to investigate reciprocal relations between children's body fat self-concept, physical self-concept, and in-school PA across one school year. We hypothesized that the strongest relations would occur between autoregressive pathways (solid lines in Figure 1). We also explored reciprocal relations (dashed paths in Figure 1) whereby physical self-concept, body fat self-concept, MVPA, and Light PA at time 1 (T1) predict the other constructs at time 2 (T2) after accounting for autoregressive relations. Previous REM studies have relied on self-report measures of PA (Lindwall et al., 2014; Marsh et al., 2006) and it is unclear if these findings can be replicated with objective measures of PA. Furthermore, there is a dearth of research investigating predictive utility of body fat self-concept. Finally, the moderating role of sex, ethnicity, sex*ethnicity, and weight status is examined within the REM to determine the generalizability of relations across the various subpopulations represented in this sample.

Participants

Participants were 376 grade four students (*M* age= 9.07, *SD*= .61, range 8-11) from six different elementary schools in the Midwestern United States. There were slightly more boys (55%) than girls. Approximately 46% of the children reported their ethnicity as Black/African-American, 26% as White/Caucasian, 14% Multi-Racial, 5% American Indian, and 3% Arab-American, with smaller percentages for a variety of other ethnic groups. The average body mass index (BMI) for the sample was 18.46 (*SD*= 5.23) with limited variability between girls (*M*= 19.05, *SD*= 5.85) and boys (*M*= 17.96; *SD*= 4.61). In order to provide greater context for BMI scores, we used CDC's BMI norms delineated by sex and age to classify students' weight status (Kuczmarski et al., 2002). Approximately 25% of these children were at or above the 95th percentile (obese), 10% were between the 85th and 94th percentiles (overweight), 61% were between the 6th and 84th percentile (normal weight), and 4% were at the 5th percentile or below (underweight). The percentage of students receiving free and reduced lunch ranged from roughly 20% to 80% across the six schools while the size of the schools ranged from approximately 300 to 700 students. All six schools were targeted because they were in the first year of a comprehensive school PA program initiative and, collectively, represented a sample that reflected students commonly found in diverse urban school districts in the Midwest state that the study took place. All grade 4 classrooms from the six schools were sampled and the student participation rate (> 85%) was very high.

Procedure

Permission to conduct the study was obtained from the researchers' university institutional review board. School administrators from the six schools were initially contacted about the study and all provided permission to move forward with the study in their schools. Members of the research team and trained research assistants visited each school and introduced the study to grade four classes during the first month of school. Once parent permission and child assent were obtained, research assistants started the first wave of data collection, which occurred over a three week time period. Specifically, two schools were completed each week whereby surveys and three days of in-school PA data were collected. All survey questions were read to the children. The Flesch-Kincade formula was used to examine readability of each item, which revealed that some of the items surpassed typical grade 4 reading levels, especially the physical self-concept items (grade 6-8 readability range). Previous studies recommend the use of such a read-aloud procedure for collecting self-concept data with children because of close links between language and self-concept and the fact that children limited reading skills may inadvertently bias their ratings in the absence of additional support (see Harter, 2012; Marsh, Ellis, & Craven, 2002). Our goal was to potentially limit the impact of students with low reading ability, which can be prevalent in urban schools serving students living in poverty (Esposito, 1999). The research team used the same procedures for wave 2 at the end of the school year. The interval between time one (T1) and time two (T2) was approximately eight months. This timeline was chosen for a variety of factors. First, weather patterns in the region are typically similar at T1 and T2. Second, collecting data early and late in a school year is a typical approach in REM studies examining physical self-concept and PA (e.g., Marsh et al., 2006).

Measures

Self-Concept. The Physical Self-Description Questionnaire – Short (PSDQ-S; Marsh et al., 2010) was used to measure the body fat and physical self-concepts of these children. There are a total of three items in the body fat subscale ("My waist is too large"; "I am overweight"; "I have too much body fat on my body") that are all reverse coded. There are also three items representing physical self-concept ("Physically, I am happy with myself"; "Physically, I feel good about myself"; "I feel good about who I am physically"). Items are measured on a six-point scale ranging from *False* (1) to *True* (6).

In order to evaluate construct validity of the body fat and physical self-concepts measures, preliminary confirmatory factor analyses were conducted at T1 and T2. Findings supported the a priori two-factor structure at both time points. The fit of the model was good at both T1 [$S\text{-}B\ \chi^2$ (8) = 13.680, p = .09, CFI = .977, TLI = .958, RMSEA = .043] and T2 [$S\text{-}B\ \chi^2$ (8) = 11.521, p = .14, CFI = .989, TLI = .979, RMSEA = .034], with standardized factor loadings ranging from .61 - .76 at T1 and.71 - .84 at T2.

Physical activity. Student in-school PA was collected using tri-axial accelerometers (ActiGraph GT3X+). They recorded data in 15-second intervals (epochs). Children wore the accelerometers on the right hip, secured with an elastic belt. The ActiGraph GT3X+ has demonstrated outstanding criterion validity and reliability in previous research (Melanson, & Freedson, 1995). Accelerometer data were collected over a three-day period of time (Monday – Wednesday) from the beginning to the end of the school day. Although seven days in considered the gold standard, research shows that three days are sufficient with children to achieve adequate levels of reliability (.70) similar to those obtained for a full week (Mattocks et al., 2008; Trost, Pate, Freedson, Sallis, & Taylor, 2000). Results from Mattocks et al. (2008) also suggest that measuring three days of PA with accelerometers during the week produces minimal differences compared to three days including one weekend day. Considering that our focus was on in-school PA, we determined that Monday – Wednesday was an appropriate evidence-based approach that also provided consideration of school schedules and school administrators' tolerance for classroom disruption. Data was downloaded using the manufacturer's software (ActiLife version 6, ActiGraph LLC, Florida, USA).. The Meterplus 4.2 software was then used to screen and clean the accelerometer data files. Non-wearing time was calculated as periods of more than 30 minutes of consecutive zero counts (Rowlands, 2007). Children were included in the study if they had at least 2 weekdays with a minimum of 5 hours wearing time. Minutes per day (average of all valid days) of PA were estimated using cut-points recommended by Freedson, Pober, and Janz, (2005) for children within the same age range (i.e., 8-12): 100 – 499 counts per minutes (cpm) equals light PA, whereas higher levels represent MVPA (500 - 3999 cpm equals moderate PA, 4000 and higher equals vigorous PA). These cut-points have demonstrated robust criterion validity when compared to direct observation techniques in school-based contexts with children of similar age (McClain, Abraham, Brusseau, & Tudor-Locke, 2008).

Data Analysis

A series of confirmatory factor analyses (CFA) were used to test the longitudinal invariance of body fat and physical self-concepts to ensure the same constructs were being measured at both time points (Widaman, Ferrer, & Conger, 2010). A total of three nested models with increasingly restrictive constraints were tested using the lavaan package in R software (Rosseel, 2012). The configural model was used as a baseline where no constraints were placed on the model. Factor loadings were constrained to be equal across time in the second model to test for weak factorial invariance. Factor loadings and intercepts were constrained to be equal across time in the third model to test for strong factorial invariance. Establishing longitudinal invariance provides evidence of measurement stability for the set of indicators at T1 and T2. Situated in this study, longitudinal invariance demonstrates that body fat self-concept and physical self-concept represent the same constructs across time points and confirms differences or change are occurring at the construct level and not at the indicator level (Little, 2013). In all of these models, as well as in the following SEM and multiple group models, a priori correlated uniquenesses were included among matching indicators of the constructs over time to reflect the fact that indicators' unique variance are known to emerge, in part, from shared sources of influences over time (Jöreskog, 1979; Marsh, 2007).

The main hypotheses were then tested using structural equation modeling (SEM) including both latent (body fat self-concept and physical self-concept at T1 and T2) and manifest variables (i.e., Light PA and MVPA at T1 and T2). The initial step tested the measurement model of an autoregressive model where each T2 variable was regressed on its T1 measure. Once the measurement model was established, we examined structural relations of the autoregressive paths. This model was termed the autoregressive model. Next, we built a full REM model that included all autoregressive and cross-lagged paths identified in Figure 1. The measurement model of the REM was compared to the autoregressive model to determine if it produced a better fit. Structural relations within the REM were then examined. The lavaan.survey package (Oberski, 2014) was used to test the SEM models because it provided flexibility to investigate our hypotheses, aimed at the individual level, while adjusting χ^2 values and standard errors in accordance with the clustered nature of these data at the school level (Muthén & Satorra, 1995).

Finally, a series of multigroup SEM analyses were used to explore the moderating role of sex (females = 165; males = 211), ethnicity (Black students = 172; Other students = 204), sex*ethnicity (Black males = 103; Black females = 69; Other males = 108; Other females = 96), and weight status (overweight / obese students = 131; normal weight / underweight students = 245) on the REM relations. Following CDC recommendations, students in the 85^{th} percentile or above based on their age and sex were classified as overweight / obese. Like longitudinal invariance testing conducted with the preliminary CFA models, tests of configural, weak, and strong invariance were initially completed. Additionally, tests focusing on the invariance of the latent means, omnibus variances and covariances, and regression coefficients across groups were also conducted. Failure to confirm invariance at the latent level suggests there are different patterns of relations between groups, providing support for moderation.

All of these models were estimated using robust maximum likelihood (MLR) estimation procedures, together with full information maximum likelihood (FIML) procedures to handle the relatively low level of missing data present at the item level (Enders, 2010). Furthermore, although 42 participants (approximately 11%) did not complete measures at Time 2, FIML procedure have been found to result in unbiased parameter estimates under even very high levels of missing data (e.g., 50%), making it particularly well suited to longitudinal studies such as this (Enders, 2010; Little, 2013).

The MLR chi-square statistic (Satorra-Bentler scaling statistic; *S-B* χ^2), comparative fit index (CFI), Tucker-Lewis Index (TLI) and root mean square error of approximation (RMSEA) were used to evaluate the fit of data to the proposed model. Lower values and non-significant p-values for the *S-B* χ^2 represent a good fit. CFI and TLI values of .95 or higher and RMSEA values of .06 or lower highlight a good fit (Hu & Bentler, 1999). Evaluation of invariance was determined by examining changes in CFI (Cheung & Rensvold, 2002) and RMSEA (Cheung & Rensvold, 2002; Chen, 2007). Specifically, model comparisons that produce less than .01 change in CFI and .015 in RMSEA supports invariance. McDonald's (1999) omega reliability estimates were also obtained.

Results

Longitudinal Invariance

A series of nested models with increasingly restrictive constraints were used to test invariance of the body fat self-concept latent variable over time. Standardized factor loadings for body fat self-concept ranged from .61 - .77 at T1 and .72 - .85 at T2 and were all statistically significant $p < .001$. The overall χ^2 statistic was non-significant across all nested models. Based on recommendations about changes in CFI (Cheung & Rensvold, 2002) and RMSEA (Chen, 2007), the body fat self-concept latent variable demonstrated configural, weak, and strong invariance over time. This supported the notion that body fat self-concept was measured on the same metric at T1 and T2 (Widaman et al., 2010). The same procedures were used to investigate factorial invariance of physical self-concept over time. Factor loadings ranged from .63 - .78 at T1 and .72 - .81 at T2 ($p < .001$). Similar to body fat self-concept, the overall fit of the model was excellent and the factorial invariance of physical self-concept over time was supported.

Descriptive Statistics

Descriptive statistics and estimated correlation coefficients between the latent and manifest variables are provided in Table 2. Participants reported high levels of body fat self-concept and physical self-concept at both time points. These children accumulated approximately 27 minutes of MVPA during the school day at T1 and just over 25 minutes at T2 and about 48 minutes of light PA at each time point. Interestingly, T1 body fat self-concept had a stronger relation to T2 MVPA than T1 MVPA. T1 physical self-concept was not related to MVPA or light PA at either time point. McDonald's omega estimates ranged from .72 - .82, with slightly higher values at T2.

Test of Reciprocal Effects

Comparisons of the goodness-of-fit statistics obtained in the autoregressive and REM SEM models are presented in Table 3. These results revealed a good fit to the data for both models. The REM, however, appeared to produce a better fit to the data than the autoregressive model. Structural relations estimated from these two models are reported in the bottom section of Table 3 and visually in Figure 2. All autoregressive slopes were significant, demonstrating similar patterns and moderate longitudinal stability for the four constructs. Previous body fat self-concept was a positive predictor of children's future in-school MVPA and physical self-concept after controlling for T1 levels of MVPA and physical self-concept. A significant relation did not emerge between T1 body fat self-concept and T2 light PA. Previous physical self-concept was not a predictor of future body fat self-concept, MVPA, or light PA. Similarly, previous MVPA and light PA were not predictors of future physical self-concept or body fat self-concept. The final REM model accounted for meaningful levels of variance for body fat self-concept (R^2 =. 37), physical self-concept (R^2 =. 32), MVPA (R^2 =. 33) and light PA (R^2 =. 31).

Multigroup Analyses: Weight Status, Sex, Ethnicity, and Sex*Ethnicity

Results concerning the moderating role of weight status, sex, ethnicity, and sex*ethnicity in the REM are presented in Table 3. Evidence supported the strong invariance of the measurement model underlying the constructs of body fat self-concepts and physical self-concepts across all subgroups of participants, which is a necessary prerequisite to make meaningful group comparisons. Similarly, the findings supported the equivalence of the latent variance and covariances, as well as regression coefficients across all subgroups of participants. Invariance across latent means was less clear-cut. That is, three changes in CFI were greater than .01 (for the invariance of latent means across ethic groups and sex*ethnic groups and variance/covariance of sex*ethnicity), but changes in RMSEA were less than .015. There were, however, clear latent mean differences on body fat self-concept, but not on physical self-concept, as a function of weight status. Specifically, students classified as obese/overweight reported lower body fat self-concept at T1 (-.821, *SE* = .134, z = -6.148, p< .001) and T2 (-.308, *SE* = .119, z = -2.587, p= .01) than those classified as underweight/normal weight. Taken together, these moderating factors did not appear to impact the relations identified in the REM.

Discussion

The present study sought to investigate children's physical self-concept using an REM approach. Special interest focused on temporal ordering of physical self-concept and body fat self-concept in relation to objectively measured in-school PA. General findings were not supportive of reciprocal effects, yet temporal relations did emerge. The self-enhancing relation between body fat self-concept and MVPA was an important finding because body fat self-concept is rarely considered in relation to health-related behaviors in physical self-concept research (e.g., Marsh et al., 2006; Morin et al., 2011; Standage et al., 2012). The bottom-up predictive utility of body fat self-concept on future physical self-concept was also noteworthy. Finally, REM model was stable across sex, ethnicity, and sex*ethnicity. Relations in the REM were also similar for students classified as obese/overweight and normal weight / underweight; however, lower latent mean scores were reported by obese and overweight students compared to students classified as normal or underweight.

To date, physical self-concept subdomains have been understudied in child populations (e.g., Lindwall et al., 2014; Marsh et al., 2006; Welk & Eklund, 2005) despite recommendations for exploring physical self-concept in children (Crocker et al., 2003) . For example, in one of the few REM studies focusing on a physical self-subdomain, Lindwall et al. (2014) revealed bi-directional relations between body attractiveness beliefs and self-reported PA across three waves of data in adolescent girls. The self-enhancing effects of body attractiveness beliefs on future self-reported PA relation were stronger than the skill development effects of self-reported PA on future body attractiveness beliefs. This trend was also present in the Marsh et al. (2006) study between physical self-concept and self-reported PA. While both Lindwall et al. (2014) and Marsh et al. (2006) supported the skill development and self-enhancement hypotheses, stronger support was garnered for the self-enhancement hypothesis.

Direct comparisons of our findings to those obtained by Lindwall et al. (2014) and Marsh et al. (2006) should be avoided for a variety of reasons (e.g., different age groups; different measures of PA; different time intervals). However, in light of the non-significant association between prior PA and future body fat self-concept and physical self-concept, further exploration of these issues using more diverse samples and timelines seems warranted. For example, examining issues such as measurement of objective versus subjective PA and students' in-school PA versus overall PA could be fruitful. Kavanaugh et al. (2014) recently demonstrated striking contrasts in the relations between self-perceptions and self-reported versus objectively measured PA in a sample of early adolescents. The general trends noted by these authors revealed significant associations with self-reported PA and non-significant associations with objectively measured PA. Kavanaugh et al. theorized that young people may overestimate PA levels in self-report measures, which in turn inflates relations between PA and physical self-perceptions. More research is clearly needed to substantiate that claim.

It is possible that the lack of reciprocal effects was attributable to measuring PA in the school context. During the school day, children spend a majority of their time confined to desks, constraining PA opportunities. However, all participants in this study attended schools that were in the first year of a comprehensive PA program, which are theorized to allow children to acquire a majority of their 60 minutes of PA in the school context (CDC, 2013). Despite the emphasis placed on PA in these schools, these students acquired less than 30 minutes of MVPA on average across the days of measurement. Approximately 48 minutes of light PA, which can enhance health and at times be more appealing than MVPA, appeared to supplement the overall school PA for these students. It appears, however, this simply was not enough PA to impact body fat or physical self-concepts for the majority of students in this study.

Nonetheless, it was promising that body fat self-concept impacted children's future MVPA. Body fat self-concept appears to be a psychological regulator that promotes in-school MVPA. Although the effect of body fat self-concept on future MVPA was small, the standardized beta estimate was similar to the effect of physical self-concept on future self-reported PA reported in the Marsh et al. (2006) investigation. This is noteworthy because there was no shared method variance between self-reports of body fat self-concept and accelerometer measurements of PA. It should also be noted that the effect, albeit small, was present after controlling for previous MVPA and the cross-sectional correlation between T2 body fat self-concept and T2 MVPA.

The substantive meaning of the finding is important from both intervention and practical (e.g., teachers; coaches; school counselors) perspectives. School-based PA interventions and teachers alike could benefit by including strategies and encouragement aimed at enhancing children's body fat self-concept because positive appraisals simultaneously increase future MVPA and physical self-concept for both boys and girls in the school context. Consideration of this result should be taken into the bigger picture of these findings. Specifically, finding effective ways to improve children's body fat self-concept may be challenging. Neither physical self-concept nor PA at T1 related to future body fat self-concept at T2. One possible interpretation is that children's body fat self-concept is somewhat fixed and difficult to enhance within a year.

Relations within the REM were not moderated by children's weight status, sex, ethnicity, or sex*ethnicity. There was only support for heterogeneity of means based on students' weight status. Variances, covariances, and regression coefficients were generalizable across weight status and demographic groupings for these children. These findings may reflect both developmental and methodological issues. Morin et al. (2011) highlighted the complexities of sex and ethnicity that occur at different levels of pubertal development during adolescence. However, participants of this study were approximately nine years old; therefore, puberty effects were likely minimal. Similarly, the homogeneity of physical self-concepts across gender and ethnic groups may also reflect children's still developing and less differentiated self-concept structure (Harter, 2012). It is also possible that the grouping system employed had an impact on findings. This study took place in the urban context, with Black/African American students representing the greatest numbers. Caucasian females, who typically report greater levels of body dissatisfaction than males and other ethnic groups, were grouped with other non-Black/African American students because the sample did not lend itself to creating a Caucasian subgroup. Clearly, future research should look at increasingly fine-grained ethnic distinctions.

Limitations and Conclusions

There are a number of limitations associated with this study. First, MVPA was measured for three days during school hours. In the future, researchers should explore all five school days including active living outside of school within the REM. Only two waves of data were analyzed in this study, which is the minimum for testing a REM. Future research using more waves of data, exploring the impact of the specific time lag used between waves of data, and ideally tracking children into adolescence could help substantiate the findings of this study. Unlike Morin et al. (2011) and Lindwall et al. (2014), within-person change relations were not investigated. Additional investigation of the within-person change of body fat self-concept in children could provide a more holistic view of the change process in boys and girls. It should also be noted that research assistants read items to the participants, which could have inflated levels of social desirability for the self-concept data. Furthermore we did not include a measure of pubertal maturation or collect individual data on student socioeconomic status, both of which could impact the results. Finally, the four group-level sample sizes within the sex*ethnicity multigroup analysis were relatively small so we caution generalizations to be made across theses populations due to a possible lack of statistical power to clearly detect smaller differences. Similarly, because our sample size and the demographic characteristics of the sample, we were not able to make comparisons between each unique ethnicity group. We were only able to compare African-American/Black boys and girls to boys and girls from other ethnicities and acknowledge that invariance testing between each ethnicities (e.g., Black/African-American; White/Caucasian; Multi-racial; Arab American) would advance our findings.

Despite these limitations, our findings add to current understanding of physical self-concept. Body fat self-concept was relevant to both health-enhancing psychological characteristics and behavior in these youth. Although there are still questions about the malleability of physical self-concept (domain-level) and body fat self-concept (subdomain level), targeting both physical self-concept and its subdomains and behavior in programs and interventions are likely to be more efficient at creating enhancements than focusing on one or the other (Kavanaugh et al., 2014). In other words, interventions should be aimed at improving body fat self-concept (e.g., messages about body acceptance), physical self-concept (e.g., encouragement about physical abilities) and behavioral strategies (e.g., rewards for PA). Relatively straightforward guidelines have been established for creating interventions that increase self-concepts across a variety of contexts (Chanal & Sarrazin, 2007; Marsh & Peart, 1988; O'Mara et al., 2006). Interventions that promote self-concept: (a) use cooperation, encouragement, and feedback implementation strategies; (b) target children with the greatest need (e.g., low body fat and physical self-concepts and MVPA engagement); (c) reduce ambiguous external frames of reference; and (d) include explicit strategies that help children make positive self-evaluations. The self-enhancing effects of body fat self-concept on future MVPA and physical self-concept highlight the potential of creating interventions that address the mental and physical health challenges currently facing children.

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Table 1

Descriptive Statistics and Correlation Estimates of Study Variables.

	T1BFSC	T1PSC	T1MVPA	T1Light	T2BFSC	T2PSC	T2MVPA	T2Light
T1BFSC	1.00							
T1PSC	0.41**	1.00						
T1MVPA	0.10	0.01	1.00					
T1Light	0.01	0.01	0.63**	1.00				
T2BFSC	0.64**	0.31**	0.04	-0.06	1.00			
T2PSC	0.37**	0.54**	0.02	0.03	0.43**	1.00		
T2MVPA	0.18*	0.07	0.56**	0.34**	0.10	0.13*	1.00	
T2Light	0.01	0.03	0.39**	0.55**	-0.06	-0.03	0.58**	1
M	4.98	5.26	27.01	48.50	5.24	4.49	25.26	48.46
SD	1.18	1.02	9.41	13.15	0.94	0.76	10.86	14.24
Min	1	1	6.17	11.25	1	1	3.08	10.17
Max	6	6	54.33	84.25	6	6	63.58	98.25
ω	0.72	0.75			0.82	0.79		

Note. BFSC = body fat self-concept; PSC = physical self-concept; MVPA = average moderate-to-vigorous physical activity per day across three school days (minutes and seconds); Light = average light physical activity per day across three school days; *M* = mean; *SD* = standard deviation; Min = minimum value; Max = maximum value; ω = McDonald's omega of latent construct.
* $p < .05$; ** $p < .01$.

Table 2

Results of Autoregressive and Reciprocal Effects Models (REM).

Model	χ^2	*S-B* χ^2	*df*	*p*	CFI	TLI	RMSEA
Autoregressive	136.884	103.275	86	.099	.989	.983	.023
REM	113.269	80.446	74	.284	.996	.993	.015

Path Coefficients	*B*	*SE*	*p*	β
Autoregressive				
BFSC→ T2BFSC	0.491	0.061	.001	.573
PSC → T2PSC	0.436	0.082	.001	.532
MVPA→ T2MVPA	0.492	0.068	.001	.542
Light → T2 Light	0.494	0.049	.001	.553
REM				
BFSC→ T2BFSC	0.518	0.084	.001	.591
PSC → T2PSC	0.380	0.076	.001	.459
MVPA → T2MVPA	0.505	0.072	.001	.550
Light → T2 Light	0.454	0.055	.001	.506
BFSCV → T2PSC	0.148	0.056	.001	.183
BFSC → T2MVPA	0.024	0.012	.040	.119
BFSC → T2 Light	0.004	0.004	.806	.020
PSC → T2BFSC	0.046	0.046	.317	.051
PSC → T2MVPA	0.005	0.008	.522	.025
PSC → T2 Light	0.007	0.009	.749	.037
MVPA → T2BFSC	0.414	0.276	.134	.103
MVPA → T2PSC	0.086	0.230	.708	.023
MVPA → T2 Light	0.063	0.018	.001	.077
Light → T2BFSC	0.080	0.298	.789	.018
Light → T2PSC	0.179	0.194	.357	.044
Light → T2MVPA	0.005	0.077	.946	.005

Note. BFSC = body fat self-concept; PSC = physical self-concept; MVPA = average moderate-to-vigorous physical activity per day across three school days (minutes and seconds); Light = average light physical activity per day across three school days.

Table 3

*Results of Multigroup Analyses Testing Moderating Role of Sex, Ethnicity, Sex*Ethnicity, and Weight Status in REM.*

Model	χ^2	S-B χ^2	*df*	*p*	CFI	Δ CFI	TLI	RMSEA	ΔRMSEA
Sex									
Configural	195.516	154.885	148	0.333	0.995	---	0.992	0.016	---
Weak	203.559	155.86	156	0.488	1.000	0.000[1]	1.000	0.001	0.000[1]
Strong	208.158	161.546	164	0.54	1.000	0	1.000	0.001	0
Means	225.487	177.377	172	0.373	0.996	0.004	0.994	0.013	0.012
Var/Covar	263.386	203.59	192	0.27	0.991	0.005	0.989	0.018	0.005
Betas	285.557	221.594	208	0.247	0.990	0.001	0.988	0.019	0.001
Eth									
Configural	211.647	167.288	148	0.133	0.986	---	0.977	0.026	---
Weak	228.519	174.89	156	0.143	0.986	0	0.979	0.025	0.000[1]
Strong	244.047	190.426	164	0.077	0.981	0.005	0.972	0.029	0.004
Means	272.899	216.004	172	0.013	0.968	0.013	0.955	0.037	0.008
Var/Covar	306.386	238.193	192	0.013	0.966	0.002	0.957	0.036	0.000[1]
Betas	327.76	254.64	208	0.015	0.966	0	0.960	0.035	0.000[1]
*Sex*Eth*									
Configural	403.678	333.364	296	0.066	0.973	---	0.956	0.037	---
Weak	439.702	346.295	320	0.15	0.981	0.000[1]	0.972	0.03	0.000[1]
Strong	466.917	377.761	344	0.102	0.976	0.005	0.966	0.032	0.002
Means	527.913	436.959	368	0.008	0.950	0.026	0.935	0.045	0.013
Var/Covar	638.186	513.958	428	0.003	0.938	0.012	0.931	0.046	0.001
Betas	711.011	566.316	476	0.003	0.935	0.003	0.934	0.045	0.000[1]
Weight Status									
Configural	201.084	161.359	148	0.214	0.989		0.982	0.022	
Weak	215.806	167.915	156	0.243	0.990	0.000[1]	0.985	0.020	0.000[1]
Strong	224.970	177.032	164	0.230	0.989	0.001	0.984	0.021	0.001
Means	285.671	230.284	172	0.002	0.952	0.037	0.934	0.042	0.021
Var/Covar	358.995	284.097	192	0.001	0.928	0.023	0.912	0.049	0.007
Betas	371.718	295.360	208	0.001	0.929	0.000[1]	0.918	0.047	0.002

Note. Eth = ethnicity. 0.000[1] indicates changes represented a better fit in the more restrictive model e.g. increased CFI or decreased RMSEA.

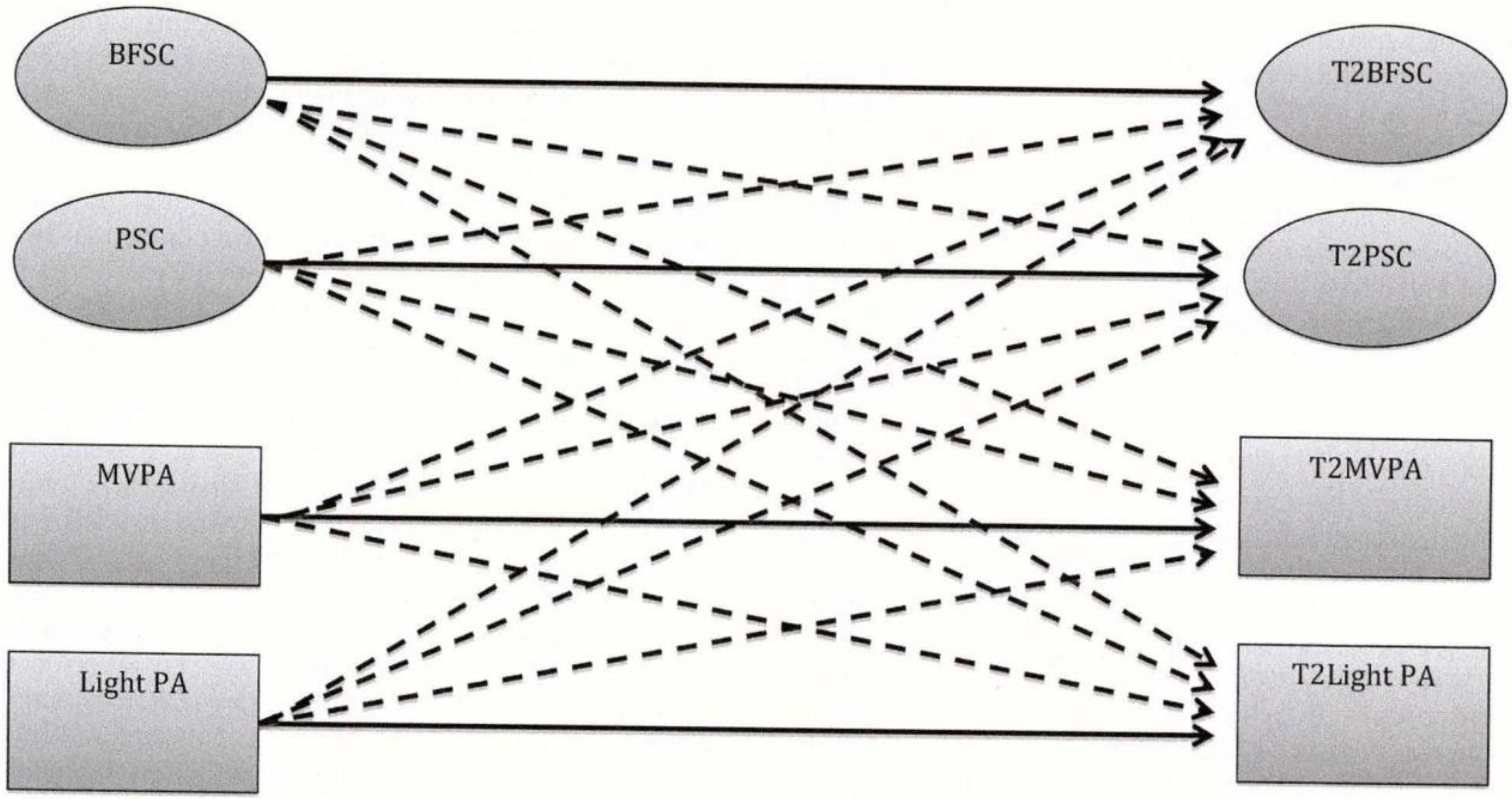

Figure 1 — Hypothesized reciprocal effects model of body fat self-concept, physical self-concept, MVPA, and light PA.

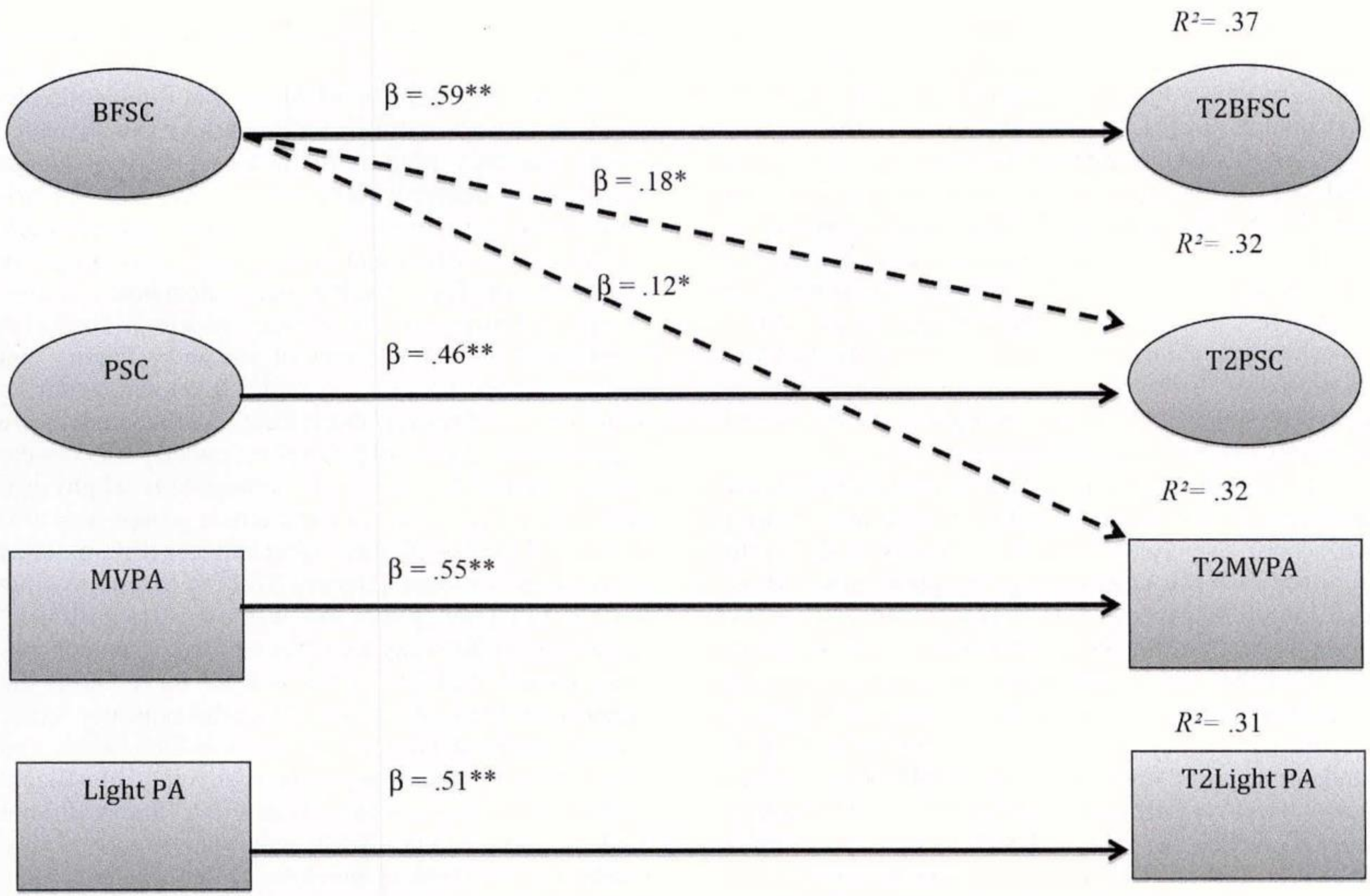

Figure 2 — Standardized beta coefficients of statistically significant pathways in the REM model. $^{*}p < .05$; $^{**}p < .01$.