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Exercise and self-esteem model: Validity in a sample of healthy female adolescents

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Abstract
Low self-esteem is frequently identified as source of personality, anxiety and body image disorders among adolescent females. The Exercise Self-Esteem Model (EXSEM) is a framework that embodies the multidimensional and hierarchical structure of global self-esteem and its relationship to physical activity and has been effective in guiding the design of physical activity interventions. Although this model has been tested with a variety of populations, it remains to be validated in adolescent females. Additionally, we sought to expand the original model by investigating how additional parameters of body fat and cardiovascular fitness independently contributed to physical and global domains of self-esteem. Ninety-four adolescent females ($M_{age} = 15.6 \pm 1.7$) completed validated measures of global self-esteem, physical self-esteem and physical self-efficacy. Participants completed the Physical Activity Questionnaire for Adolescents to quantify habitual physical activity levels. Objective physical measurements included height, weight, body fat and cardiovascular fitness. The newly proposed expanded-EXSEM model provided a good model-data fit tested using structural equation modeling ($\chi^2 = 4.54$ ($p = .21$), CFI = .99, RMSEA = 0.07, SRMR = 0.02) compared to the original EXSEM. Physical activity levels were significantly associated with both cardiovascular fitness and body fat and were a positive predictor of physical self-efficacy. Physical self-efficacy, cardiovascular fitness, and body fat were all predictors of physical self-esteem, which directly affected global self-esteem. Our data validates the expanded-EXSEM model in a sample of adolescent females and identifies targets for interventions to change global self-esteem as well as sub-domains of physical self-esteem. While changing fitness variables may be effective in targeting perceptions of body-esteem alone, physical activity participation still remains the primary determinant to bring about the cascade of positive changes in physical self-efficacy and self-esteem in this population.

Keywords Exercise and self-esteem model · Adolescent females · Physical activity · Self-efficacy · Self-esteem · Structural equation modeling · Cardiovascular fitness · Body fat

Introduction

Physical activity is well regarded for its many physiological and psychological health benefits across the lifespan. One aspect of psychological health which physical activity has been shown to impact is an individual's global self-esteem (GSE) (Fox, 2000; Spence, McGannon, & Poon, 2005). GSE is a multidimensional concept defined as "the individual's positive or negative attitude toward the self as a totality" (Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995) and has been identified as a key indicator of positive mental health and wellbeing (Paradise & Kernis, 2002). It is at the apex of a hierarchical and multidimensional framework underpinned by several sub-domains of the self, which include academic, social, emotional, and physical self-concept (Shavelson, Hubner, & Stanton, 1976). The contribution of each of these subcomponents to GSE varies among individuals across the lifespan, and is dependent on the importance the individual places on them (Marsh, 1986).

The Exercise and Self-Esteem Model (EXSEM, see Fig. 1) (Sonstroem & Morgan, 1989) was developed to examine the mechanism of change in GSE due to exercise participation. The EXSEM examines different dimensions of physical self-perception, including physical self-efficacy (the belief one can be successful at a given activity), physical competence (one's

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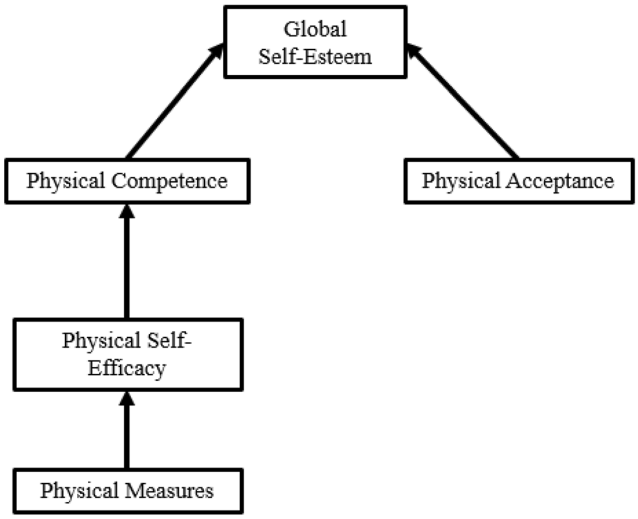

Fig. 1 The exercise and self-esteem model, as originally proposed by Sonstroem and Morgan

self-evaluation of his or her overall physical fitness), and physical acceptance (one's overall feelings of satisfaction or dissatisfaction regarding his or her body) and how each contributes toward GSE. According to the EXSEM, changes in physical measures as a result of exercise engagement increase physical self-efficacy expectations, which in turn improve one's perception of physical self-esteem. This domain-specific self-esteem is what directly contributes to improve GSE. The model was initially tested among cardiac patients and healthy adults (Gemma, Osborne, & Sonstroem, 1988), and has since been tested and validated in a variety of different populations, including elementary school children (Noordstar, van der Net, Jak, Helders, & Jongmans, 2016), adult women (Levy & Ebbeck, 2005), male high school swimmers (Sonstroem, Harlow, & Salisbury, 1993), and adult aerobic dancers (Sonstroem, Harlow, & Josephs, 1994). A recent study (Rubeli, Oswald, Conzelmann, & Schmidt, 2019) applied a portion of the EXSEM model to young adolescents (mean age = 11.33) to examine the moderating role of "importance of sport competence" within the relationship between perceived sports competence and global self-esteem. However, it is worth noting that the application of their findings would be primarily limited to sporting contexts; to an individual who engages in exercise for purposes other than organized sport participation, "perceived sport competence" and "importance of sport competence" may be irrelevant factors towards their self-concept and self-esteem. Additionally, to understand EXSEM's utility for a specific population, it is important to test the full model. As such, one population this model has yet to be directly validated with is female adolescents. Adolescence is defined as the age period of 10–19 years old (World Health Organization, 2020). This period is accompanied with numerous physiological changes, such as increases in height, weight and body fat mass, specifically with females gaining fat mass at an average rate of 1.14 kg/year (Rogol, Roemmich, & Clark, 2002). Accompanying these age-related transitions in body size and composition are neuroendocrine changes, such as elevated production of certain hormones, changes in neural circuitry, and increased activity within specific brain regions regarding reward, emotional stimuli, and social cognitive processing- all of which contribute to an increased susceptibly to one's social environment (Peper & Dahl, 2013). Media images, cultural trends and social influences can also negatively shape a female adolescent's views of body image and appearance (Voelker, Reel, & Greenleaf, 2015). These external and internal influences can culminate into reduced GSE among female adolescents (Robins, Trzesniewski, Tracy, Gosling, & Potter, 2002), leaving this population at risk for developing mental health conditions, such as depression and eating disorders (World Health Organization, 2019). Mental health conditions account for 16% of the global burden of disease and injury in people aged 10–19 years, yet often go undetected and untreated (World Health Organization, 2019). The EXSEM is of particular relevance to female adolescents, as it can offer a framework to positively impact physical self-perceptions and self-esteem, which are considered central to a number of mental health disorders (Mann, Hosman, Schaalma, & De Vries, 2004).

Previous studies have found that exercise participation (Babic et al., 2014), cardiovascular fitness (Schneider, Dunton, & Cooper, 2008) and body fat (Tiggemann, 2005) indirectly contribute to female adolescent's GSE. Under the original EXSEM model (Fig. 1), all of these components are categorized as "physical measures" which are hypothesized to improve self-esteem perceptions via altering self-efficacy. However, self-efficacy beliefs are most important among novice individuals who are in the early stages of adopting a behavior, and have less influence among individuals where the behavior is being "maintained" as part of their routine (McAuley, Lox, & Duncan, 1993). Thus, assuming that all physical measure-related changes directly alter physical self-efficacy beliefs potentially neglects to capture alternative ways in which specific measures (i.e. fitness, body composition, and physical activity levels) may influence self-esteem. This is a significant point to acknowledge, as individuals may place different degrees of importance on outcomes related to physical activity engagement. Thus, it is necessary to understand what constructs of the self "physical activity participation," "aerobic fitness" and "body composition" independently work through to influence GSE.

Current Study

Given that this model has been validated on a variety of populations, it has promising potential to be beneficial for the current population of interest. Therefore, the first objective of the present study was to test the originally-proposed EXSEM in a sample of healthy female adolescents. Consistent with the EXSEM predictions, we hypothesized that physical activity levels would indirectly affect GSE through physical self-efficacy and physical self-esteem. The second objective of our study was to expand the model by assessing and testing the separate roles of cardiovascular fitness and body fat in conjunction with the EXSEM constructs. We hypothesized that both of these objective measures would be affected by physical activity and play a role in predicting the physical self-esteem domains of the EXSEM.

Methods

Participants

Ninety-four healthy adolescent female high school students were recruited to participate in this study. All potential participants were initially screened via a resting ECG and completed a health and medical history questionnaire. Only those that passed this Institutional Review Board (IRB)-mandated preliminary screening protocol were allowed to participant in the study. Participants were then scheduled for a laboratory visit to complete the body fat assessment and maximal exercise test to assess cardiovascular fitness. They were instructed not to eat for two hours prior to the scheduled lab visit. Basic demographic information and objective height and weight were obtained during the study visit. Each participant was given a binder with the study questionnaires. All study testing was conducted in the morning and subjects were instructed not to exercise vigorously within 24 h of their appointment. Prior to all data collection, participants received both written and oral explanations of the study procedures in accordance with the IRB guidelines. Informed consent was obtained from the parents and participating adolescents provided informed consent prior to data collection.

Measures

Cardiovascular Fitness

An assessment of cardiovascular fitness (VO_{2max}) was performed using a continuous, graded maximal exercise protocol (Bruce, Kusumi, & Hosmer, 1973) on a calibrated medical treadmill (Model 65, Quinton, Seattle, WA). For that purpose, oxygen uptake (VO_2), carbon dioxide production (VCO_2), and minute ventilation (VE) were measured continuously by open-circuit spirometry indirect calorimetry using an automated metabolic cart (AMETEK Model OCM2, Physiodyne, Farmington, NY). Prior to each test, the Model S-3A oxygen and Model CD-3A carbon dioxide analyzers of this respiratory gas analysis system were calibrated using a primary standard medical gas mixture of known concentrations. Inspired air flow was measured with a turbine volumeter (Applied Electrochemistry, Pittsburgh, PA). Throughout each test, subjects breathed through a low resistance, large 2-way Hans Rudolph breathing valve (Model #2700, Hans Rudolph, Kansas City, MO) and wore a nose-clip to eliminate nasal breathing. In addition, exercise heart rates were monitored by electrocardiography using a telemetry system (Model G-2400 T, EatonCare Telemetry, Ann Arbor, MI) and bipolar V5 lead configuration. The 15-grade category scale developed by Borg (Borg, 1982) was used to asses a subject's rating of perceived exertion (RPE) throughout and at the point of exhaustion during maximal exercise. Per the present study's protocol, it was determined a participant had reached her VO_{2max} if two of the following criteria were met: evidence of a plateau in VO2max; a respiratory exchange ratio of ≥1.00; a heart rate of ≥90% of age predicted HR_{max} (220-age); and an RPE of ≥18 (McMurray, 1996; Robben, Poole, & Harms, 2013).

Body Fat Measurement

Body fat was assessed using a standard hydrostatic weighing procedure (Katch, 1969). Prior to underwater submersion, body weight was measured on land (to the nearest 0.1 kg) using a medical scale (SECA, Creative Health Products, Plymouth, MI) and residual lung volume was determined by oxygen dilution. For that purpose, subjects assumed the same body position as in the hydrostatic weight tank while rebreathing pure oxygen from a dry spirometer (Model RS-232 TV, Fitness Instrument Technologies, Farmingdale, NY) connected to a nitrogen gas meter (Model 505D Nitralyzer, MedScience, St. Louis, MO). Each subject completed at least two residual lung volume measurements. If the first two test results differed by more than 100 ml, a third trial was performed and the mean of the two closest volumes was used in subsequent computations (Wilmore, Vodak, Parr, Girandola, & Billing, 1980). Body weight in water was measured using a specially designed load cell apparatus involving four calibrated load cells (Model 1010-HL-500, Interface, Scottsdale, AZ) that were connected to a sampling head and pen strip chart recorder (Model 1241, Soltec, San Fernando, CA). Ten trials were performed to determine underwater weight and the mean of the heaviest three trials was used to determine body density. Body density measurements obtained from hydrostatic weighing were transposed into body fat percentage values using the recommended pediatric-specific formula (American College of Sports Medicine, 2014).

Physical Activity

Physical activity was measured using the self-report, well-validated Physical Activity Questionnaire for Adolescents (Kowalski, Crocker, & Kowalski, 1997) which was designed for individuals 14–20 years old. This instrument was modified from the Physical Activity Questionnaire for children and measures levels of habitual physical activity in adolescents, using a nine-item, 7-day recall format. Questions inquire about physical activity levels during spare time, physical education classes, lunch time, after school, evenings, and on weekends. A summary score is derived from the nine items, each scored on a 5-point scale. A total score of 1 indicates low physical activity, while a total score of 5 indicates high levels of physical activity.

Physical Self-Efficacy

Physical Self-Efficacy was measured using the 22-item Likert scare Physical Self-Efficacy (PSE) questionnaire (Ryckman, Robbins, Thornton, & Cantrell, 1982). The PSE scale is made up of two subscales: perceived physical ability (PPA) and physical self-presentation confidence. The PPA assesses a person's confidence regarding their reflexes, physique, coordination, speed and agility. Scores for this subscale indicate the individual's level of their perceived physical ability. Since the PPA aligns with the description of physical self-efficacy in the EXSEM, this was the only subscale used in the present study. A total score possibility ranges from 10 to 60, with higher scores indicating a stronger sense of physical self-efficacy and Cronbach's Alpha for this dataset was 0.76.

Physical Self-Esteem

Physical Self-Esteem was measured using the 32-item Likert scale Body Esteem Questionnaire (BEQ) (Franzoi & Shields, 1984), which has been widely used with adolescent populations. The BEQ is made up of three interrelated factors for young men and women, but the characteristics differ between genders. For females, the BEQ is composed of three subscales: sexual attractiveness, weight concern, and physical condition. We omitted the sexual attractiveness responses from the current analysis. Weight concern (WC) subscale collectively describes physical appearance of body parts that can be physically altered. Physical condition (PC) collectively describes qualities such as strength, stamina, and agility. Scores for weight concern range from 10 to 50, and scores for physical condition range from 9 to 45. For both subscales, higher scores indicate strong, positive feelings. Cronbach's Alpha was 0.87 and 0.81 for the WC and PC subscales, respectively.

Global Self-Esteem

GSE was measured using the Rosenberg Self-Esteem Scale (RSE), a 10-item, 4-point Likert scale. The RSE is used to measure overall self-esteem and has a score range of 10–40, with higher scores indicative of higher GSE. This scale has been found to have consistent test-retest reliability and demonstrates construct validity (Rosenberg, 2015). Cronbach's Alpha for this dataset was 0.87.

Data Analysis

Analyses were conducted using Mplus version 8 and SPSS version 24 (IBM Corp). Prior to the main analyses, measures were examined for outliers and normality. Participant demographics, means and standard deviations for the model variables are presented in Table 1. Pearson correlations between all the EXSEM variables are reported in Table 2. We ran two bootstrapped (10,000 iterations) EXSEM models - the original EXSEM proposed by Sonstroem and Morgan, and our proposed expanded EXSEM- and assessed model–data fit by using the following indices: chi-square statistic; standardized root mean square residual (SRMR); comparative fit index (CFI); and the root mean square error of approximation (RMSEA). All path coefficients are reported as standardized estimates in Fig. 2**.** There was no missing data to be accounted for in analyses.

Results

Participant demographics are described in Table 1. In summary, our sample consisted of females ($n = 94$) with an age range of 11 to 20 years. Their average BMI was 21.05 (SD = 2.54) which would classify as being normal weight per the CDC guidelines. The VO_{2max} ranged from 25.00 ml/kg/min to 58.40 ml/kg/min. The average total physical activity score on the PAQ-A was 2.62 (SD = 0.66).

Table 2 lists the correlations between EXSEM variables. Notably, there was a significant negative correlation between age and PAQ-A total activity score, indicating that older participants engaged in less habitual physical activity. As expected, there was also a negative correlation between cardiovascular fitness and body fat percent. Physical self-efficacy scores showed significant correlations with every model variable except age.

Figure 2 shows the relationships between the hypothesized EXSEM variables in the original EXSEM **(**Fig. 2a**)** and the expanded EXSEM **(**Fig. 2b**).** The model pathways hypothesized in the original EXSEM did not adequately fit the data, as indicated by the following fit indices: chi-square = 57.863 (df = 11, $p < 0.001$), RMSEA = 0.213, SRMR = 0.128, and

Table 1 Participant characteristics and EXSEM variables ($N = 94$)

Variable	Mean (SD)	Range (min, max)
Age (years)	15.62 (1.72)	(11, 20)
BMI (kg/m^2)	21.05 (2.54)	(14.69, 28.40)
Body fat (%)	21.35 (4.86)	(11.03, 37.01)
PAQ-A total activity score	2.62 (0.66)	(1.33, 3.96)
VO_{2max} (mL/kg/min)	41.90 (6.09)	(25.00, 58.40)
Physical self-efficacy (Perceived physical ability subscale)	44.09 (6.24)	(31.00, 56.00)
Body esteem - weight concern subscale	31.15 (7.89)	(12.00, 50.00)
Body esteem - physical condition subscale	34.98 (5.04)	(22.00, 45.00)
Global self esteem	31.60 (4.35)	(16.00, 40.00)

CFI = 0.635. The original EXSEM explained 17.4% (p = 0.032) of the variance in GSE. Parameter estimates, and significance are listed in Fig. 2a. Only physical activity levels significantly predicted higher levels of physical self-efficacy-body fat percentage and cardiovascular fitness were non-significant.

The results of the structural equation model with standardized regression coefficients for the expanded EXSEM are presented in Fig. 2b. The model had a good fit with a chi-square = 4.539 (df = 3, $p = 0.2088$), RMSEA = 0.074, SRMR = 0.024 and CFI = 0.991. As theorized, higher levels of physical activity significantly predicted higher levels of physical self-efficacy (β = 0.221, $p = 0.05$), cardiovascular fitness (β = 0.513, $p < 0.001$), and lower percentage of body fat (β = −0.304, $p < 0.01$). Higher levels of physical self-efficacy significantly predicted physical self-esteem WC (β = 0.24, $p < 0.01$), and PC (β = 0.464 $p < 0.001$). These sub-domain physical self-esteem variables were also significantly predicted by cardiovascular fitness (β = 0.203, $p < 0.05$) and body fat (β = −0.33, $p < 0.001$), respectively. Both physical self-esteem WC (β = 0.321, $p = 0.006$) and PC (β = 0.24, $p < 0.01$), significantly predicted GSE. Overall, the model explained 24.4% ($p = 0.002$) of the variance in GSE.

Discussion

The purpose of the present study was to 1) examine the fit of the Sonstroem and Morgan's EXSEM's hierarchical structure on a population of healthy adolescent females and 2) explore the role of cardiovascular fitness and body fat in shaping GSE among this population by expanding the EXSEM. Our data supports the application of the expanded-EXSEM to female adolescents, with objectively assessed fitness variables (cardiovascular fitness and body fat) and self-reported physical activity predicting higher levels of physical self-esteem, which in turn predicted GSE. Furthermore, the data-supported model reveals two alternate pathways to change female adolescent's physical self-esteem, emphasizing the pivotal roles physical activity plays in one's perception of physical and global self-esteem.

The addition of cardiovascular fitness and body fat components to the EXSEM is especially pertinent for the model's utility among adolescent females. Among adolescents, cardiovascular fitness has been beneficially associated with brain structure and function, which is suggested to enhance resilience, self-regulation and ultimately mitigate risk for mental health problems (Belcher et al., 2020). The authors of the

Table 2 Pearson correlations between the EXSEM variables

Model variables	1	2	3	4	5	6	7
1. Age (years)	–						
2. VO_{2max} (mL/kg/min)	−0.127	–					
3. Body fat (%)	0.131	−0.401**	–				
4. PAQ-A total activity score	−0.250*	0.513**	−0.295**	–			
5. Physical self-efficacy	−0.162	0.265**	−0.227*	0.324**	–		
6. Body esteem -weight concerns	−0.220*	0.342**	−0.462**	0.358**	0.389**	–	
7. Body esteem – physical condition	−0.236*	0.402**	−0.264*	0.386**	0.573**	0.573**	–
8. Global self-esteem	−0.198	0.117	−0.061	0.189	0.392**	0.409**	0.411**

PAQ-A: Physical Activity Questionnaire for Adolescents; * Correlation significant at 0.05 level; ** Correlation significant at 0.01 level

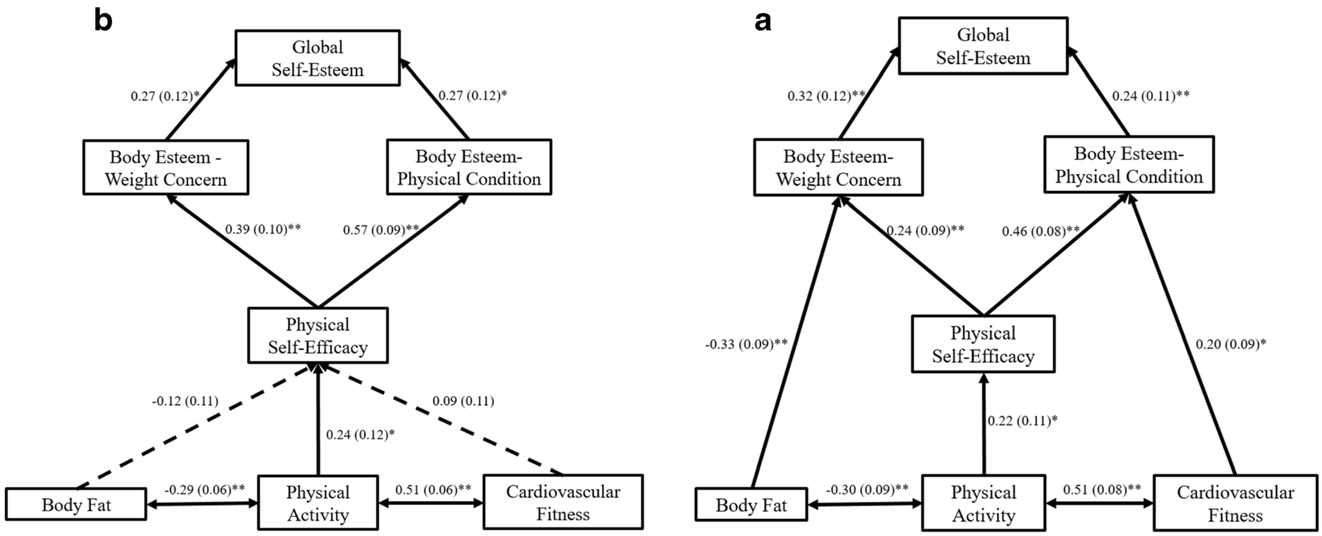

Fig. 2 The original EXSEM (**a**) and our proposed, expanded EXSEM (**b**) for female adolescents. Significant pathways are denoted in solid lines, non-significant paths are indicated by dashed lines. **p < 0.05, ** p < 0.01*

original EXSEM model hypothesized that cardiovascular fitness would be more influential towards physical self-efficacy than towards physical or global self-esteem (Sonstroem & Morgan, 1989); however, in our expanded-EXSEM model cardiovascular fitness did not significantly predict physical self-efficacy. Rather, this physical measure was a significant predictor for the 'physical condition' subdomain of physical self-esteem and insignificantly predictive of self-efficacy. One possible explanation for this newly observed pathway is that higher-fit individuals engage in enough regular physical activity that "physical self-efficacy" is not an important contributor to their self-esteem.

In our expanded EXSEM model, "body fat" was also insignificantly associated with physical self-efficacy. Instead, it was directly associated with the "weight concern" subdomain of physical self-efficacy. It has been previously observed that adolescent females who perceive themselves as "bulky" and/or want to achieve an ideal body size are more motivated by weight management to engage in exercise (Ingledew & Sullivan, 2002). Normally this type of extrinsic motivation, to improve body image/appearance, often does not rely on self-efficacy perceptions.

As expected, the relationship between physical self-efficacy, physical self-esteem and global self-esteem did not differ between the two EXSEM models. The fact that both models reported significant pathways reaffirms the relationships of these higher-order constructs among female adolescents. As seen in Fig. 2a, by "forcing" body fat and cardiovascular fitness to act through physical self-efficacy (as proposed in the original EXSEM), they appear to be insignificant predictors in the relationship towards female adolescents' GSE. However, our expanded model reveals that, in actuality, these two physical measures do affect GSE via alternative paths.

Pathway 1 (Physical Activity → Self-efficacy → Self-esteem)

This pathway is consistent with the hierarchical relationships originally proposed by Sonstroem and Morgan (Sonstroem & Morgan, 1989) and other studies examining different aspects of the model. Lindwall and Lindgren (Lindwall & Lindgren, 2005) found that in a population of female adolescents, a six-month exercise intervention improved physical self-perception and social physique anxiety. The authors attributed these improvements to the participants' reported increases in physical competence. A multitude of studies have reported both cross-sectional (Biddle & Asare, 2011) and longitudinal (Moore, Mitchell, Bibeau, & Bartholomew, 2011) relationships between physical activity participation, physical self-esteem and GSE. However, these studies failed to explicitly assess physical self-efficacy as a mediating variable between physical activity level and self-esteem and acknowledged that as a limitation of their studies. Our model provides support for the EXSEM demonstrating that physical activity levels do not directly predict physical self-esteem measures, but rather indirectly do so through physical self-efficacy. Thus, we emphasize that in order to fully capture the effect physical activity participation has on both domain-specific and global self-esteem, physical self-efficacy should be taken into consideration.

In many health behavior theories, self-efficacy is recognized as a key predictor for meaningful behavior changes and maintenance (Strecher, Devellis, Becker, & Rosenstock, 1986). The sense of mastery one experiences during physical activity engagements, especially during adolescence, has been suggested to have profound effects on improving one's self-esteem (Calfas & Taylor, 1994). Our data supports physical self-efficacy as an outcome of physical activity participation, and that the feeling of "mastery" or "physical competence" one gains contributes to their physical self-esteem. Physical activity interventions can be developed to utilize this pathway and promote building physical self-efficacy as an outcome of physical activity participation and minimizing the focus on building stamina (fitness) or losing weight (body fat), especially for sedentary populations. It can be argued that engaging in physical activity naturally leads to changes in cardiovascular fitness and body fat, so those changes are "built in" to physical activity. However, the fact that both cardiovascular fitness and body fat did not predict physical self-efficacy shows in fact that they are independent, and physical activity levels do not particularly rely on such changes to occur to affect upstream psychological processes in the EXSEM.

Pathway 2 (Physical Activity→ Fitness and Body Fat→ Self-Esteem)

While physical activity is still at the foundation, this second pathway is mediated by the cardiovascular fitness and body fat variables which independently affected physical self-esteem, with body fat relating to the WC subscale and cardiovascular fitness relating to the PC subscale. This pathway supports existing research findings that enhanced cardiovascular fitness and lower body fat produce favorable increases in physical esteem. A cross-sectional study (Dunton, Schneider, Graham, & Cooper, 2006) found that the VO_{2max} scores of adolescent females were more closely associated with physical self-concept and GSE. The researchers also found similar correlations between lower percent body fat composition and higher perceptions of physical self-concept and global self-esteem. Similar findings have been reported in other studies (Carraro, Scarpa, & Ventura, 2010; Schneider et al., 2008) suggesting that the physical changes an individual experiences, be it in their cardiovascular fitness or body size, may enhance perceptions of domain-specific and global self-esteem. However, it should be pointed out again that these studies which found only associations of physical activity and self-concept/esteem by indirect means of fitness and fatness changes did not measure physical self-efficacy.

This pathway may be meaningful for female adolescents who are highly active and already exhibit high levels of self-efficacy in their specific athletic domain. Participation in competitive sports or athletics may put a greater emphasis on performance abilities or skills; therefore, these athletes may value and perceive changes in fitness and body fat as integral to their athletic performance and physical self-concept. However, as tested in our model and per the original EXSEM, physical self-efficacy is the key mediator between physical activity behavior and physical self-esteem and should be included as an assessment to fully understand the dynamics of physical activity participation, fitness and self-esteem.

Strengths and Limitations

Strengths of this study include the use of well-validated and psychometrically established measures to assess the model variables. Additionally, we incorporated objective measures such as the VO_{2max} test and the underwater weighing procedure to assess cardiovascular fitness and body fat, respectively. Both of these measures are considered to be "gold-standards" in the exercise science literature. To the best of our knowledge, this was the first study to examine the EXSEM in a sample of healthy adolescent females. Our study is not without limitations. Although we had a good sample size to conduct the test of the EXSEM, it is possible that it may have lacked power to test the effects; therefore, larger sample sizes should be tested in the future. Our study was also cross-sectional, and confirmation is needed if similar findings would result from a longitudinal study across adolescence and teenage developmental years.

Conclusion

Understanding the hierarchical structure of female adolescent's global self-esteem, and distinct roles physical measures (physical activity levels, cardiovascular fitness, body fat) play, has vital implications for future interventions. Our expanded-EXSEM demonstrates two alternate pathways by which physical activity participation can lead to positive changes in global self-esteem. This suggests that before researchers implement a physical activity-based intervention, they need to understand the outcome expectations of their sample. It is important to distinguish amongst the female adolescent sample if positive changes in cardiovascular fitness and/or body fat are desired, or if simply increasing physical activity levels will positively alter higher-order esteem measures.

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Data Availability The dataset analyzed in the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from all study participants and their legal guardians.

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