JOURNAL OF APPLIED SPORT PSYCHOLOGY, 18: 185–200, 2006

ISSN: 1041-3200 print / 1533-1571 online
DOI: 10.1080/10413200600830257

Routledge
Taylor & Francis Group

Longitudinal Assessment of the Relationship Between Physical Self-Concept and Health-Related Behavior and Emotion in Adolescent Girls

PETER R. E. CROCKER AND CATHERINE M. SABISTON

School of Human Kinetics, University of British Columbia

KENT C. KOWALSKI

College of Kinesiology, University of Saskatchewan

MEGHAN H. MCDONOUGH

School of Human Kinetics, University of British Columbia

NANETTE KOWALSKI

College of Kinesiology, University of Saskatchewan

This study investigated the changes in and the relationships among body mass index (BMI), global self-esteem, physical self-perceptions, social physique anxiety (SPA), physical activity, and dietary restraint in adolescent females over a 24-month period. Participants ($N = 501$) completed annual assessments in grade 9, 10, and 11. The results showed moderate covariance stability in all variables. There were several significant time effects (group mean change), with small increases in BMI, moderate decreases in physical activity, and very small changes over time in SPA and physical self-perceptions. Longitudinal analyses indicated that specific physical self-perceptions were important predictors of physical activity, dietary restraint and SPA; however, most of the variance was explained by previous year values. Evidence of bidirectional effects revealed that specific self-perceptions impact specific behaviors and SPA more so than the impact of behavior/emotion on self-perceptions. These results highlight the importance of understanding the physical self and its links to health-related behaviors and emotion in adolescents.

Adolescence is a critical developmental period whereby social, emotional, and physical factors tend to influence perceptions of the physical self (Harter, 1999). Subsequently, researchers have clearly identified that physical self-concept is associated with many health-related behaviors and emotions in female adolescents (Crocker, Kowalski, Kowalski, Chad,

Received 27 February 2004; accepted 23 June 2005.
This research was funded through the Heart and Stroke Foundation of Canada.
Address correspondence to Peter Crocker, PhD., School of Human Kinetics, 6081 University Boulevard, Vancouver, B.C. Canada V6T 1Z1. E-mail: Pcrocker@interchange.ubc.ca

Humbert, & Forrester, 2001; Crocker, Sabiston, Forrester, Kowalski, Kowalski, & McDonough, 2003; Davis, 1997; Dunton, Jamner, & Cooper, 2003; Fox, 1997, 2000). Self-presentational concerns related to the body can also be a major trigger for the adoption and maintenance of behaviors such as physical activity, dietary behaviors, and smoking, as well as emotional experiences including body anxiety and depressed self-esteem (Crawford & Eklund, 1994; Leary, 1992; Martin, Leary, & O'Brien, 2001). This is hardly surprising given the western societal emphasis on thin lean bodies in females (Markula, 1995). Adolescence specifically is a critical developmental period whereby social, emotional, and physical changes to the body can intensify negative self-perceptions (Davis, 1997; Harter, 1999). Therefore, understanding the relationship between the physical self and health behaviors in females during the adolescent years has important public health ramifications.

The psychological and physiological benefits and costs of avoiding health behaviors such as physical activity and engaging in dietary restraint are well known. Physical activity decreases during adolescence (Kemper, Twisk, Koppes, van Mechelen, & Bertheke Post, 2001; Kimm, Glynn, Kriska, et al., 2002) and prospective studies tracking physical activity indicate greater decreases in teenage females compared to males, although physical activity is relatively unstable over time (Fortier, Katzmarzyk, Malina, & Bouchard, 2001; Twisk, Kemper, & van Mechelen, 2000). Potential serious health implications associated with the avoidance of exercise include obesity, increased cardiovascular risk factors, osteoporosis, diabetes, and depression. There is also emerging evidence that declining physical activity is associated with evolving body image and self-perception disturbances (Kimm et al., 2002). Similar negative health implications are also evident as a result of engagement in dietary restraint. Concerns over body appearance and dietary restraint are precursors to disordered eating (Davis, 1997) and restrained eating is associated with lower self-esteem in adolescents (Fox, Pate, Armstrong, & Kirby, 1994). Body anxiety is also associated with the adoption of weight-reduction strategies, lower self-esteem, and the avoidance of physical activity under some conditions (see Page & Fox, 1997).

Understanding the relationships among physical self-concept and associated health behaviors and emotions has been facilitated by the development of multidimensional models of self-concept. In these models the domain-specific representation of the physical self is nested under general self-concept or self-esteem (Fox & Corbin, 1989; Marsh, Richards, Johnson, Roche, & Tremayne, 1994; Shavelson, Hubner, & Stanton, 1976). Multidimensional models of the physical self hold that specific subdomains represent multiple aspects of physical self-concept. Fox and Corbin (1989) have identified four specific subdomains that include sport competence, body attractiveness, physical conditioning, and physical strength.

Research has consistently found that physical self-concept predicts physical activity, dietary behavior, body anxiety, and global self-esteem in various populations (Crocker et al., 2001; Fox, 2000; Martin, Engels, Wirth, & Smith, 1997). Furthermore, physical self-concept is a better predictor of behaviors and emotion than actual body characteristics such as height and weight (i.e., Page & Fox, 1997). Specific subdomains of the physical self are linked to particular behaviors and psychological/emotional states. For instance, (i) perceptions of physical conditioning, and also sometimes sport competence, are moderate predictors of physical activity (Biddle, Page, Ashford, & Jenning, 1993; Crocker et al., 2000; Dunton et al., 2003; Kowalski, Crocker, & Kowalski, 2001), (ii) social physique anxiety and perceptions of body appearance are highly correlated (Crocker, Synder, Kowalski, & Hoar, 2000; Kowalski et al., 2001) and (iii) dietary restraint and weight management behaviors are linked to body appearance and self-esteem (Crocker et al., 2001; Fox et al., 1994). Despite these findings, a limitation in our understanding of the link between physical self-perceptions and health behaviors in adolescence is that the research is almost exclusively cross-sectional. Little

is known about how adolescents' perceptions of their physical self changes over time and how these changes are linked to changes in and the adoption of health-related behaviors. Furthermore, few studies attempt to control for the impact of actual physical characteristics such as weight and height, or their ratio representation, body mass index (BMI). BMI is a predictor of adolescent females' desires to reduce their weight and change their appearance (see Page & Fox, 1997), and may confound research findings in this area.

A fundamental question in investigating the relationship between the physical self and behavior is the direction of causality. Self-concepts in specific domains are thought to influence the choice of behavior and subsequent persistence in that domain (Harter, 1999). Theorists also argue that physical self-perceptions are shaped by social, cognitive, and behavioral processes such as skill development, peer and parental support, motivational climate, social comparison, and feedback (see Fox, 1997, 2000; Harter, 1999; Horn, 2004).The literature also acknowledges bidirectional effects over time (Sonstroem, 1997). For example, perceptions of sport skills and conditioning competence might lead an adolescent to engage in regular physical activity, thus increasing physical skills. This skill enhancement would lead to increased physical self-perceptions and thus increase the likelihood of engaging in future physical activity. Potential bidirectional effects can only be examined using longitudinal or repeated measures designs. In one study, Sonstroem, Harlow, and Salisbury (1993) examined bidirectional effects between swimming performance and perceived physical competence in swimmers. Assessing swimmers three times over a one-year period, Sonstroem et al. found some evidence that perceived competence had a subsequent impact on swimming performance. There was, however, no evidence that better performance improved perceived competence.

The literature reveals that there is significant empirical and theoretical evidence that the physical self is related to a number of important health-related behaviors and emotions. However, there are significant gaps in our understanding of changes in key variables over time, and the nature of relationships among the physical self and behavior over time. This paper reports a three-year longitudinal study of adolescent females examining the relationships among certain health-related behaviors (physical activity and dietary restraint), perceptions and emotions (physical self-perceptions and social physique anxiety), and physical characteristics (BMI). Data from the first two years found meaningful group decreases in physical activity and increases in BMI over a 12 month period (Crocker et al., 2003). Further, all variables had moderate to strong stability. Change in body appearance perceptions were significantly related to changes in social physique anxiety and dietary restraint. There was also a significant relationship between change in physical activity and conditioning perceptions. Nevertheless, a limitation in this previous study was that one year may not be of sufficient duration to produce meaningful changes in all variables. Bidirectional effects were also not examined.

The present data set provides a unique contribution to the literature. The data collected in grades 9, 10, and 11 will provide an opportunity to examine how the physical self and associated health behaviors change over a significant period of adolescence in females. This longitudinal data allowed us to advance traditional cross-sectional research on the physical self and health-related behavior in several ways, including (a) examining changes in mean levels over time (mean stability), (b) changes in the distribution of individual differences over time (covariance stability), (c) examining the consistency of relationships among variables at specific time intervals, (d) examining whether changes in specific variables covary over time, (e) examining bidirectional effects among key physical self and health-related behavior variables over time and (f) examining differences in the prediction of cross-sectional and longitudinal data. The ability to investigate the prevalence of and to predict change in specific health behaviors and affect during adolescence could have significant implications for interventions focused on adolescent health.

METHODS

Participants and Procedures

Participants were 501 female adolescents involved in the three-year longitudinal study on physical self-perceptions and health behavior. In the first year (term one, 1998/99 school year) 705 grade nine female students (14–15 years old) participated, representing a range of socio-economic backgrounds from Saskatoon, Saskatchewan (Canada) and surrounding rural and urban areas. Following approval from the university and participating school ethics boards and school principals, researchers met with the students to describe the study and distribute consent forms. One week later the questionnaire package was administered during class time, with a researcher available to answer any questions. Approximately one year later, data were collected using the same procedures, which were again followed in the third year. By the end of the third year, 501 students (aged 16–17 years old) had complete data sets for all three years in the study.

Measures

Physical Characteristics

The young women reported age, height and weight. Previous research (Childress, Brewerton, Hodges, & Jarrell, 1993; Tomeo, Field, Berkey et al., 1999) found that both self-reported height and weight have acceptable validity for adolescent populations. Body mass index was calculated by a weight-to-height ratio (kg/m^2).

Physical and Global Self-Perceptions

The Physical Self-Perceptions Profile (PSPP; Fox & Corbin, 1989) consists of five 6-item scales that measure perceptions of physical self-worth (PSW), sport competence (Sport), bodily attractiveness (Body), physical conditioning and exercise (Conditioning), and physical strength and muscular development (Strength). The item score can range from 1 (low) to 4 (high) on a structured-alternative scale. The PSPP scales have acceptable scale reliability and validity with older children and adolescents (Crocker, Eklund, & Kowalski, 2000; Marsh et al., 1994). The average reliability of the PSPP scales in this study were Sport ($\alpha = 0.92$); Strength ($\alpha = 0.87$), Conditioning ($\alpha = 0.88$), Body ($\alpha = 0.87$) and PSW ($\alpha = 0.87$). The "What I am Like" Questionnaire from the Adolescent Self-Perception Profile assessed global self-esteem/worth (GSE). The GSE is a validated five-item self-report questionnaire recommended for use with adolescents (Harter, 1988). In the present study the reliability of the GSE was $\alpha = 0.79$.

Physical Activity

The Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski, Crocker, & Kowalski, 1997) is an 8-item self-report seven-day activity questionnaire. Each item is scored on a 5-point Likert scale, with higher scores indicating greater physical activity levels. The PAQ-A has demonstrated acceptable concurrent validity with other measures of physical activity. The average reliability for the PAQ-A in this study was $\alpha = .80$.

Social Physique Anxiety

The modified Social Physique Anxiety Scale (SPA) is a 9-item self-report scale, which assesses the degree of anxiety an individual experiences as a result of perceived observation or evaluation of his/her physique (Martin, Rejeski, Leary, McAuley, & Bane, 1997). The items

are scored on a 5-point Likert scale, with higher scores indicating greater levels of social physique anxiety. In this study, the reliability of SPA was $\alpha = 0$ .85

Dietary Restraint

The Dutch Eating Behavior Questionnaire—Restrained Eating (DEBQ-R) is a self-report questionnaire designed to assess the degree to which an individual restrains her eating behavior (van Strein, Frijters, Bergers, & Defares, 1986). The DEBQ-R is scored on a five-point scale ranging from 1 (Never) to 5 (Very Often). A sample item is, "Do you deliberately eat less in order not to become heavier?" The scale has acceptable reliability and validity for adolescents (Fox et al., 1994) and had an average reliability in the present study of $\alpha = 0$ .87

Data Analysis Strategy

A multi-step process was used to examine the questions of mean stability, covariance stability, cross-sectional relationships, relationship among change in variables over time, and bi-directional effects. First, mean stability was analyzed by repeated measures analysis of variance (ANOVA). Second, covariance stability was examined through intraclass correlations using ANOVA technique. Third, cross-sectional relationships were examined by Pearson product correlations. Fourth, we predicted physical activity, SPA, and dietary restraint in Year 3 through hierarchical regression. We specially examined the influence of the physical self-perceptions variable (Step 2) and global self-esteem (Step 3) after controlling for BMI in Step one.

A key research question was to determine if changes in self-perceptions were related to changes in the health-related behaviors and emotion over the three waves of assessment. Further, we wanted to test bi-directional effects. For the latter tests, the total number of predictors would make model testing very complex given the number of potential pathways. To utilize only a global measure of the physical self (physical self-worth [PSW]) in the bi-directional analysis would be problematic given that specific physical subdomains are known to be stronger predictors than PSW for specific criterion. Based on previous research, we expected that conditioning self-perceptions would be a prime covariate of physical activity and that body perceptions would be related to SPA and dietary restraint. However, most of this evidence is from cross-sectional studies. Therefore, we used a two-step analytical strategy. First, we used a residual change score technique (see Schutz, 1989). The standardized residual or change score of each variable was determined using regression analysis, with Year 1 being the independent variable and year 3 the dependent variable. The resulting residual or change score reflects the degree of change from the first to the third year of the study, independent of the first year score. This was followed by hierarchical multiple regression analyses, which involved forced entry of the standardized residuals for BMI on Step One, PSPP subdomain variables on Step Two, and then GSE on the final step. Separate analyses were conducted for physical activity, dietary restraint, and social physique anxiety. This strategy allowed us to identify the key self-perceptions that are linked to the three separate criteria over the two-year period.

The second step of our analysis strategy was to examine bidirectional effects (see Gollob & Reichardt, 1987) with path analysis using EQS (version 5.7b). The prominent self-perceptions were used in the path model along with a specific health-related behavior/emotion. We examined two particular models. First, we examined an isolated stability model that did not consider cross-lagged effects, allowing the examination of autoregressive effects. Second, we examined models that combined autoregressive and cross-lagged effects. The parameter estimates were fixed for the autoregressive effects based on the isolated stability model to control for these effects.

RESULTS

Descriptive Analysis, Group Mean Stability, and Covariance Stability

The means and standard deviations for BMI, PAQ-A, DEBQ-R, self-perception measures, and SPA for Years One, Two and Three are shown in Table 1. Repeated measures ANOVA were conducted to determine time effects (mean stability) over the three years of the study. Sphericity was assumed based on the high Mauchly's index and epsilon values close to 1. Significant ($p < .05$) time effects were observed for BMI (F (2,1000) = 66.33), SPA (F (2,1000) = 4.43), and PAQ-A (F (2,1000) = 130.94), and all physical self-perception variables (Body (F (2,1000) = 5.00); Conditioning (F (2,1000) = 30.89); Sport (F (2,1000) = 20.42); Strength (F (2,1000) = 4.57). There were no significant time effects for GSE and DEBQ-R. Effect sizes for group mean changes varied, with the largest effects for BMI and PAQ-A (see Table 1). Post hoc analyses (Tukey HSD) were conducted to determine if there were significant changes between each of the time periods (Year 1 through Year 3). All time periods for BMI, PAQ, Conditioning, and Sport were significantly different ($p < .05$). There were no significant differences in PSW or Strength scores from Year 2 to Year 3. Body self-perceptions did not demonstrate significant change from Year 1 to Year 2, and SPA scores were not significantly different from Year 1 to Year 3.

Intraclass correlation coefficients were calculated using a two-way mixed effect model to examine covariance stability between each year. All variables demonstrated a simplex structure, with proximal correlations (r_{12}, r_{23}) higher than the distal (r_{13}) correlation. All variables showed moderate to high stability estimates, with BMI being highly stable (see Table 1). The data does provide, however, evidence of some change within individuals over the three assessment periods.

Table 1
Descriptive Statistics, Effect Sizes for Group Differences, and Intraclass Correlations for Self-Perception Variables, Physical Activity, Social Physique Anxiety, and BMI

Variable	Year 1 Mean (SD)	Year 2 Mean (SD)	Year 3 Mean (SD)	Eta^2	r_{12}	r_{23}	r_{13}
BMI (kg/m^2)	20.65 (3.17)	21.20 (3.23)	21.46 (3.18)	.12*	.87	.90	.85
PAQ	2.65 (0.59)	2.42 (.56)	2.23 (.69)	.21*	.57	.63	.55
SPA	26.91 (7.44)	27.48 (7.82)	26.66 (7.75)	.01*	.69	.69	.58
DEBQ-R	2.17 (1.01)	2.15 (1.00)	2.11 (1.01)	.00	.73	.75	.61
GSE	2.96 (.71)	2.97 (.66)	2.94 (.63)	.00	.58	.62	.49
PSW	2.66 (.71)	2.59 (.67)	2.58 (.64)	.01*	.71	.71	.62
BODY	2.32 (.69)	2.33 (.72)	2.39 (.66)	.01*	.73	.71	.65
CONDITION	2.78 (.66)	2.70 (.68)	2.60 (.65)	.06*	.72	.73	.68
SPORT	2.63 (.70)	2.56 (.71)	2.50 (.68)	.04*	.78	.83	.75
STRENGTH	2.58 (.61)	2.53 (.63)	2.52 (.62)	.01*	.70	.73	.66

Notes: *significant ($p < .05$).
r_{12} is a single measure interclass correlation between Year 1 and Year 2.
r_{23} is a single measure interclass correlation between Year 2 and Year 3.
r_{13} is a single measure interclass correlation between Year 1 and Year 3.
BMI: body mass index; PAQ: physical activity questionnaire; SPA: social physique anxiety scale; DEBQ-R: Dutch Eating Behavior Questionnaire—Restrained Eating; GSE: global self-esteem; PSW: physical self-worth; Body: bodily attractiveness; Condition: physical conditioning and exercise; Sport: sport competence; Strength: physical strength and muscular development.

Table 2
Pearson Correlation Coefficients for Health-Related Behaviors, Social Physique Anxiety and Self-Perceptions in Years One, Two and Three

Variable	1	2	3	4	5	6	7	8	9
				Year one					
1. BMI	—								
2. PAQ	−.10*	—							
3. SPA	.38*	−.08	—						
4. DEBQ-R	.36*	−.04	.44*	—					
5. GSE	−.19*	.12*	−.54*	−.41*	—				
6. PSW	−.32*	.30*	−.64*	−.43*	.65*	—			
7. BODY	−.51*	.12*	−.75*	−.47*	.54*	.68*	—		
8. CONDITIONING	−.34*	.53*	−.47*	−.29*	.48*	.76*	.55*	—	
9. SPORT	−.15*	.47*	−.35*	−.19*	.38*	.64*	.35*	.72*	—
10. STRENGTH	.11*	.33*	−.29*	−.07	.32*	.53*	.22*	.52*	.58*
				Year two					
1. BMI	—								
2. PAQ	−.06	—							
3. SPA	.33*	− .09*	—						
4. DEBQ-R	.34*	−.03	.47*	—					
5. GSE	−.23*	.17*	−.60*	−.38*	—				
6. PSW	−.29*	.39*	−.64*	−.43*	.66*	—			
7. BODY	−.49*	.14*	−.78*	−.46*	.63*	.72*	—		
8. CONDITIONING	−.27*	.57*	−.44*	−.27*	.49*	.79*	.53*	—	
9. SPORT	−.13*	.52*	−.34*	−.21*	.42*	.70*	.39*	.76*	—
10. STRENGTH	.15*	.36*	−.22*	−.02	.26*	.50*	.19*	.50*	.57*
				Year three					
1. BMI	—								
2. PAQ	−.02	—							
3. SPA	.37*	−.16*	—						
4. DEBQ-R	.30*	−.07	.45*	—					
5. GSE	−.13*	.20*	−.52*	−.33*	—				
6. PSW	−.25*	.37*	−.65*	−.38*	.62*	—			
7. BODY	−.48*	.18*	−.76*	−.38*	.50*	.74*	—		
8. CONDITI0NING	−.21*	.55*	−.45*	−.27*	.45*	.77*	.53*	—	
9. SPORT	−.08*	.51*	−.34*	−.20*	.36*	.68*	.38*	.75*	—
10. STRENGTH	.14*	.38*	−.25*	−.09*	.32*	.58*	.28*	.59*	.62*

Note: *significance ($p < .05$).
BMI: body mass index; PAQ: physical activity questionnaire; SPA: social physique anxiety scale; DEBQ-R: Dutch Eating Behavior Questionnaire–Restrained Eating; GSE: global self-esteem; PSW: physical self-worth; Body: bodily attractiveness; Condition: physical conditioning and exercise; Sport: sport competence; Strength: physical strength and muscular development.

Cross-Sectional Analyses for Year Three

Correlations for all three years are reported (Table 2). In Year 3 the four subdomains of the PSPP were moderately correlated, as expected, with PSW and GSE. Body and Conditioning perceptions were the primary correlates with both PSW and GSE. All health-related behaviors and SPA were significantly correlated with all global and physical self-perceptions, but with unique patterns. Conditioning and sport competence perceptions were the dominant correlates with PAQ-A. Body self-perception was the primary correlate of SPA, DEBQ-R, and BMI. BMI was not correlated with physical activity and had low-moderate correlations with SPA and dietary restraint. SPA and DEBQ-R were moderately correlated and both had low or no significant correlation with PAQ-A.

Hierarchical regression analysis was used to predict the third-year physical activity, social physique anxiety, and dietary restraint scores from third-year physical and global self-perception variables, after controlling for BMI. For all analyses, Step One consisted of forced entry of BMI, followed by the four PSPP subdomain scale scores, and then GSE. The physical self-worth (PSW) variable was not included in any analyses since the four PSPP subdomain scales represent specific dimensions of the physical self and are collectively strong predictors of PSW. The inclusion of the PSW scale may also have the potential to introduce colinearity or suppressor effects.

Physical Activity

In Step One BMI was not a significant predictor. Only Step Two made a significant contribution to the model prediction, accounting for 36.4% of the variance. In the final standardized equation, Conditioning ($\beta = .476$), Sport ($\beta = .195$), and Body ($\beta = -.135$) were significant individual predictors.

SPA

All three steps made significant contributions to the prediction of SPA, accounting for 61.9% of the variance. BMI predicted 12.7% in Step One, PSPP subdomains added 46.8% on Step Two, and GSE contributed 2.3% on Step Three. In the final model, only Body ($\beta = -.658$) and GSE ($\beta = -.184$) were significant individual predictors.

Dietary Restraint

All three steps were significant, predicting 20% of the variance in DEBQ-R. In Step One BMI predicted 8.7%, with PSPP subdomains contributing 8.2% in Step Two, followed by GSE adding 3% in the last step. The individual predictors in the final model were GSE ($\beta = -.209$), Body ($\beta = -.162$) and BMI ($\beta = .169$).

Predicting the Relationship in Change Among Variables from Year 1 to Year 3

To determine whether changes in physical activity, social physique anxiety, and dietary restraint covaried with changes in BMI, physical self-perceptions and global self-worth, standardized residual change scores were examined. The correlations among standardized residuals change scores can be viewed in Table 3. Physical activity residuals were not significantly correlated with SPA or dietary restraint (DEBQ-R), yet SPA and DEBQ-R residuals had a significant moderate correlation ($r = .39$) Separate hierarchical multiple regression analyses were conducted for physical activity, dietary restraint, and social physique anxiety. In all models, BMI residual scores were not significant predictors of physical activity, dietary restraint, or SPA.

Change in Physical Activity

The residuals correlation matrix indicated that all physical self-perceptions and global self-esteem scores were significantly correlated with physical activity, with conditioning ($r = .35$) being the dominant correlate. The only significant change in the regression model occurred for the PSPP variables, accounting for 12.9% of the explained variance in physical activity change. In the model, only the self-perception for Conditioning ($\beta = .292$) was a significant individual predictor.

Table 3
Pearson Correlation Coefficients for Health-Related Behaviors, Social Physique Anxiety, and Self-Perception Change Standardized Residuals

Variable	1	2	3	4	5	6	7	8	9
1. BMI	—								
2. PAQ	.07	—							
3. SPA	.05	−.08	—						
4. DEB-R	.00	.02	.39*	—					
5. GSE	.01	.10*	−.35*	−.24*	—				
6. PSW	.01	.18*	−.45*	−.28*	.47*	—			
7. BODY	−.15*	.10*	−.57*	−.25*	.36*	.60*	—		
8. CONDITIONING	.01	.34*	−.27*	−.15*	.32*	.58*	.41*	—	
9. SPORT	.10*	.26*	−.24*	−.09	.26*	.51*	.31*	.54*	—
10. STRENGTH	.13*	.22*	−.22*	−.14*	.31*	.50*	.28*	.47*	.44*

*Significant at the 0.05 level.
BMI: body mass index; PAQ: physical activity questionnaire; SPA: social physique anxiety scale; DEBQ-R: dutch eating behavior questionnaire—restrained eating; GSE: global self-esteem; PSW: physical self-worth.

Change in Social Physique Anxiety

All self-perception residuals scores were significantly correlated with SPA, with body appearance emerging as the dominant correlate ($r = -.57$). The PSPP self-perception residual change scores accounted for 33.7% of the variance in SPA change, and GSE contributed an additional 1.8% of the variance. In the final model, Body ($\beta = -.513$) and GSE ($\beta = -.151$) change scores were significant individual predictors.

Change in Dietary Restraint

Dietary restraint residual scores were correlated with all self-perception residual scores, with Body ($r = -.25$) and global self-esteem ($r = -.24$) having similar correlations. In the regression analysis, physical self-perception variables accounted for 6.9% of the variance in dietary restraint change, with GSE accounting for an additional 2.1%. In the final model, Body ($\beta = -.184$) and GSE ($\beta = .162$) change were significant individual predictors.

Bidirectional Causal Lagged Effects Over Time

The residual analyses examining change between Year One and Year Three produced similar results as reported by Crocker et al. (2003) for changes between Year One and Two. For physical activity, SPA, and dietary restraint, there was one significant individual PSPP subdomain predictor, with GSE adding a small portion of additional explanatory variance for SPA and DEBQ-R in the present data set. Therefore, for the directional effects, we analyzed the bidirectional effects for (a) conditioning perceptions and physical activity, (b) body perceptions and SPA, and (c) body perceptions and DEBQ-R. Path analysis was performed using EQS 5.7b (Bentler, 1995), with isolated stability model (autoregressive) effects and causal cross-lagged (bidirectional) effects across all three waves (see Figures 1, 2, and 3).

It has been recommended to examine an isolated stability model as a null hypothesis model before examining cross-lagged causal relationships (Hertog & Nesselroade, 1987). These models posit an initial covariance between two different manifest (measured) variables at Time One and autoregressive pathways between waves of each independent variable (model a in Figures 1, 2, and 3). The causal models (model b) add cross-lagged pathways. In the figures,

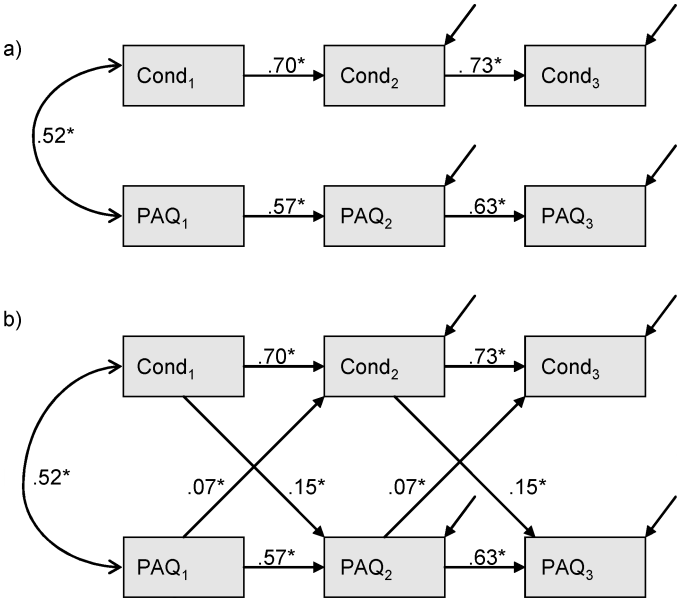

Figure 1. Standardized solutions for autoregression analysis of (a) isolated stability model and (b) causal cross-lagged effects between conditioning self-perceptions and physical activity over three waves of data.

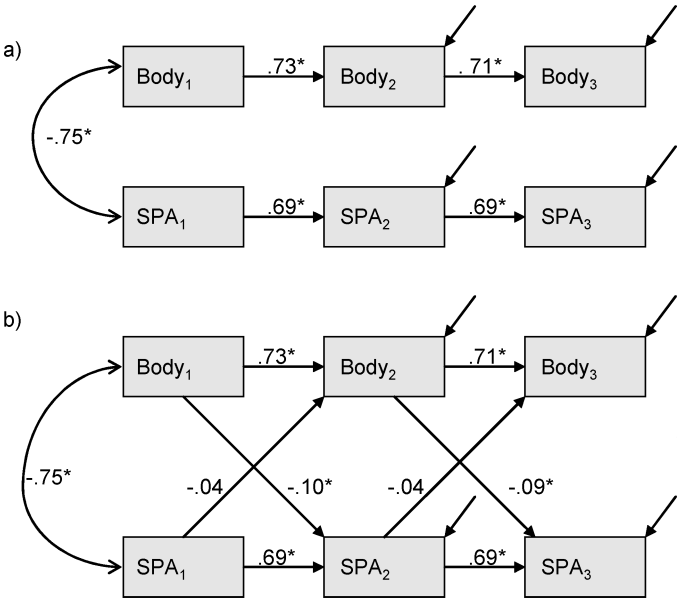

Figure 2. Standardized solutions for autoregression analysis of (a) isolated stability model and (b) causal cross-lagged effects between body appearance self-perceptions and social physique anxiety over three waves of data.

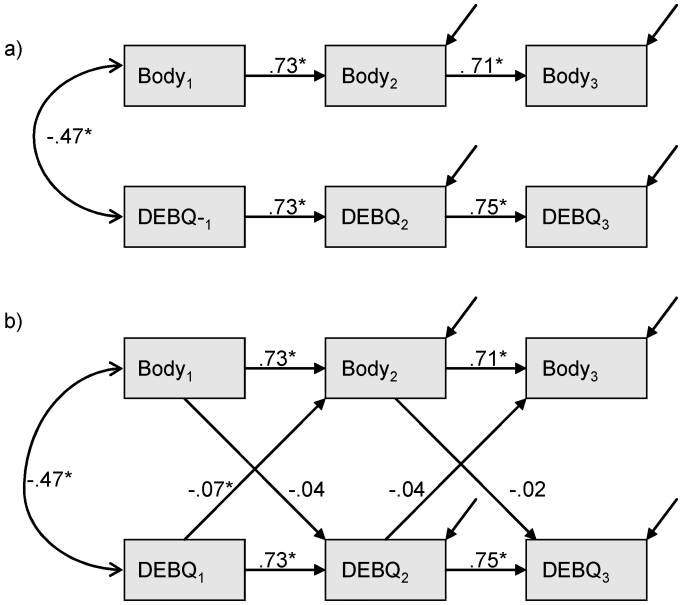

Figure 3. Standardized solutions for autoregression analysis of (a) isolated stability model and (b) causal cross-lagged effects between body appearance self-perceptions and dietary restraint over three waves of data.

the correlation coefficient associated with each single-headed arrow denotes the size of the causal effect.

Physical Activity and Conditioning Self-Perceptions

When the isolated stability model and the cross-lagged model are compared, there is evidence of a bidirectional causal relationship between conditioning perceptions and physical activity (see Figure 1). The data from the cross-lagged model indicates self-perceptions seem to have a stronger impact on behavior than behavior on self-perceptions. Further, the cross-lagged effects are the same in each wave. In terms of physical activity, the results show that a one-unit increase in physical activity is a function of an autoregressive effect (.57) and a cross-lagged conditioning effect (.12) plus a disturbance (error) effect. For Conditioning, a one unit increase in conditioning is associated with an autoregressive effect (.70) and a cross-lagged physical activity effect (.07) plus a disturbance effect.

The pattern of results for SPA and body perceptions indicates evidence of only self-perception effects on future SPA, in addition to autoregressive effects. Body produces a significant but small (.10 and .09) cross-lagged effect on SPA in Waves One and Two, respectively. The cross-lagged effect of SPA on body perceptions is not statistically significant (.04). Again the model is consistent across waves. The covariance between SPA and body is very high ($r = -.75$).

Dietary Restraint and Body Self-Perceptions

There is weak evidence of cross-lagged causal effects for dietary restraint and body perceptions. Only one cross-lagged effect is significant, with a low coefficient ($-.07$) between Time One DEBQ-r and Time Two body. All other cross-lagged pathways are not statistically significant.

DISCUSSION

The findings of this three-year longitudinal study of adolescent females provide a unique data set that can facilitate understanding the relationships among the physical self and health-related behaviors and social physique anxiety. This longitudinal research allowed us to investigate a number of research questions related to change. The data indicated that all the variables demonstrated moderate covariance stability from grades 9 to 11, with BMI manifesting high stability. This level of stability affected all subsequent analyses since examining change was a primary purpose of this study. Nevertheless, the physical self was a cross-sectional and longitudinal predictor of health-related behavior and social physique anxiety. As expected, specific subdomains of the physical self were associated with physical activity, dietary restraint, and social physique anxiety. However, autoregressive path analysis of cross-lagged effects raised questions about causal relationships. Our results highlight the importance of understanding how specific behaviors change throughout adolescence at both the group mean level and in the distribution of individual differences over time (covariance stability), as well as considering how changes covary in meaningful ways.

Consistent with previous work (Kemper et al., 2001; Kimm et al., 2002), there was a significant decrease in the group mean physical activity levels during adolescence but only moderate covariance stability across time. Self-perceptions of physical conditioning and sport competence were both cross-sectional and longitudinal correlates of physical activity. Although body appearance was negatively related to physical activity during Year Three, it did not predict change in physical activity. This highlights the biased estimates of effects produced by cross-sectional regression analysis (Gollob & Reichardt, 1987). The longitudinal analyses of the data, using both residual analysis and path analysis, showed that most of the variance in physical activity can be explained by previous year physical activity levels. The explained variance in the residual change analysis was relatively small and consistent with previous research with older children (Sallis, Alcarez, McKenzie, & Hovell, 1999). The covariation between activity change and physical self-perceptions supports the contention that the physical self plays a role in the adoption and maintenance of physical activity (Sonstroem, 1997). The autoregression analysis, however, tempers a conclusion that self-perceptions have a strong impact on future physical activity. To a large extent, the data suggest that activity and conditioning self-perceptions are moderate covariates. These findings are supported by theoretical propositions that conditioning self-perceptions are related to perceived confidence in fitness settings and are influenced not only by actual fitness but also by feedback from significant others such as peers, parents, and coaches (Fox, 1997). Irrespective of the links between self-perceptions and physical activity, it is important not to lose sight of the group decrease in physical activity. Given the health benefits of physical activity, the decrease in the activity levels of many adolescent females is a fundamental public health concern.

Theorists have argued that women in western cultures are under enormous pressure to conform to unrealistic body shapes, leading to increased body dissatisfaction, body anxiety, and a drive for thinness (Fredrickson & Roberts, 1997; Markula, 1995). The present study found significant links among body perceptions, body anxiety, and dietary restraint. While BMI increased systematically over time, there was little group mean change in social physique anxiety or body appearance self-perceptions. BMI was only a weak cross-sectional correlate of social physique anxiety and dietary restraint. Although BMI increased over each assessment wave, increases in BMI were not related to changes in perceptions of body appearance. Cross-sectional biased effects were found for both social physique anxiety and dietary restraint. In particular, it appeared that BMI was a key cross-sectional individual predictor of dietary restraint yet the longitudinal residual analysis found no evidence of predictive effects. In the

longitudinal analysis, the key predictor of social physique anxiety and dietary restraint appears to be physical self-perceptions. Covariance changes in social physique anxiety were predicted by changes in body attractiveness perceptions and, albeit weakly, global self-esteem. Similar relationships were found for dietary restraint. The autoregressive path analysis data again raised questions about meaningful causal links between the body and both social physique anxiety and dietary restraint. However, the weak links with the physical self may be due to moderately high covariance stability in social physique anxiety and dietary restraint over time.

The findings also indicated that physical activity was relatively independent from social physique anxiety and dietary restraint. Previous research in college women had found weak and ambiguous relationships between social physique anxiety and physical activity (Crawford, & Eklund, 1994; Kowalski et al., 2001). In the present study there was a significant, but very weak, negative relationship between physical activity and social physique anxiety in Year Three. There was no evidence of longitudinal relationships. Gaining a better understanding of the consequences of social physique anxiety is important since it might lead young women to choose a number of functional (increased physical activity, healthy eating) or dysfunctional (exercise avoidance, laxatives, disordered eating, drugs) coping strategies (Sabiston, Sedgwick, Farrell, et al., 2003). The critical moderators that regulate the adoption of various coping strategies to manage social physique anxiety are not well understood.

The data set also allows a unique examination of the PSPP model over time in adolescent females. The majority of studies using the PSPP model have been cross-sectional. Consistent with the multidimensional model, the present research indicates that PSPP sub-domains are more strongly correlated with physical self-worth (PSW) than global self-esteem (GSE), a finding that was constant across all three years. Consistent with the work of Harter (1999), body appearance was the strongest correlate to GSE. An interesting finding, however, is that conditioning, body appearance, and sport competence perceptions had similar relationships with PSW. These results are contrary to previous work indicating that body appearance is the primary determinant of physical self-worth (Fox, 1997; Kowalski et al., 2001). This data might reflect an increased societal pressure in young women to not only be thin, but to be thin and athletic (Markula, 1995; McCabe, Ricciardelli, & Banfield, 2001).

When the stability of the physical self is examined, it is clear that the physical self remains relatively stable. Although there are significant changes in the group means of some PSPP subdomains from grades 9 to 11, the group mean change is small. These findings suggest that young women are forming physical identities relatively early in adolescence. Further, consistent with Marsh and Yeung (1998), the physical self is more stable than global self-esteem (see also Kowalski, Crocker, Kowalski, Chad, & Humbert, 2003). Based on the observation that specific physical self-perceptions are better predictors of change in specific health-related behaviors and emotion, two key ramifications are revealed. First, we need to understand the formation of specific physical self-perceptions if we are to comprehend cognitive, behavioral, and emotional consequences related to the physical self. Second, interventions focused on the physical self and body image need to target young adolescents, if not children.

A major challenge in investigating the role of the physical self in the adoption and maintenance of health-related behaviors is determining causality. Cross–sectional designs and analyses can produce biased causal effects since it is not possible to determine the influence of prior variables. The autoregressive analysis techniques used in this study indicated that much of the variance of physical activity, dietary restraint, and social physique anxiety were related to prior values of the same variable. The residual analysis from Time One to Time Three was based on the premise that two years would allow significant change to occur in both physical self and health-related behaviors, since causes take time to produce effects. It is not clear, however, what the optimal time lag is to assess causal effects (Gollob & Reichardt,

1987). For example, Amorose (2001) examined physical self-worth on six separate days over a three-week period. The present study examined much longer time lags. The time periods used in the various analyses (one or two years) may have been too long, since casual effects might have occurred more rapidly. However, the moderate covariance stability indicates that most variables are behaving as relatively stable entities. Clearly models of change and causal effects involving the physical self must begin to address the key causal agents and time frames.

The strength of this study is that it used valid instruments coupled with a sound physical self conceptual model to examine health-related behaviors and emotion. The combination of both cross-sectional and longitudinal analyses with a large sample of adolescent females generated greater clarity about the nature of change in these variables. One limitation in the study is the use of self-report instruments; however, all of the psychological instruments have been validated with this population. The use of self-report for physical characteristics may be a limitation, although studies have reported acceptable reliability estimates between reported and actual measure of height and weight (Childress et al., 1993). The high covariance stability coefficients in the present study also support the reliability of the BMI values. Research has also consistently indicated that physical activity measures, especially self-report instruments have error problems (Ainsworth, 2000). Objective measures such as pedometers and accelerators are not influenced by memory and recall bias but have their own multitude of measurement problems in children and adolescents such as instrument breakdown, reactivity, and compliance (Crocker, Holowachuk, & Kowalski, 2001; Kowalski et al., 1997). A final limitation was the small number of data points for performing more complex change analyses (Gottman, 1995).

Future considerations for tracking change analyses in psychologically and physiologically driven research are recommended. A greater number of data points should be considered for change analysis. Three data points precludes certain advanced statistical procedures such as growth curve modeling due to the limited degrees of freedom and possible misleading trends that emerge (Gottman, 1995). More observations would also allow a better examination of intraindividual variability (Amorose, 2001), in addition to mean stability and covariance stability. Change at an individual level is not conclusive based on limited data points, and the amount of variance and scatter in the change data is not adequately portrayed in the analyses. Another consideration for future research is to advance the theoretical links between the psychological and physiological relationships (i.e., physical activity and physical self-perceptions) with combined quantitative and qualitative methodologies. Perhaps then we will understand the antecedents and consequences of the physical self and the specific roles of physical activity, BMI, dietary restraint and social physique anxiety that were not fully explained in this current research project.

REFERENCES

Ainsworth, B. (2000). Challenges in measuring physical activity in women. *Exercise and Sport Sciences Reviews, 28*, 93–96.

Amorose, A. J. (2001). Intraindividual variability of self-evaluations in the physical domain: Prevalence, consequences, and antecedents. *Journal of Sport & Exercise Psychology, 23*, 222–244.

Bentler, P. M. (1995). *EQS Structural Equations Program Manual*. Los Angeles, CA: Multivariate Software.

Biddle, S. J., Page, A., Ashford, B., & Jenning, D. (1993). Assessment of children's physical self-perceptions. *International Journal of Adolescence, 4*, 93–109.

Childress, A., Brewerton, T., Hodges, E., & Jarrell, M. (1993). The kids' eating disorder survey (KEDS): A study of middle school students. *Journal of American Academy Child Adolescent Psychiatry, 32*, 843–850.

Crawford, S., & Eklund, R. C. (1994). Social physique anxiety, reasons for exercise, and attitudes toward exercise settings. *Journal of Sport and Exercise Psychology, 16*, 70–82.

Crocker, P. R. E., Eklund, R., & Kowalski, K. C. (2000). Children's physical activity and physical self-perceptions. *Journal of Sports Sciences, 18*, 383–394.

Crocker, P. R. E., Holowachuk, D., & Kowalski, K. C. (2001). Feasibility of using the Tritrac motion sensor over a 7-day trial with older children. *Pediatric Exercise Science, 13*, 70–81.

Crocker, P. R. E., Kowalski, N., Kowalski, K. C., Chad, K., Humbert, L., & Forrester, S. (2001). Smoking behavior and dietary restraint in young adolescent women. The role of physical self-perceptions. *Canadian Journal of Public Health, 92*, 428–432.

Crocker, P. R. E., Sabiston, C., Forrester, S., Kowalski, N. C., Kowalski, K. C., & 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.

Crocker, P. R. E., Snyder, J., Kowalski, K., & Hoar, S. (2000). Don't let me be fat or physically incompetent! The relationship between physical self-concept and social physique anxiety in Canadian high performance female adolescent athletes. *Avante, 6*, 1–8.

Davis, C. (1997). Body image, exercise, and eating behaviors. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 143–174). Champaign, IL: Human Kinetics.

Dunton, G. F., Jamner, M. S., & Cooper, D. M. (2003). Physical self-concept in adolescent girls: Behavioral and physiological correlates. *Research Quarterly for Exercise and Sport, 74*, 360–365.

Fortier, M. D., Katzmarzyk, P. T., Malina, R. M., & Bouchard, C. (2001). Seven-year stability of physical activity and musculoskeletal fitness in the Canadian population. *Medicine and Science in Sports & Exercise, 33*, 1905–1911.

Fox, K. R. (1997). The physical self and processes in self-esteem development. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 111–139). Champaign, IL: Human Kinetics.

Fox, K. R. (2000). Self-esteem, self-perceptions, and exercise. *International Journal of Sport Psychology, 31*, 228–240.

Fox, K. R., & Corbin, C. (1989). The physical self-perception profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*, 408–430.

Fox, K. R., Pate, A., Armstrong, N., & Kirby, B. (1994). Dietary restraint and self-perceptions in early adolescence. *Personality and Individual Differences, 17*, 87–96.

Fredrickson, B., & Roberts, T. (1997). Objectification theory: Toward understanding women's lived experiences and mental health risks. *Psychology of Women Quarterly, 21*, 173–206.

Gollob, H. F., & Reichardt, C. S. (1987). Taking account of time lags in causal models. *Child Development, 58*, 80–92.

Gottman, J. M. (1995). *Analysis of change*. Mahwah, NJ: Lawrence Erlbaum.

Harter, S. (1988). *Manual of the self-perception profile for adolescents*. Denver, CO: University of Denver.

Harter, S. (1999). *The construction of the self: A developmental perspective*. New York, NY: Guilford.

Hertog, C., & Nesselroade, J. R. (1987). Beyond autoregressive models: Some implications of the trait-state distinction for the structural modeling of developmental change. *Child Development, 58*, 93–109.

Horn, T. S. (2004). Developmental perspectives on self-perceptions in children and adolescents. In M. R. Weiss (Ed.), *Developmental sport and exercise psychology: A lifespan perspective* (pp. 101–144). Morgantown, WV: Fitness Information Technology.

Kemper, H., Twisk, J., Koppes, L., van Mechelen, W., & Bertheke Post, G. (2001). A 15-year physical activity pattern is positively related to aerobic fitness in young males and females (13–27 years). *European Journal of Applied Physiology, 84*, 395–402.

Kimm, S., Glynn, N., Kriska, A., Barton, B., Kronsberg, S., Daniels, S., Crawford, P., Sabry, Z., & Liu, K. (2002). Decline in physical activity in black girls and white girls during adolescence. *New England Journal of Medicine, 347*, 709–715.

Kowalski, K. C., Crocker, P. R. E., & Kowalski, N. (1997). Convergent validity of the physical activity questionnaire for adolescents. *Pediatric Exercise Science, 9*, 342–352.

Kowalski, K. C., Crocker, P. R. E., Kowalski, N. P., Chad, K. E., & Humbert, M. L. (2003). Examining the physical self in adolescent girls over time: Further evidence against the hierarchical model. *Journal of Sport and Exercise Psychology, 25*, 5–18.

Kowalski, N., Crocker, P., & Kowalski, K. (2001). Physical self and physical activity relationships in college women: Does social physique anxiety moderate effects? *Research Quarterly for Exercise and Sport, 72*, 55–62.

Leary, M. (1992). Self-presentational processes in exercise and sport. *Journal of Sport and Exercise Psychology, 14*, 339–351.

Markula, P. (1995). Firm but shapely, fit but sexy, strong but thin. The postmodern aerobicizing female bodies. *Sociology of Sport Journal, 12*, 424–453.

Marsh, H. W., Richards, G. E., Johnson, S., Roche, L., & Tremayne, P. (1994). Physical Self—Description Questionnaire: Psychometric properties and a multitrait-multimethod analysis of relations to existing instruments. *Journal of Sport and Exercise Psychology, 16*, 270–305.

Marsh, H. W., & Yeung, A. S. (1998). Top-down, bottom-up, and horizontal models: The direction of causality in multidimensional, hierarchical self-concept models. *Journal of Personality and Social Psychology, 75*, 509–527.

Martin, J. J., Engles, H. J., Wirth, J. C., & Smith, K. L. (1997). Predictors of social physique anxiety in elite female youth athletes. *Women in Sport and Physical Activity Journal, 6*, 29–48.

Martin, K., Leary, M. R., & O' Brien, J. (2001). Role of self-presentation in the health practices of a sample of Irish adolescents. *Journal of Adolescent Health, 28*, 259–262.

Martin, K., Rejeski, W. J., Leary, M. R., McAuley, E., & Bane, S. (1997). Is the Social Physique Anxiety Scale really multidimensional? Conceptual and statistical arguments for a unidimensional model. *Journal of Sport and Exercise Psychology, 19*, 359–367.

McCabe, M., Ricciardelli, L., & Banfield, S. (2001). Body image, strategies to change muscles and weight, and puberty. Do they impact on positive and negative affect among adolescent boys and girls? *Eating Behavior, 2*, 129–149.

Page, A., & Fox, K. R. (1997). Adolescent weight management and the physical self. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 229–256). Champaign, IL: Human Kinetics.

Sabiston, C. M., Sedgwick, W., Farrell, R., Crocker, P. R. E., Kowalski, K. C., & Stevens, D. (2003). Body-related anxiety and coping strategies used by Canadian female adolescents. In *Proceeding of XI European Congress of Sport Psychology*. Copenhagen. WWW.fepsac2003.dk.

Sallis, J., Alcarez, J., McKenzie, T., & Hovell, M. (1999). Predictors of change in children's physical activity over 20 months: Variations by gender and level of adiposity. *American Journal of Preventive Medicine, 16*, 222–229.

Schutz, R. (1989). Analysing change. In M. J. Safrit, & T. M. Wood (Eds.), *Measurement concepts in physical education and exercise science* (pp. 207–228). Champaign, IL: Human Kinetics.

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*, 407–441.

Sonstroem, R. J. (1997). The physical self-system: A mediator of exercise and self-esteem. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 3–26). Champaign, IL: Human Kinetics.

Sonstroem, R. J., Harlow, L., & Salisbury, K. (1993). Path analysis of a self esteem model across a competitive swim season. *Research Quarterly for Exercise and Sport, 64*, 335–342.

Tomeo, C. A., Field, A. E., Berkey, C. S., Colditz, G. A., & Frazier, A. L. (1999). Weight concerns, weight control behaviors, and smoking initiation. *Pediatrics, 104*, 918–24.

Twisk, J. W. R., Kemper, H. C., & van Mechelen, W. (2000). Tracking of activity and fitness and the relationship with cardiovascular disease risk factors. *Medicine and Science in Sports and Exercise, 32*, 1455–1461.

van Strein, T., Frijters, J., Bergers, G., & Defares, P. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders, 5*, 295–315.