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Obesity, cardiovascular fitness, and physically active adolescents' motivations for activity: A self-determination theory approach

Thomas G. Power [a,*], Sarah C. Ullrich-French [b], Michael M. Steele [c], Kenn B. Daratha [d], Ruth C. Bindler [d]

[a] Department of Human Development, Washington State University, P.O. Box 644852, Pullman, WA 99164-4852, USA
[b] Department of Educational Leadership and Counseling Psychology, Washington State University, P.O. Box 642136, Pullman, WA 99164-2136, USA
[c] Department of Psychology, Auburn University, 226 Thach Hall, Auburn, AL 36849, USA
[d] College of Nursing, Washington State University, P.O. Box 1495, Spokane, WA 99120-1495, USA

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ABSTRACT

Objectives: Overweight and obesity pose significant health problems for adolescents. Rates of overweight and obesity in children have increased 45% in the last decade and have increased three-fold since 1980. Because children who are physically active are at lower risk for the development of obesity, it is important to understand some of the factors that influence children's physical activity patterns. The purpose of this study was to examine the relationship between motivation, cardiorespiratory fitness, and weight status, defined as obese or non-obese. We predicted that the association between motivation and weight status would become non-significant when controlling for cardiorespiratory fitness.
Design: The study employed a correlational, cross-sectional design.
Method: Participants included physically active middle school students ($N = 82$. 51% female) of aged 12–14 years, who participated in the Teen Eating and Activity Mentoring in Schools (TEAMS) study aimed at improving health and preventing obesity among middle school students. Students completed attitudinal questionnaires about physical activity and self-determination on a computer-based system and participated in a number of fitness performance, health behavior, and anthropometric assessments.
Results: Non-obese adolescents showed higher intrinsic motivation scores than obese adolescents. Mediational analyses showed that cardiorespiratory fitness mediated the relationship between motivation and weight status.
Conclusions: The results of this study demonstrate differences in physical activity motivation as a function of adolescent weight status, but only for intrinsic motivation. As predicted, adolescents who were intrinsically motivated for physical activity were more fit and thereby less likely to be obese. The findings are consistent with self-determination theory.

Introduction

Overweight and obesity pose significant health problems for adolescents. Approximately 18% of U.S. youth are obese, and another 16% are overweight (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Rates of overweight and obesity in youth have increased three-fold since 1980 (Centers for Disease Control and Prevention, 2010a, 2010b). The consequences of childhood obesity are well-known, including an increased risk for a number of medical conditions, dysfunctional eating behaviors, and impaired social/emotional development (Williams, Wake, Hesketh, Maher, & Waters, 2005).

Although many factors contribute to the development of childhood obesity (e.g., metabolism, food intake, sedentary behavior—see Gorin & Crane, 2008 and Hawkins & Law, 2006 for reviews), increasing physical activity is an effective way of preventing and/or reducing childhood obesity (Hills, King, & Armstrong, 2007). In one recent review, Connelly, Duaso, and Butler (2007) found that the only school-based, obesity prevention programs demonstrating a measurable impact on child body mass index were those with a compulsory physical activity component. Sustained levels of physical activity, particularly aerobic activity, have been shown to have a consistent effect on weight status with strong evidence for a positive relationship between physical activity and cardiorespiratory fitness, metabolic health, and body composition for youth (Physical Activity Guidelines Advisory Committee, 2008). Therefore, the mechanism by which

* Corresponding author. Tel.: +1 509 335 8439; fax: +1 509 335 2456.
E-mail addresses: tompower@wsu.edu (T.G. Power), sullrich@wsu.edu (S.C. Ullrich-French), mms0018@auburn.edu (M.M. Steele), kdaratha@wsu.edu (K.B. Daratha), bindler@wsu.edu (R.C. Bindler).

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physical activity affects weight status may largely be attributed to metabolic health and cardiorespiratory fitness that result from sustained aerobic activity.

Given that children who are physically active are at lower obesity risk (Physical Activity Guidelines Advisory Committee, 2008; Stensel, Gorely, & Biddle, 2008), it is important to understand some of the factors that influence children's physical activity patterns. One way to address such factors is to take a motivational perspective that considers the reasons why children participate in physical activity. It is likely that children with a strong motivation for physical activity would be more physically active and less likely to become obese.

Self-determination theory (Deci & Ryan, 1980; Ryan & Deci, 2000) provides a well-validated framework for understanding individual differences in motivation. Deci and Ryan (1980) proposed that the underlying reasons for behavior comprise a continuum of self-determination, ranging from intrinsic or self-regulated reasons to externally controlled reasons. Intrinsic motivation involves participating in an activity for its own sake, in the absence of external contingencies.

According to Ryan and Deci (2000), intrinsically motivated behaviors are not the only behaviors that are autonomous and self-regulated. People engage in many behaviors, not because they are intrinsically rewarding, but because they help individuals reach their self-defined goals. Such behaviors are often initially extrinsically motivated and may have their origins in expectations imposed on them by their culture, community, or family. Ryan and Deci (2000) helped identify the environmental factors that can move the motivation for these behaviors along the continuum from less to more self-determined motivation. Organismic integration theory, a mini-theory within self-determination theory, details a continuum of external motivation from external, to introjected, to identified, to integrated regulation. External regulation involves control outside of the individual. Introjected regulation stems from internal contingencies of reward and punishment, such as guilt or shame. Both represent forms of motivation controlled by pressures and contingencies. Relatively autonomous extrinsic motives include identified regulation (motivations that derive from personal meaning or values) and integrated regulation (behavior congruent with one's sense of self or identity).

Self-determination theory is particularly useful for application during adolescence, because this is a phase of the lifespan characterized by increased autonomy from parents (Blos, 1979; Eccles et al., 1991; Erikson, 1959). Not only do adolescents spend less time with their immediate families, but they show increased autonomy in their decision-making as well. This is truer in some areas than others. Smetana and colleagues (Smetana, 1995; Smetana, Campione-Barr, & Daddis, 2004) have demonstrated that adolescents feel particularly entitled to make decisions in the personal and social conventional domains (Turiel, 1983)—domains including decisions about appearance, lifestyle, and recreational behaviors. When adolescents feel that their freedom to engage in these behaviors is threatened by adults, they may show resistance and psychological reactance (doing the exact opposite of what is expected of them) (e.g., Brehem & Sensenig, 1966; Grandpre, Alvaro, Burgoon, Miller, & Hall, 2003). Many of these lifestyle and recreational decisions (e.g., sports, screen time, diet) are those that increase or decrease the likelihood of developing obesity (Physical Activity Guidelines Advisory Committee, 2008).

Numerous researchers have applied self-determination theory to physical activity in adolescents. In these studies, both *intrinsic motivation* (e.g., a tendency to find physical activity exciting, rewarding, or fun) and *identified motivation* (e.g., acting in accordance with one's values) are associated positively with numerous psychosocial outcomes including enjoyment, attitudes, values, behavioral norms, beliefs, affect, effort, self-perceptions, and intentions for future involvement in physical activity (Biddle, Soos, & Chatzisarantis, 1999; Chatzisarantis, Hagger, Biddle, & Karageorghis, 2002; Hagger, Chatzisarantis, & Biddle, 2002; Ntoumanis, 2001; Ullrich-French & Cox, 2009; Wang, Chatzisarantis, Spray, & Biddle, 2002). Intrinsic and identified motivation are positively associated with self-reported involvement in physical activity as well (Chatzisarantis et al., 2002; Ullrich-French & Cox, 2009; Wang et al., 2002).

The similarities in the correlations for intrinsic and identified motivation probably are due to the high correlations between these constructs in studies of youth. Hagger et al. (2002), for example, combined intrinsic and identified motivation in their analyses because they found that the average correlation between these constructs across 18 studies (after removing sampling and measurement error) was $r = .73$. Similarly, Standage, Duda, and Ntoumanis (2005) dropped their measure of identified motivation due to a high correlation with intrinsic motivation. So although these two constructs are theoretically distinct, empirical evidence for their discriminative validity is lacking in adolescent samples.

The correlations for *introjected motivation* (internalized pressure such as guilt) in the studies cited above are generally the same as intrinsic and identified motivation with one exception—introjected motivation was less consistently associated with self-reported physical activity. Only Ullrich-French and Cox (2009) found a significant correlation between introjected motivation and self-reported physical activity. The associations between *extrinsic motivation* (i.e., responding to pressure from parents, peers, or others) and self-reported involvement are inconsistent as well. Chatzisarantis et al. (2002) found that externally regulated youth reported higher levels of physical activity; Wang et al. (2002) found that externally regulated youth reported lower levels; and Ullrich-French and Cox (2009) found no relationship.

These findings are consistent with Ryan and Deci's (2000) model, in that the more externally oriented motivations (i.e., extrinsic and introjected) are less consistent predictors of reported behavior than more autonomous motives (i.e., identified and intrinsic). Although these studies have demonstrated important ways that physical activity motivations are associated with various psychological constructs and self-reports of physical activity, the reliance on a single source of data (adolescent self-reports) raises concerns about the validity of these associations. Because self-reports of physical activity often show weak associations with more objective measures (e.g., Jago, Baranowski, Baranowski, Cullen, & Thompson, 2007; Treuth et al., 2004) it is important to examine how adolescents' self-reports of physical activity motivation are associated with independently assessed measures of theoretically relevant constructs. Blair and Morris (2009) suggest that fitness performance may provide a more accurate representation of physical activity habits than self-reported behavior.

Given our interest in the development of childhood obesity, we felt it was important to examine how these four types of motivation relate to adolescent's actual weight status—something rarely examined in the self-determination literature. Because active adolescents are more likely to have healthier weights (Stensel et al., 2008), one would expect a significant relationship between adolescent weight status and motivation for physical activity. Moreover, we proposed that this relationship would be mediated by the level of cardiovascular fitness (i.e., the health benefits derived from physical activity explain the link to weight status). Therefore the purpose of the present study was to examine the relationship between four types of motivation and weight status, defined as obese and not obese. It was predicted that intrinsic and identified motivation for physical activity would be negatively associated with adolescent obesity, whereas introjected and external motivation would not be related (given their inconsistent relations with physical activity involvement). Second, because youth who are intrinsically motivated

to engage in physical activity are more likely to be active and thus more physically fit, we predicted that the relation between motivation and weight status would be mediated by cardiovascular fitness (i.e., a health benefit derived from physical activity). Therefore, we predicted that the association between motivation and weight status would become non-significant when controlling for cardiorespiratory fitness. A measure of fitness was used as a mediator, rather than self-reports of physical activity, so that all three variables in the model would come from independent sources—eliminating the problem of rater effects. Given the social desirability problems in reporting physical activity involvement, physical fitness may be a more valid measure of physical activity involvement than adolescent self-reports (Blair & Morris, 2009). Additionally, this approach may provide new insights into the inconsistent findings of self-reported physical activity behavior and motivation.

Finally, because we focused exclusively on physical activity motivations, we only examined these relationships in adolescents who currently self-reported as physically active. Including adolescents who were not active may have biased our results because their low scores on the self-determination measures would have not measured physical activity motivations, but instead reflected a low level of physical activity. The fitness and weight status benefits of physical activity would not be expected in adolescents who are insufficiently active (Physical Activity Guidelines Advisory Committee, 2008); therefore to test our hypotheses we only examined the relationships among these constructs with adolescents who currently were physically active.

Method

Participants

Participants were self-reported physically active middle school students ($N = 82$. 51% female) who participated in the Teen Eating and Activity Mentoring in Schools (TEAMS) study aimed at improving health and preventing obesity among middle school students. Students were recruited during parent–teacher night open houses, school-based family barbeques, school newsletters, and by school and study personnel in the first month of attendance in the seventh grade. Students with mental or physical conditions that would limit their participation in the larger study activities were excluded. One student with a cardiovascular condition was excluded based on exclusion criteria. Data reported in this paper were taken at baseline and do not reflect any potential intervention effects. Students were drawn from four public middle schools in the inland Pacific Northwest and ranged in age from 12 to 14 years ($M_{age} = 12.60$ years, $SD = .42$). Consistent with the middle school student population of the school district, students in the study were primarily European-American (86%). Overall, the sample represented middle socioeconomic status as indicated by the Hollingshead index ($M_{ses} = 38.06$, $SD = 15.22$).

These students were a subset of the larger TEAMS participants participating in the first cohort of the study. As part of their baseline assessment, all students read a standard definition of physical activity (moderate to vigorous activity for at least 30 min at a time) and were instructed to respond "yes" or "no" to the following question "I am active regularly". Moderate to vigorous activity was defined in terms of effort and respiration rate and specific examples of activities were given (i.e., running, football, soccer, basketball, hockey, roller skating, tennis, bicycling, swimming, skiing). Students were familiar with this definition from a required health and fitness class they had taken previously. Of the total sample of 110 participants where body mass index (BMI) was available, 82 participants answered "yes" to the 'I am active regularly' question and were directed to complete the self-determination questionnaire. As these were the only participants who completed the self-determination questionnaire, they comprise the participants in the current study. Students who indicated that they were not active regularly completed a brief questionnaire about their reasons for not being active (data not presented here).

Procedure and measures

Following university Institutional Review Board and school district approval, students from four public middle schools were recruited to participate in the TEAMS project. Students with parental permission and those who assented completed attitudinal questionnaires on a computer-based system and participated in a number of fitness performance, health behavior surveys, health biomarkers, and anthropometric assessments.

Physical activity motivations

In two studies of 3rd–6th graders, Ryan and Connell (1989) developed questionnaires to assess children's motivation in the achievement and prosocial domains. These questionnaires assessed four types of behavioral self-regulation derived from self-determination theory—external regulation, introjected regulation, identified regulation, and intrinsic motivation. The studies provided good evidence of reliability and validity for the measures, showing significant correlations with child, mother, father, and teacher measures of children's motivation, competence, and coping. Self-determination theory researchers at the University of Rochester (Deci & Ryan, 2010) have developed a similar questionnaire for the exercise domain that was used in the present study. The questionnaire is made up of 16 items—four items that assess each type of regulation. All students who indicated that they were active regularly completed the "Motivation for Exercise" questionnaire. To make this questionnaire more appropriate for the present study, participants answered the 16 items in response to the following prompt – "There are a variety of reasons why people try to be active. Read the reasons below and indicate how true they are for you"—rather than the original prompt – "I try to exercise on a regular basis because…" Standardized coefficient alphas for the four scales in the current sample were .67 for external, .76 for introjected, .83 for identified, and .71 for intrinsic respectively.

Weight status

Anthropometric measurements were taken, including height and weight. Height was measured on a standing stadiometer and weight was measured on a Seca digital scale using procedures recommended by the U.S. Centers for Disease Control and Prevention (2010a, 2010b). BMI was calculated by dividing weight in pounds by height in inches squared and multiplying by a conversion factor of 703 (Cole, Faith, Pietrobelli, & Heo, 2005). Exact BMI percentiles for each participant based on age and gender were determined using LMS parameters provided by the CDC (http://www.cdc.gov/growthcharts/percentile_data_files.htm). The LMS parameters are the median (M), the generalized coefficient of variation (S), and the power in the Box–Cox transformation (L).

Fitness performance

Cardiorespiratory fitness was assessed using the Progressive Aerobic Cardiovascular Endurance Run (PACER) Fitnessgram protocol (Meredith & Welk, 2007). This is a multi-stage aerobic capacity test adapted from the 20-m shuttle run that progresses in intensity with higher scores representing greater aerobic capacity. The PACER test is a widely used and well-validated measure among adolescents (Morrow, Jackson, Disch, & Mood, 2000). PACER scores were available on a subset of the sample that completed the self-determination questionnaire—68 out of 82 participants.

Statistical analysis

To examine group differences in motivation for physical activity, four 2 × 2 ANOVAs were conducted—one for each of the four motivation types. The independent variables were gender and weight status (obese, non-obese). Motivational scores were calculated by standardizing the scores for each item and then calculating the average for each construct (four items per construct). Baron and Kenny's (1986) approach was used to determine if cardiovascular fitness mediated the relationship between exercise motivation and weight status. This involved first examining the correlations between weight status, the motivational variables, and the PACER scores, and then determining, using logistic regression, if the relationship between motivation and weight status became smaller or non-significant after controlling for cardiovascular fitness.

Results

Descriptive statistics

Based upon their BMI percentiles, 57% of the total participants were of recommended weight (<85th percentile for age and sex), 16% were overweight (≥85th percentile and <95th percentile), and 27% were obese (≥95th percentile). Because of the small sample size, the physically active research participants were grouped into two categories for the analyses—non-obese ($n = 60$) and obese ($n = 22$). The cardiorespiratory fitness performance scores ranged widely from 4 to 109 laps completed, providing an average of 26.94 laps ($SD = 19.80$). Only 24% of participants' scores fell within the recommended healthy fitness zone (Meredith & Welk, 2007). Because the PACER scores were positively skewed (skewness = 2.03, $SE = .29$), the natural logarithm transformation was employed for all analyses involving this variable. This yielded a more normal distribution (skewness = .04).

The correlations between the variables are presented in Table 1. Consistent with the previous literature and the theoretical expectation that more proximal motivation types will be more highly correlated, intrinsic motivation in the present sample was correlated with identified motivation, $r(80) = .70$; external was correlated with introjected, $r(80) = .73$; and introjected was correlated with identified, $r(80) = .24$. No other correlations between the scales were significant.

Analyses of variance

Results showed that only the ANOVA for intrinsic motivation yielded a significant effect of weight status (See Table 2). Adolescents who were non-obese showed higher intrinsic motivation scores for physical activity than adolescents who were obese. The F values for all other weight status main effects were non-significant and less than 1.0. There were no significant main effects or interactions involving gender.

Table 1
Descriptive statistics and correlations.

Variables	1	2	3	4	5	6
1. Intrinsic	–					
2. Identified	.70**	–				
3. Introjected	.14	.24*	–			
4. External	.01	.06	.73**	–		
5. ln PACER	.27*	.09	.12	−.08	–	
6. Obesity status	−.21+	−.10	.06	.00	−.51**	–
Mean	.00	.00	.00	.00	3.08	.27
SD	.73	.81	.76	.71	.65	.45

Note. $+p = .06$, $^{*}p < .05$, $^{**}p < .01$. ln PACER = cardiorespiratory fitness (Natural Logarithm). Obesity status: 0 = healthy weight, 1 = obese.

Table 2
Motivations for physical activity as a function of weight status.

Type of motivation	$F(1,78)$	p	Non-obese		Obese		η^2
			Mean	*SD*	Mean	*SD*	
External	.03	<.86	.00	.73	.00	.66	.000
Introjected	.33	<.57	−.03	.77	.07	.76	.004
Identified	.74	<.39	.05	.81	−.13	.82	.009
Intrinsic	4.50	<.04	.09	.60	−.26	.98	.055

Mediational analyses

The first step of the mediational analyses showed that all of the relevant bivariate correlations were significant for intrinsic motivation: 1) intrinsic motivation was correlated with cardiovascular fitness, $r(66) = .27$, $p < .05$; 2) cardiovascular fitness was correlated with weight status, $r(66) = -.51$, $p < .001$; and 3) intrinsic motivation was correlated with weight status, $r(80) = -.21$, $p < .06$. (Point-biserial correlations were calculated for all correlations involving the dichotomous variable of weight status.) (Note: although the correlation between intrinsic motivation and weight status did not reach conventional levels of significance, the significant ANOVA—which removed variance due to gender—did reveal a significant relationship between these two variables, justifying the meditational analysis.) Mediation was supported because the final relationship became non-significant when both intrinsic motivation and cardiovascular fitness were simultaneously entered into a significant logistic regression predicting the dichotomous weight status variable, $\chi^2(2) = 21.43$, $p < .001$. Examination of the variables in the equation showed that while the B weight for fitness was significant ($B = -2.87$, $p < .001$), the B weight for intrinsic motivation was non-significant ($B = .08$, $p = .85$).

Discussion

This study demonstrated differences in motivation for physical activity between adolescents of different weight statuses, but only for intrinsic motivation. As predicted, adolescents who were not obese had greater intrinsic motivation for physical activity. Moreover, the relation between intrinsic motivation and weight status was mediated by cardiovascular fitness (our proxy measure for physical activity). Although the cross-sectional, correlational nature of this study makes it impossible to draw conclusions about the direction of causality, the current pattern of results is consistent with the hypothesis that adolescents who were intrinsically motivated for physical activity were more fit (and likely more active) and thereby less likely to be obese.

The findings are consistent with self-determination theory, which suggests that more self-determined forms of motivation lead to optimal functioning and well-being (Deci & Ryan, 1980; Ryan & Deci, 2000). Unlike previous studies that have focused primarily on predicting psychological constructs such as intentions, beliefs, and attitudes (see Biddle, Treasure, & Wang, 2008), the present results extended the literature on self-determination and physical activity by demonstrating that both physical fitness and weight status were associated with motivations for physical activity.

The finding that intrinsic motivation was the only motivation type associated with cardiovascular fitness and weight status clearly supports the consistent associations identified in the literature with indices of self-reported physical activity behavior (e.g., Chatzisarantis et al., 2002; Ullrich-French & Cox, 2009; Wang et al., 2002). This finding is consistent with the age of the participants. It is unlikely that most seventh graders engage in physical activity for the health benefits—see focus group data by Power, Bindler, Goetz, and Daratha (2010) that support this conclusion. Instead, those who

are active likely do so because they enjoy it—so intrinsic motivation should be the most powerful predictor of fitness and weight status. The small sample size, however, limited our power to detect relationships. The sample size of 82 was large enough to yield a significant effect for intrinsic motivation accounting for about 6% of the variance—somewhere between a small and medium effect size (Cohen, 1988). It clearly was not large enough to detect a small effect size (as defined by Cohen, 1988) that accounts for 2% of the variance. For example, a larger sample might have yielded a significant effect for identified motivation as well. In light of this limitation, we forward our conclusions as preliminary and hope to encourage further research considering the impact of motivation regulations on weight status.

Although the current findings are consistent with a causal model that motivations influence physical activity which in turn influence fitness and subsequently weight status, alternative explanations need to be considered as well. For example, it is possible that adolescents who are overweight or obese are less physically fit and therefore feel less competent and find physical activity less pleasurable and intrinsically rewarding. Some evidence suggests that weight status is predictive of pressure to lose weight which predicts less self-determined motivation (Gillison, Standage, & Skevington, 2006). Given the inability of the current design to directly examine the direction of effects, this issue should be addressed in future longitudinal and experimental research.

Consideration of the mechanisms by which physical activity is expected to influence health and weight status in particular is an important future direction. Issues associated with self-report have led to recent calls for more objective measures of physical activity behaviors (Reilly et al., 2008). However, it is important to note that objective measures, such as accelerometers, pose limits as well. For example, accelerometers do not capture information on the type of activity performed, which is highly relevant information to inform interventions. Because it is often identified that a critical pathway for the benefits of physical activity is through improved physical fitness (Physical Activity Guidelines Advisory Committee, 2008; USDHHS, 2000), capturing fitness and/or the level and intensity of activity necessary to derive health benefits is an important consideration in work examining the outcomes of physical activity behavior.

Despite the preliminary status of the current findings, several practical implications can be suggested. This study provides further support for the importance of encouraging more self-determined motives for physical activity in adolescents. Parents, teachers, and health practitioners can accomplish this by fostering secure relationships with others, by enhancing feelings of physical competence, and by providing a sense of choice and freedom from external pressure in physical activity settings, targeting essential psychological needs that support more autonomous motivation (Biddle et al., 2008). Special emphasis should be given to helping youth identify internal reasons for and the value of participating in physical activity. Given the current level of obesity in adolescence, it is imperative that adults become aware of the ways that they may enhance the motivation of youth to engage in healthy behaviors that protect against the development of weight-related health risk.

The results of this study need to be considered within the limits of the relatively small sample used in the current study. As a primarily middle-class, self-selected, European-American sample of seventh graders in the Pacific Northwest, the generalizability is somewhat limited. It is likely that these findings may vary as a function of population demographics. The sample also was limited to those who self-identified as being regularly active. This could have biased the sample, possibly limiting the range of the identified and intrinsic motivation scores. Larger samples, with more variability, and of greater age range will be important to better understand and validate the associations among self-determined motivation, weight status, and cardiorespiratory fitness. The ability to include more fine-tuned weight status indicators would also be helpful, as we utilized a dichotomous distinction based on BMI percentiles.

Despite these limitations, the current research shows that motivation for physical activity—in particular intrinsic motivation—was associated with adolescents' cardiovascular fitness and weight status. Little research has considered these constructors together, despite the commonly cited importance of physical activity motivation and behavior in improving weight status and other health-related implications. We hope that future studies continue to examine these relationships in order to further understand the complex relationships between motivation, behavior, fitness, and health.

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