

## Need fulfillment and motivation in physical education predict trajectories of change in leisure-time physical activity in early adolescence



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### ABSTRACT

**Objectives:** We examined (1) how psychological need fulfillment and motivation in physical education and leisure-time physical activity change during early adolescence, and (2) the degree to which need fulfillment and motivation predict trajectories of change in physical activity.

**Design:** Longitudinal survey.

**Methods:** Students ( $N = 134$ , ages 10–13 years) completed surveys assessing perceived competence, autonomy, relatedness, intrinsic motivation, and identified, introjected, and external regulations in physical education, and leisure time physical activity each semester in school for 3 years.

**Results:** Unconditional growth models showed an average increase in physical activity. Competence also increased, while autonomy and relatedness, and identified and introjected regulation decreased. Conditional models showed that students with higher levels of autonomy, relatedness, intrinsic motivation, and identified regulation had higher levels of physical activity at baseline and throughout the study. Students with lower levels of autonomy, relatedness, intrinsic motivation, and identified regulation experienced significantly greater increases in physical activity, but these effects were very small.

**Conclusions:** Need fulfillment and motivation variables positively predict physical activity. While youth with lower levels of need fulfillment and motivation have lower levels of physical activity, they also tend to increase physical activity levels more across early adolescence. These associations highlight how physical education experiences in early adolescence may influence change in physical activity, and suggest efforts to foster need fulfillment and autonomous regulation in physical education may promote physical activity.

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A fundamental objective of physical education is to help students internalize the value of physical activity and to engage regularly in physical activity outside of the classroom (i.e., leisure time physical activity) to enhance fitness and health (e.g., National Association for Sport and Physical Education, 2009; Pate, O'Neill, & McIver, 2011). Children who participate in more physical education tend to be more physically active overall; however, students typically do not spend the recommended amount of time engaging in moderate-to-vigorous physical activity during class (i.e., >50% of class time; Pate et al., 2011). Findings regarding the association between participation in physical education and leisure time physical activity are mixed. Some studies report that students

engage in more leisure-time physical activity on days when they have physical education (Dale, Corbin, & Dale, 2000), while other studies report that students engage in more leisure-time physical activity on days when they have limited or no physical education (Mallam, Metcalf, Kirkby, Voss, & Wilkin, 2003). A better understanding of how the quality of students' experiences within physical education predicts leisure-time physical activity behavior is critical to clarify the mixed findings on the associations between physical education and physical activity related health benefits in youth.

One consistent link between physical education participation and leisure-time physical activity is the type of motivation that students experience in class (e.g., Standage, Gillison, Ntoumanis, & Treasure, 2012). Motivation can be conceptualized as the different reasons why students engage in activities during physical education (Deci & Ryan, 1985; Ryan & Deci, 2007). Self-determination

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theory (SDT) purports that these reasons reflect different forms of motivation, ranging from more internalized and autonomous (intrinsic motivation and identified regulation) to less autonomous and controlling (introjected and external regulation). Intrinsic motivation is the most autonomous form of motivation and occurs when students participate in physical education as an end in itself. For example, they may participate because they enjoy it and have fun. Identified regulation occurs when students participate as a means to achieve a personally valued end, such as fitness outcomes. Introjected regulation occurs when students participate in physical education to avoid feelings of shame or to gain pride. External regulation involves participating to comply with an external demand such as avoiding punishment or seeking a reward. Autonomous motivation in physical education is positively associated with self-reported and objectively assessed leisure-time physical activity behavior, intentions for exercise, health-related quality of life, and effort, concentration, and pedometer step counts in physical education (Cox, Smith, & Williams, 2008; Hagger & Chatzisarantis, 2009; Lonsdale, Sabiston, Raedeke, Ha, & Sum, 2009; Ntoumanis, 2005; Standage et al., 2012).

The fulfillment of psychological needs for autonomy (perceptions of agency and volition; Katz & Assor, 2007), competence (perceptions of effectiveness; Deci & Ryan, 2000), and relatedness (perceptions of closeness and connectedness to others; Deci & Ryan, 2000), are also theorized to directly predict health and well-being outcomes (Deci & Ryan, 2000; Deci et al., 2001). Perceptions of autonomy, competence, and relatedness in physical education are positive predictors of effort and enjoyment in class, autonomous motivation for class participation, intentions for leisure-time physical activity, and self-reported physical activity behavior, and perceptions of relatedness are a negative predictor of worry in class (Cox, Duncheon, & McDavid, 2009; Cox et al., 2008; Ntoumanis, 2001; Standage, Duda, & Ntoumanis, 2005; Taylor, Ntoumanis, Standage, & Spray, 2010). More autonomous forms of motivation are theorized to exist in contexts where students' psychological needs are nurtured. Empirical evidence in physical education settings has shown that need satisfaction in physical education class directly and indirectly (via autonomous motivation) predicts intention for (Standage, Duda, & Ntoumanis, 2003) and self-reported (Cox et al., 2008; Standage et al., 2012) leisure-time physical activity. Overall, these findings indicate that both need satisfaction and motivation within the context of physical education may facilitate physical activity and perhaps health benefits in youth.

Most research linking need satisfaction and autonomous motivation in physical education to leisure-time physical activity behavior has used assessments at three or fewer time points, so can only examine cross-sectional associations or linear trajectories of change over time. Furthermore, most prior studies have not examined whether variations in needs and motivation predict trajectories of change in physical activity over time (e.g., Cox et al., 2008; Standage et al., 2012). By measuring need satisfaction, motivation, and physical activity behavior on more than four occasions, an average trajectory of time can be fitted to describe how the sample changes and, if the trajectory assumes a linear or non-linear form (i.e., quadratic, or cubic effects). A quadratic effect would reflect average trends that accelerate or decelerate over time, while cubic effects would reflect trends that have two points of acceleration or deceleration of change over time. Furthermore, between-student predictors of the average trajectory of change in physical activity can be tested. Early adolescence may be a particularly crucial time to explore these longitudinal associations when declines in average autonomous motivation in physical education (Cox et al., 2008; Ntoumanis, Barkoukis, & Thøgersen-Ntoumani, 2009) and leisure-time physical activity (Nader, Bradley, Houts,

McRitchie, & O'Brien, 2008; Troiano et al., 2008; Wall, Carlson, Stein, Lee, & Fulton, 2011) have been reported. There is, however, a lack of longitudinal research that explores potential nuances in trajectories of change in physical activity behavior (e.g., quadratic or cubic patterns) or identifies physical education variables, such as psychological need fulfillment and motivation, that predict these trajectories, which may differ from cross sectional findings. In addition, without a longitudinal assessment researchers cannot be sure whether these tenets of self-determination theory merely correlate with or actually predict adolescents' physical activity behavior over time.

Trajectories of change in and associations between need satisfaction and motivation in physical education have been examined longitudinally. Ntoumanis et al. (2009) measured need satisfaction and motivation each fall and spring semester for three years in a cohort of 13–15 year olds; however, they did not examine trajectories of, or associations with, physical activity. Intrinsic motivation showed an average linear decline, and identified regulation and relatedness showed an average decline that tapered during the final year of junior high school. There was no average trend for competence need satisfaction or introjected or external regulation, but there was significant between-student variability in trajectories of external regulation over time. Competence and relatedness at time one predicted between-student differences in intrinsic motivation and identified regulation. In addition, initial perceptions of competence moderated the linear trajectories of identified and external regulation. Specifically, students with relatively high levels of competence had no significant change in identified and external regulation, and students with relatively low levels of competence decreased in identified regulation and increased in external regulation over time.

Taylor et al. (2010) longitudinally examined need satisfaction and motivation in physical education and physical activity in students ages 11–16, but the time period was relatively brief, with assessments at the beginning, middle, and end of one school trimester. Physical activity behavior increased over time, and students who reported relatively higher average levels of competence across the study had greater increases in physical activity behavior over time compared to students with relatively lower levels of competence. In contrast, another study found a linear decline in physical activity from the fall of grade seven to the fall of grade nine (Yli-Piipari, Leskinen, Jaakkola, & Liukkonen, 2012). However, motivation was only examined at one time point, in the spring semester of grade six. A composite index of self-determined motivation predicted self-reported leisure-time physical activity in grade seven, but not in subsequent years. Considered together, these findings provide preliminary evidence regarding the trajectories of change in need fulfillment, motivation, and physical activity during adolescence, and suggest that need fulfillment and autonomous motivation may predict trajectories of physical activity over time. But further research including the concurrent measurement of psychological need fulfillment and motivation in physical education class and leisure-time physical activity is necessary to determine how these variables change, and how between-person variation in need fulfillment and motivation predict trajectories of physical activity during adolescence.

The purpose of this study was to test (1) change over time (including linear, quadratic, and cubic change) in psychological need fulfillment and motivation in physical education, and leisure-time physical activity, and (2) the degree to which individual differences in need satisfaction and motivation predict trajectories of leisure-time physical activity across grades six to eight. Based on theoretical propositions and empirical longitudinal and cross-sectional evidence, we hypothesized that (1) physical activity behavior, psychological need fulfillment, and autonomous

motivation would decline on average and that controlling motivation would increase on average; (2) between-student variations in psychological need fulfillment would positively predict the trajectory of physical activity; and (3) between-person variations in autonomous forms of motivation would positively predict and controlling forms of motivation would have a non-significant association with the trajectory of physical activity across grades six to eight.

## Methods

### Participants and procedures

This study was approved by the institutional review board, school administrators, and teachers. Students attending a middle school in the Midwest region of the United States were given a parental consent form and letter describing the study via their teacher. Students who returned signed parental consent forms to their physical education teacher were invited to complete an online survey in their school's computer lab during a physical education class in each of the fall and spring semesters in grades six to eight. Students' psychological need fulfillment, motivation, and self-reported physical activity behavior were measured six times: during their sixth grade fall (Time 0) and spring (Time 1) semesters, seventh grade fall (Time 2) and spring (Time 3) semesters, and eighth grade fall (Time 4) and spring (Time 5) semesters. This data set is part of a larger study in which sixth to eighth grade students were followed until they graduated from eighth grade. Only those students who began the larger study in the sixth grade ( $N = 134$ ) were included in the present analyses. Three prior studies have examined cross-sectional associations among variables at one of the time points from the larger dataset (Cox et al., 2009; Cox & Ullrich-French, 2010; Ullrich-French & Cox, 2009).

At each survey administration, students were first told that this study was being conducted to better understand the factors that influence their physical education experiences and physical activity behavior outside of school. Then, instructions were read aloud to the students and research assistants were available to answer questions as students completed the questionnaire. Students who were absent on data collection days and data collection make-up days had missing data for that wave of the study. Participants ranged in age from 10 to 13 years old ( $SD_{age} = 0.51$ ; seven unreported) and were, on average, 11.27 years old at the beginning of sixth grade, 12.26 years old at the beginning of seventh grade, and 13.22 years old at the beginning of eighth grade. Fifty-six percent were girls and most were Caucasian (81.3%). The remaining students identified themselves as Hispanic (3.7%), Black (3.0%), American Indian (2.2%), Asian (0.7%), or other (9.0%). Students participated in physical education classes for approximately 40 min every other day during the school year. Students had the same physical education teacher during the three years of the study.

### Measures

#### Motivation regulations

The Perceived Locus of Causality Scale (Goudas & Biddle, 1994; Ntoumanis, 2005; Standage & Ryan, 2012) was used to assess intrinsic motivation and identified, introjected, and external regulations. Each type of motivation is measured by four items that follow the stem, "I take part in PE class ...". Items represent the different reasons why students might be motivated to participate in physical education class. Example items include, "because PE is fun" (intrinsic motivation), "because it is important for me to do well in PE" (identified regulation), "because I would feel bad about myself if I didn't" (introjected regulation), and "because I'll get into trouble

if I don't" (external regulation). Items are scored on a seven-point scale ranging from *strongly disagree* (0) to *strongly agree* (6). Support for adequate internal consistency reliability and factorial and construct validity of this scales has been documented with physical education students (Ntoumanis, 2005; Ullrich-French & Cox, 2009).

#### Psychological need fulfillment

Students' feelings of competence in physical education class were measured with a modified version of the athletic competence subscale (six items) from Harter's (1985) Self-Perception Profile for Children. Specifically, "in PE" was added to each item to contextualize the measure to the physical education setting. In this measure, students are directed to choose which of two statements is more true for them (e.g., "Some kids do very well at all kinds of sports in PE, BUT Other kids don't feel that they are very good when it comes to sports in PE") and then to answer whether it is "really true" or "sort of true" for them, resulting in a scale that ranges from zero to three. Perceptions of autonomy were assessed with six items that were developed to measure students' experiences of having choices and feeling volitional in a sport setting (Hollebeak & Amorose, 2005). Items were modified to refer to physical education (e.g., "I have a say in what I do when participating in PE") and were scored on a scale that ranged from *not at all true for me* (0) to *completely true for me* (4). Perceived relatedness was measured using the Need for Relatedness Scale (Richer & Vallerand, 1998) modified for the physical education setting. The modified stem reads, "In my PE class, I feel ..." and is followed by 10 items (e.g., "supported," "listened to," and "valued") to which students responses range from *strongly disagree* (0) to *strongly agree* (6). The phrase "teacher and classmates" was also substituted in items that referred to specific others. Reliable and valid scores have been obtained with similarly modified versions of the measures for perceived competence (Ridgers, Fazey, & Fairclough, 2007), perceived autonomy (Hollebeak & Amorose, 2005), and perceived relatedness (Standage, Duda, & Ntoumanis, 2006). The perceptions of competence and autonomy measures were rescaled to the same metric of the perceptions of relatedness measure (Little, 2013).

#### Physical activity behavior

Students' leisure-time physical activity behavior was measured with five questions from the Physical Activity Questionnaire for Older Children (Kowalski, Crocker, & Faulkner, 1997) that specifically referred to how much moderate-to-vigorous activity they engaged in after school, in the evening, over the weekend, during all free time in general and on each day of the week for the past seven days. Students were given instructions regarding which days to think back to when recalling the amount of physical activity they had completed and rated their physical activity levels from zero to four with higher scores indicating greater physical activity during their free time. The validity of this measure was supported in a study comparing scores of fourth to eighth grade students with reports of physical fitness, perceptions of athletic competence, and physical activity assessed via motion sensor, physical activity recall, activity rating index, teacher ratings and alternative physical activity questionnaire (Kowalski et al., 1997). Similar versions of this measure have demonstrated good internal consistency and construct validity in past research with middle school physical education students (Cox et al., 2008; McDavid, Cox, & Amorose, 2012).

#### Data analysis

Analyses were conducted using SPSS 20 (IBM, 2011). Data were screened for missing values and distributional properties (Tabachnick & Fidell, 2007). Descriptive statistics, internal

consistency reliability, and correlations were calculated separately for each time point. Multi-level modeling (MLM; Singer & Willett, 2003) was used to examine change in physical activity, need fulfillment, and motivation, and the degree to which need fulfillment and the four motivations predicted leisure-time physical activity.

Unconditional models with no predictor variables were tested, and an intraclass correlation coefficient was calculated to establish the degree of between-student variation in each variable. To address the first study purpose, unconditional growth models were tested for physical activity, need fulfillment, and motivation. Unconditional growth models included time as a within-student predictor and tested whether there was a fixed effect of time on each variable. We explored whether we could also examine random effects of time on each variable; however, when the slopes of time were allowed to vary randomly across individuals the models would not converge. We therefore constrained the random, between-student variation for the slopes of time to zero and only modeled the fixed effect, that is, the average trajectory of each variable over time (Raudenbush & Bryk, 2002). Average linear, quadratic and cubic change were tested and plotted if significant. To assess the fit of the unconditional growth models, a pseudo- $R^2$  statistic was calculated. The pseudo- $R^2$  statistic is an estimate of the reduction in the proportion of variance explained by within-student predictors, such as time, in the unconditional growth models compared to the unconditional model (Singer & Willett, 2003).

To address the second study purpose, conditional models were tested. These models included time, and need fulfillment or motivation variables as within-student predictors, and the individual means of the need fulfillment or motivation variables as a between-student predictor of physical activity. They also included predictor by time interactions to test whether the psychological need or motivational variable at the between-student level predicted trajectories of physical activity over time. Seven models were tested, one for each psychological need and motivation predictor. We modeled the average linear, quadratic, and cubic trajectory of physical activity and within-student predictors were group mean centered (West, Ryu, Kwok, & Cham, 2011). Significant interactions were plotted and then probed using the Johnson–Neyman technique (Preacher, Curran, & Bauer, 2006). Regions of significance ( $p < .05$ ) were calculated to determine the range of values of the psychological needs and motivation variables where the slope between time and physical activity was significantly different from zero. To estimate the variance accounted for by including need fulfillment and motivation as predictors of physical activity, conditional intraclass correlations were calculated that compared the between-student variance in the unconditional growth model to the conditional models (Raudenbush & Bryk, 2002).

## Results

### Preliminary analyses

Examination of the skewness, kurtosis, z-score statistics, and pairwise scatterplots indicated that the data were approximately normally distributed, linear, and there were no univariate outliers. However, a significant Mahalanobis distance value (Mahalanobis' distance  $> 22.56$ ,  $p < .001$ ) suggested one possible multivariate outlier. All subsequent analyses were conducted with and without this participant and their inclusion did not affect the interpretation of the findings so all participants were included in all analyses reported. The final sample size was  $N = 134$  students, with  $n = 134$ , 110, 105, 109, 98, and 98 at each time point, respectively. Other than students who missed a time point, the only missing data were two

missing reports of physical activity. This missing data is most likely due to students closing the online survey before submitting their responses to the physical activity items, as they were on the last page of the questionnaire. Although MLM is robust to missing data (Raudenbush & Bryk, 2002), the final model was examined with and without cases that contained missing individual items, and with and without cases with two or fewer time points to examine whether the results in this study were affected by missing data. Interpretation of results remained the same in all analyses so all cases were retained. A series of ANOVAs were used to examine if students who completed all six time points were significantly different on study variables when compared to students who completed five or fewer time points. Students who completed all six time points reported significantly higher scores ( $p < .01$ ) on intrinsic motivation, identified and introjected regulation at time zero, and introjected regulation at time two.

Descriptive statistics, internal consistencies, and correlations for each wave of data collection are presented in Table 1. Boys had significantly higher levels of physical activity compared to girls at time three and five ( $p < .01$ ). Internal consistency values were all  $> 0.70$  except for introjected regulation at time 1 ( $\alpha = .65$ ). All correlations were in the expected directions except for the consistent positive correlation between introjected regulation and the autonomous motivations.

### Multilevel modeling analyses

Results of the unconditional model for physical activity showed significant residual and intercept variance parameters ( $p < .001$ ). Fifty percent of the variance in physical activity was attributed to between-student differences, suggesting that there was substantial variance available to explain by adding between-student predictors in subsequent models. Between-student variation for each psychological need and motivation ranged from 44% to 65%.

Results for the unconditional growth models are found in Table 2 and illustrated in Figure 1. Each variable demonstrated a significant average change over time, except intrinsic motivation and external regulation. There was a significant linear decrease in identified regulation and a significant linear increase in competence need fulfillment over time. Introjected regulation had a quadratic trajectory, with an initial decrease that plateaued during the spring semester of grade seven. The cubic trajectory of physical activity showed an initial increase that plateaued in grade seven and then resumed increasing in grade eight. The cubic trajectory of autonomy and relatedness need fulfillment initially decreased, transitioned to a positive trend in the fall of grade seven, and returned to negative trend in the fall of grade 8. Gender, age, and teacher were considered as potential covariates. However, these covariates did not predict the trajectories of change for each variable and did not affect the results of the study. Therefore, they were excluded from all subsequent models. Overall, the inclusion of significant linear and non-linear effects of time reduced the within-student variance of self-reported physical activity behavior by 9%, and motivation and psychological needs by 1%–7% as indicated by the pseudo- $R^2$  statistic.

Each psychological need was added as a within student predictor of physical activity behavior, and individual means of the psychological needs were examined as between-student predictors of the intercept and trajectory of physical activity behavior. The results for these models are reported in Table 3. Competence and relatedness were significant within-student predictors of physical activity. Students reported more physical activity behavior when they also reported more than their average perceptions of competence and relatedness. The mean levels of competence, autonomy, and relatedness were significant, positive, between-student

**Table 1**  
Descriptive statistics, internal consistencies, and correlations.

Variable	6th Grade								7th Grade							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1. PA	—	0.52*	0.17	0.40*	0.42*	0.39*	0.21*	−0.14	—	0.42*	0.21*	0.25*	0.35*	0.37*	0.27*	−0.04
2. Competence	0.53*	—	0.31*	0.60*	0.56*	0.52*	0.38*	−0.14	0.53*	—	0.39*	0.38*	0.44*	0.37*	0.22*	−0.25*
3. Autonomy	0.44*	0.30*	—	0.60*	0.53*	0.47*	0.32*	−0.32*	0.04	0.49*	—	0.72*	0.67*	0.62*	0.36*	−0.44*
4. Relatedness	0.51*	0.43*	0.58*	—	0.72*	0.59*	0.51*	−0.21*	0.18	0.37*	0.16*	—	0.68*	0.68*	0.44*	−0.24*
5. IM	0.48*	0.50*	0.54*	0.69*	—	0.82*	0.53	−0.27*	0.16	0.35*	0.55*	0.66*	—	0.90*	0.53*	−0.28*
6. IDENT	0.38*	0.34*	0.46*	0.67*	0.83*	—	0.64*	−0.09	0.26*	0.33*	0.46*	0.60*	0.92*	—	0.54*	−0.22*
7. INTRO	0.25*	0.20*	0.23*	0.45*	0.52	0.59*	—	0.20*	0.23*	0.28*	0.25*	0.51*	0.57*	0.62*	—	0.24*
8. EXT	−0.14	−0.14	−0.40*	−0.12	−0.25*	−0.08	0.28*	—	−0.04	−0.16	−0.49*	−0.15	−0.21*	−0.11	0.23*	—
M <sub>fall</sub>	2.35	3.70	3.17	3.98	4.24	4.45	3.62	3.25	2.81	3.97	3.05	3.54	4.10	4.11	3.07	3.31
SD <sub>fall</sub>	1.00	1.48	1.30	1.42	1.66	1.49	1.48	1.73	0.93	1.53	1.43	1.69	1.90	1.87	1.64	2.20
M <sub>spring</sub>	2.78	3.85	2.96	3.75	4.25	4.38	3.38	3.12	2.67	4.21	3.25	3.75	4.33	4.23	3.07	3.36
SD <sub>spring</sub>	0.93	1.48	1.38	1.60	1.78	1.70	1.66	1.87	0.95	1.45	1.48	1.68	1.86	1.78	1.74	2.07
α <sub>fall</sub>	0.86	0.77	0.76	0.95	0.90	0.85	0.65	0.81	0.90	0.82	0.83	0.96	0.93	0.92	0.73	0.93
α <sub>spring</sub>	0.85	0.77	0.81	0.96	0.90	0.89	0.79	0.85	0.90	0.83	0.85	0.96	0.94	0.90	0.78	0.91
Scale range	0–4	0–6	0–6	0–6	0–6	0–6	0–6	0–6	0–4	0–6	0–6	0–6	0–6	0–6	0–6	0–6

Variable	8th Grade							
	1	2	3	4	5	6	7	8
1. PA	—	0.43*	0.22*	0.25*	0.18	0.17	0.06	−0.20*
2. Competence	0.47*	—	0.40*	0.37*	0.40*	0.36*	0.15	−0.27*
3. Autonomy	0.08	0.46*	—	0.66*	0.58*	0.52*	0.25*	−0.27*
4. Relatedness	0.18	0.55*	0.79*	—	0.64*	0.58*	0.30*	−0.20
5. IM	0.25*	0.53*	0.64*	0.69*	—	0.90*	0.51*	−0.13
6. IDENT	0.21*	0.44*	0.61*	0.63*	0.90*	—	0.58*	−0.03
7. INTRO	0.23*	0.37*	0.21*	0.33*	0.44*	0.53*	—	0.33*
8. EXT	−0.10	−0.33*	−0.55*	−0.40*	−0.49*	−0.38*	0.10	—
M <sub>fall</sub>	2.71	3.28	4.16	4.02	4.30	4.17	2.92	3.12
SD <sub>fall</sub>	0.87	1.53	1.51	1.59	1.68	1.65	1.70	1.99
M <sub>spring</sub>	2.50	3.19	4.21	3.98	4.11	3.92	2.91	3.25
SD <sub>spring</sub>	0.91	1.56	1.34	1.56	1.66	1.75	1.79	1.89
α <sub>fall</sub>	0.91	0.90	0.87	0.97	0.92	0.90	0.80	0.91
α <sub>spring</sub>	0.90	0.88	0.79	0.96	0.91	0.91	0.82	0.85
Scale range	0–4	0–6	0–6	0–6	0–6	0–6	0–6	0–6

Note: Correlations for fall semesters are below the diagonal, spring semesters are above the diagonal. PA = leisure-time physical activity; IM = intrinsic motivation; IDENT = identified regulation; INTRO = introjected regulation; EXT = external regulation.

\**p* < .05.

predictors of the intercept for physical activity. Students with higher levels of psychological need fulfillment reported more physical activity behavior at the beginning of sixth grade. The linear, quadratic, and cubic effects of time were significant predictors of physical activity. In addition, the interactions between mean perceptions of autonomy and relatedness and the linear term of time were significant. These significant interactions were plotted in Figure 2. As indicated by the region of significance (*p* < .05), students who had relatively lower perceptions of autonomy, less than 0.85 on a six point scale (2.05 standard deviations below the mean), and relatedness, less than 3.41 on a six point scale (0.29 standard deviations below the mean), had greater average increases in physical activity over time. Specifically, autonomy

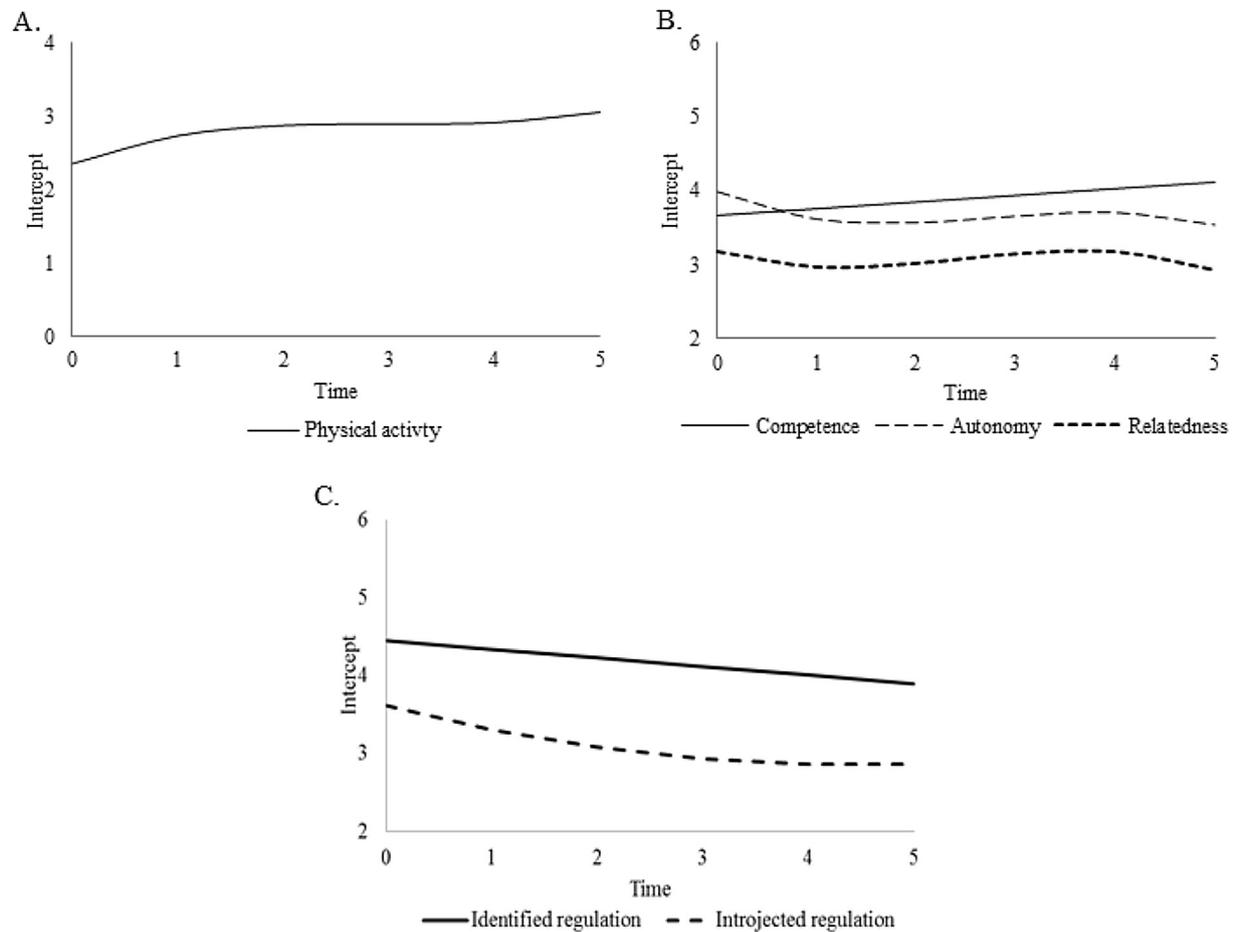
positively predicted linear increases in physical activity over time for students whose autonomy was less than 0.85, while autonomy was not significantly associated with changes in physical activity over time for students whose autonomy was greater than or equal to 0.85. Similarly, relatedness positively predicted linear increases in physical activity over time for students whose relatedness was less than 3.41, while relatedness was not significantly associated with changes in physical activity over time for students whose relatedness was greater than or equal to 3.41. Compared to the unconditional growth model, competence, autonomy, and relatedness respectively explained 53%, 13%, and 23% of the between-student variance of self-reported physical activity, while the cross-level interactions of time with autonomy and relatedness

**Table 2**  
Linear, quadratic, and cubic trajectories of self-reported physical activity, psychological need fulfillment, and motivation over time.

Variable	Fixed effects				Random effects	
	Intercept	Linear term	Quadratic term	Cubic term	σ <sup>2</sup>	τ <sub>00</sub>
Physical activity	2.35**	0.95**	−0.23**	0.02*	0.41**	0.45**
Competence	3.71**	0.09**			0.75**	1.40**
Autonomy	3.17**	−0.93**	0.30**	−0.03*	0.95**	1.04**
Relatedness	3.98**	−1.19**	0.34**	−0.03*	1.10**	1.38**
Intrinsic motivation	4.24**				1.39**	1.76**
Identified regulation	4.45**	−0.11**			1.41**	1.48**
Introjected regulation	3.62**	−0.44**	0.04*		1.45**	1.30**
External regulation	3.26**				1.91**	1.83**

Note: Models were re-specified when higher order terms were not significant.

\**p* < .05. \*\**p* < .01.



**Figure 1.** Plots of significant unconditional growth curve models of physical activity, psychological need fulfillment, and motivation. (A) significant cubic trajectory of physical activity; (B) significant linear trajectory of competence; and cubic trajectory of autonomy and relatedness; (C) significant linear trajectory of identified regulation and significant quadratic trajectory of introjected regulation.

predicted a small proportion of additional variance (0.51% and 0.42% respectively).

Each motivation variable was added as a within student predictor of physical activity behavior, and individual means of each motivation variable were examined as between-student predictors of the intercept and trajectory of physical activity behavior. The results for the models are reported in Table 3 and illustrated

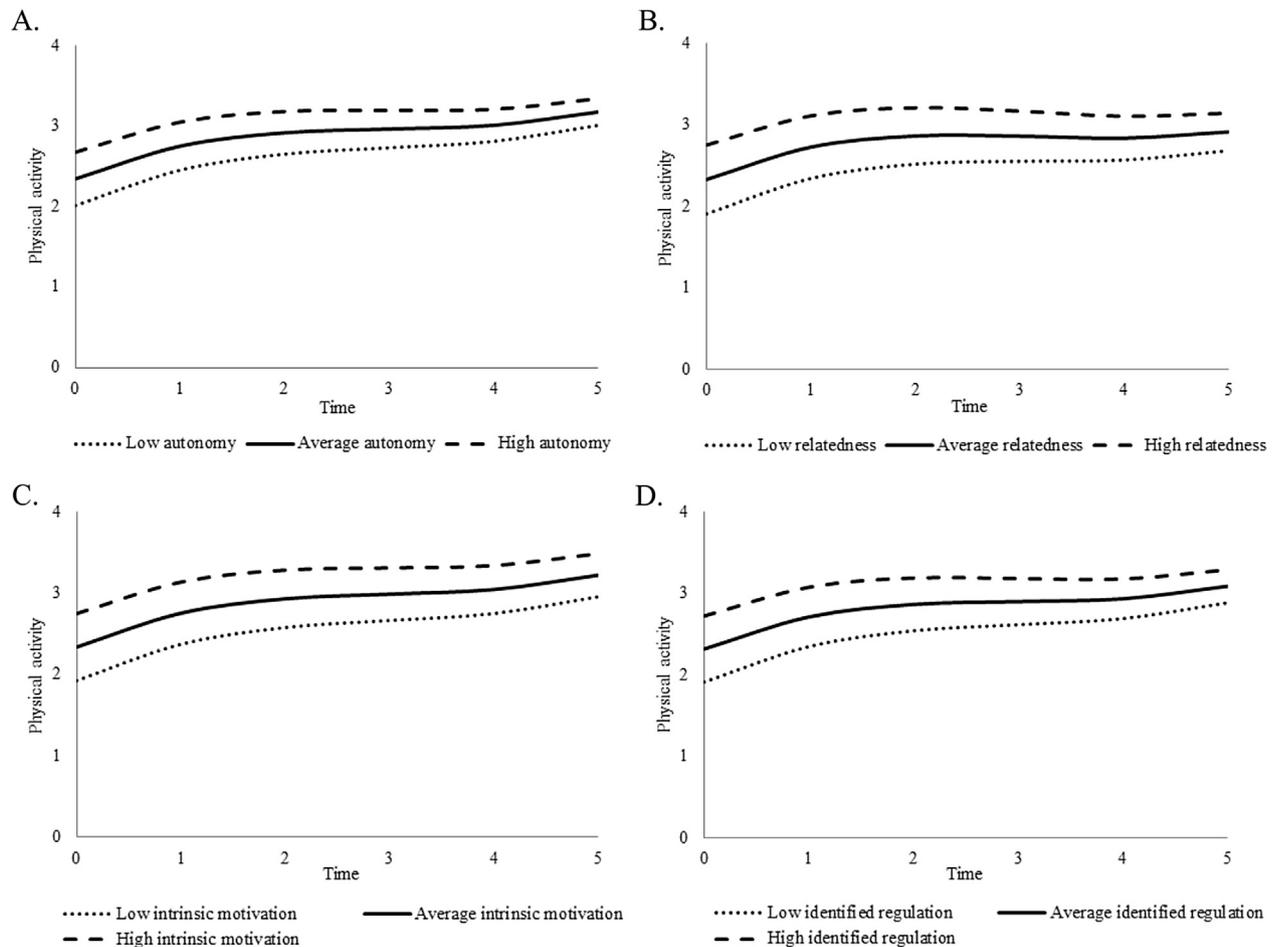
in Figure 2. Intrinsic motivation and identified regulation were significant within-student predictors of physical activity. Students reported more physical activity behavior when they also reported more than their average perceptions of intrinsic motivation and identified regulation. Greater mean levels of intrinsic motivation, identified regulation, and introjected regulation predicted greater physical activity at the beginning of sixth grade, while external

**Table 3**  
Psychological need fulfillment and motivation as predictors of self-reported physical activity behavior.

Variable	Competence		Autonomy		Relatedness		Intrinsic motivation		Identified regulation		Introjected regulation		External regulation	
	$\gamma$	SE	$\gamma$	SE	$\gamma$	SE	$\gamma$	SE	$\gamma$	SE	$\gamma$	SE	$\gamma$	SE
<i>Fixed effects</i>														
Intercept	0.83**	0.16	1.41**	0.21	1.08**	0.21	1.17**	0.20	1.06**	0.22	1.75**	0.17	2.57**	0.16
Linear change	0.92**	0.25	1.08**	0.26	1.12**	0.26	1.08**	0.25	1.10**	0.25	0.96**	0.25	0.94**	0.25
Quadratic change	-0.23**	0.08	-0.24**	0.08	-0.25**	0.08	-0.24**	0.08	-0.24**	0.08	-0.23**	0.08	-0.23**	0.08
Cubic change	0.02*	0.01	0.02*	0.01	0.02*	0.01	0.02*	0.01	0.02*	0.01	0.02*	0.01	0.02*	0.01
Time-varying predictor	0.07*	0.03	0.03	0.03	0.06*	0.03	0.07**	0.26	0.07**	0.02	0.03	0.02	-0.02	0.02
Time-invariant predictor	0.39**	0.04	0.30**	0.06	0.33**	0.06	0.28**	0.05	0.30**	0.05	0.19**	0.05	-0.07	0.04
Interaction with linear change			-0.03**	0.01	-0.03**	0.01	-0.02*	0.01	-0.03**	0.01				
<i>Random effects</i>														
Within-student residual	0.41**	0.03	0.41**	0.03	0.40**	0.02	0.40**	0.02	0.40**	0.02	0.41**	0.03	0.41**	0.03
Between-student residual	0.21**	0.04	0.39**	0.06	0.34**	0.05	0.35**	0.05	0.35**	0.05	0.40**	0.06	0.44**	0.07

Note: Models were re-specified when higher order terms were not significant. All interactions between the quadratic and cubic trajectory of time and each predictor were not significant.

\*\* $p < 0.01$ , \* $p < 0.05$ .



**Figure 2.** Plots of significant interactions between the linear term of time and the between-student terms of (A) autonomy; (B) relatedness; (C) intrinsic motivation; and (D) identified regulation predicting self-reported physical activity. Low trajectories represent one standard deviation below the mean and high trajectories represent one standard deviation above the mean.

regulation was not a significant predictor. Only mean perceptions of intrinsic motivation and identified regulation had significant interactions with the linear term of time. The region of significance ( $p < .05$ ) for average intrinsic motivation and identified regulation indicated that students who had relatively lower perceptions of intrinsic motivation, less than 3.59 on a six point scale (0.39 standard deviations below the mean), and identified regulation, less than 3.70 on a six point scale (0.36 standard deviations below the mean), reported greater increases in physical activity over time. Specifically, intrinsic motivation positively predicted linear increases in physical activity over time for students whose intrinsic motivation was less than 3.59, while intrinsic motivation was not significantly associated with changes in physical activity over time for students whose intrinsic motivation was greater than or equal to 3.59. Similarly, identified regulation positively predicted linear increases in physical activity over time for students whose identified regulation was less than 3.70, while identified regulation was not significantly associated with changes in physical activity over time for students whose identified regulation was greater than or equal to 3.70. Compared to the unconditional growth model, intrinsic motivation and identified regulation each explained 22% of the between-student variance in self-reported physical activity behavior while the cross-level interactions between time and intrinsic motivation and identified regulation accounted for a small percentage of additional variance (0.35% and 0.40% respectively).

## Discussion

This study sought to examine how need fulfillment and motivation in physical education class and self-reported leisure-time physical activity behavior change during early adolescence, and the degree to which need fulfillment and motivation predict trajectories of change in leisure-time physical activity. This study extended previous research by examining need fulfillment, motivation, and physical activity across three years among adolescents aged 10–13 years. By measuring all of these variables at six time points, we were able to describe linear and non-linear trajectories of change in the psychological needs, motivation, and physical activity behavior, which many prior longitudinal studies in physical education have not been able to do. The timeframe was also longer than many longitudinal studies examining motivation in physical education and leisure-time physical activity (e.g., Taylor et al., 2010). The examination of a younger cohort compared to other longitudinal studies in physical education (e.g., Ntoumanis et al., 2009), extends our knowledge about trajectories of change in motivation and need fulfillment during an earlier developmental period. Autonomy and relatedness need fulfillment declined, while competence increased on average over time. Among the motivation variables, identified and introjected regulations declined on average over time, while intrinsic motivation and external regulation demonstrated no average trend. Physical activity behavior increased on average over time. In addition, the trajectories of

autonomy, relatedness, and physical activity also had significant cubic changes, and trajectories of introjected regulation had a significant quadratic change, suggesting that youth tend to experience increases, decreases, and plateaus in these variables over time. Furthermore, autonomy, relatedness, and both autonomous forms of motivation were significant predictors of trajectories of change in physical activity, although effect sizes were marginal. These significant cross-level interactions indicate that, while physical activity tended to be higher at baseline for students with higher levels of autonomy, relatedness, intrinsic motivation, and identified regulation, those with lower levels tended to experience significant but marginally greater increases in physical activity over time.

Based on prior empirical evidence reporting decreases in need fulfillment over time (e.g., [Ntoumanis et al., 2009](#)), we hypothesized declines in need fulfillment over time. There was indeed an overall decrease in autonomy and relatedness, although both had significant cubic change whereby they plateaued and even increased slightly during the middle period of the study. In contrast, there was an average linear increase in competence. This departure from previous findings may be because the adolescents in the present study were somewhat younger than in previous research. There is considerable research showing that perceptions of competence tend to be higher during late childhood and early adolescence compared to mid-adolescence ([Harter, 1999](#)) due to developmental changes in evaluating perceptions of the self. Therefore, the unexpected increases in competence may be a function of this earlier developmental period. The significant cubic change in autonomy and relatedness was a novel contribution. The initial decrease in these needs may be due to students adjusting to a new school, classmates, and teacher. After these adjustments, students had a small average increase through grade seven, and then declined again beginning in grade eight. It may be that the declines during grade eight are due to developmental changes that influence students' perceptions of relatedness and autonomy. During this time, students' preoccupation with opinions of others greatly contributes to their self-concept; however, their increased capability to independently evaluate their self-concept and act in accordance to their personal values leads to a more unstable self-concept which may hinder need fulfillment ([Harter, 1999](#)). Future research that covers a longer time period could test such possibilities.

There was partial support for our hypotheses regarding trajectories of change in motivation over time. Consistent with our hypotheses and prior research (e.g., [Ntoumanis et al., 2009](#)), we found that identified regulation declined over time. However, contrary to the hypotheses there was no significant change in intrinsic motivation or external regulation, and introjected regulation exhibited an average decrease over time. Decreases in controlling motivation have less support during early adolescence, although prior research has been conducted with older adolescents (e.g., [Ntoumanis et al., 2009](#)). It is possible that increases in controlled motivation and decreases in intrinsic motivation may not occur until later in adolescence. Although the average trajectories for autonomy, relatedness, and identified and introjected regulation were significant, the overall trends were small, indicating slight average changes over time for each variable. In the present study we sampled students from one school, so larger, more diverse samples are needed to better explore the generalizability of these trends.

There was an average cubic trend and small overall increase in leisure-time physical activity behavior. This finding is in contrast with some prior research demonstrating average declines in physical activity during early adolescence ([Nader et al., 2008](#); [Troiano et al., 2008](#); [Wall et al., 2011](#)). There are, however, mixed findings regarding trends in physical activity, with some studies documenting stable average physical activity ([Cox et al., 2008](#)) or

increased physical activity ([Taylor et al., 2010](#); [Yli-Piipari et al., 2012](#)) during this developmental period. However, both studies recognize the potential influence of seasonal effects on their physical activity data. Although the cubic trajectory of physical activity behavior was positive, the overall trend was small. Therefore, just as [Yli-Piipari et al. \(2012\)](#) found that self-reported physical activity behavior was relatively stable from sixth to ninth grade but had a significant average decline, self-reported physical activity in this study was also relatively stable but with a significant cubic effect. Perhaps measuring physical activity behavior for a longer time period, later in adolescence would capture a developmental time where change in adolescents' leisure-time physical activity may be more pronounced.

Consistent with self-determination theory and considerable empirical research, psychological need fulfillment and autonomous motivation positively predicted physical activity. More specifically, at the within-student level, students who reported more than their average competence, relatedness, intrinsic motivation, and identified regulation reported more physical activity. Also, at the between-student level, average competence, autonomy, relatedness, and autonomous motivation positively predicted physical activity at the beginning of the study. Average introjected regulation also positively predicted physical activity at the beginning of the study, which is consistent with other research that has demonstrated the adaptive associations between introjected regulation and positive classroom environments, physical activity behavior, and autonomous forms of motivation (e.g., [Gillison, Osborn, Standage, & Skevington, 2009](#); [Ullrich-French & Cox, 2009](#); [Zhou, Ma, & Deci, 2009](#)). This study extends the literature by showing the longitudinal relationships among need fulfillment, autonomous forms of motivation, and physical activity. Perceptions of autonomy, relatedness, intrinsic motivation, and identified regulation interacted with the linear effect of time to predict physical activity. Lower average autonomy, relatedness, intrinsic motivation and identified regulation significantly but marginally predicted greater increases in physical activity over time. Compared to relatedness, intrinsic motivation, and identified regulation, the values of autonomy that moderate the time–physical activity relationship were farther from the mean and represent fewer students. Therefore the interaction between autonomy and time was only significant for students with very low levels of autonomy and for most students autonomy was not significantly associated with changes in physical activity over time. A closer look at these significant interactions highlights the adaptive role of greater need fulfillment and autonomous motivation, as they are associated with consistently more physical activity over time. Students with lower levels of relatedness, autonomy, and autonomous motivation, began the study with lower levels of physical activity. Therefore, the slightly greater increase in physical activity among these students may simply reflect that they have more room to increase their physical activity levels over time compared to students with higher levels of each predictor who also began the study with higher levels of physical activity. Although students with lower levels of autonomy, competence, and autonomous motivation report slightly greater change in physical activity, this change was small and their physical activity behavior never reached the levels of students with higher autonomy, relatedness, and autonomous motivation.

Limitations of this study include the self-report nature of the physical activity measure, that data were obtained from a single school and did not include transitions between schools, and not testing the random slopes of time. Some research has suggested that self-reported physical activity data inflates activity levels compared to objectively measured physical activity ([Troiano et al., 2008](#)). In addition, assessing physical activity behavior on a more nuanced scale, with a range larger than five points, would be more

apt to measure variance in physical activity over time. Researchers may also want to consider using an objective instrument such as accelerometers in future studies. Although this study adds to the current longitudinal literature regarding experiences in physical education class in early adolescence, future research should consider examining students over an extended period of time that includes older adolescents. Furthermore, the students in the present study participated in physical education in the same school with the same teacher. Future studies with multiple teachers and schools would improve confidence in generalizing these findings across teachers and schools, and could examine teacher- and school-level effects on trajectories of physical activity over time. Last, this study examined the fixed effect or average effect of linear, quadratic, and cubic time across the sample. With larger samples, more complex models including random slopes of time could also be tested which describe how students deviate from the average effect of time for the sample, and how need fulfillment and motivational variables predict individual differences in these random effects.

The findings of this study provide new longitudinal support for the application of self-determination theory in the physical education setting. Trajectories of change in psychological needs, motivation, and physical activity behavior were examined reinforcing and adding to the current longitudinal and cross-sectional research. The predictive relationships among psychological needs, motivation, and physical activity behavior also support and extend the current research. These findings emphasize the importance of fostering psychological need satisfaction and autonomous regulation in physical education settings to support leisure time physical activity during early adolescence. Future research would benefit from examining not only changes in need satisfaction but also need thwarting (the perception that an individual's needs are actively undermined). Need thwarting is shown to predict negative outcomes in sport settings (Bartholomew, Ntoumanis, Ryan, Bosch, & Thøgersen-Ntoumani, 2011) and it is possible that need thwarting in physical education also predicts negative outcomes, like lower physical activity. Finally, future longitudinal work across different developmental periods that examines predictors of change in need fulfillment and motivation, such as relational (physical educators and peers) and contextual variables (autonomous versus controlling climates) would extend the current work.

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