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REGULAR ARTICLE

Motivation for Physical Activity among U.S. Adolescents: A Self-Determination Theory Perspective

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Abstract

Background Promoting adolescent physical activity is crucial as this marks a time when physical activity rates decline.

Purpose This study examined motivation for physical activity from a self-determination theory (SDT) perspective in a large sample of adolescents in the USA across three settings: in school, out of school, and on weekends.

Methods Participants (N = 1,661) were adolescents from the National Cancer Institute's Family Life, Activity, Sun, Health, and Eating study. Participants had a mean age of 14.47 (standard deviation = 1.61) and were 50.2% female. In this national sample balanced to match the U.S. population on several key demographics, 64.2% were non-Hispanic White. Analyses included three linear regression models in which estimated weekly minutes of moderate-to-vigorous physical activity (MVPA) in school, out of school, and on weekends were entered as dependent variables. Five forms of motivation (intrinsic, integrated, identified, introjected, and external) were entered simultaneously as independent variables. Age, body mass index, gender, and race/ethnicity were also included as covariates.

Results All models were significant. For MVPA in school, external regulation, introjected regulation, identified regulation, and intrinsic motivation were positively associated with MVPA. For MVPA out of school, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation were positively associated with MVPA. For MVPA on weekends, integrated regulation, and intrinsic motivation were positively associated with MVPA.

Conclusions The relationship between motivation and MVPA varies across settings. These findings have important implications for motivating adolescents to engage in physical activity and may inform future interventions aimed at increasing physical activity.

Keywords: Motivation · Physical activity · Adolescent health · Self-determination theory

Physical inactivity is a major public health concern [1, 2], with 31% of the world's population being considered insufficiently physically active [2, 3]. Though levels of physical activity are higher in children and adolescents than adults, the prevalence of physical inactivity in these age groups remains high [3–6]. Children and adolescents are recommended to engage in 60 min of physical activity per day [7]. Worldwide, less than 20% of school-going adolescents were sufficiently active in 2010 [6]. More recent estimates suggest that 70%–80% of adolescents in the USA do not achieve 60 min of sufficient physical activity per day [3, 7] and even fewer adolescents continue to engage in physical activity as they transition to adulthood [8, 9], which impacts physical activity in adulthood [10].

The physical and psychological benefits of physical activity are well known [2, 11]. Adolescent physical activity, specifically, provides both immediate and long-term benefits [6, 10, 12–14]. Despite these established benefits, physical inactivity levels remain high; and it is important to examine the impact of physical inactivity as there are distinct metabolic, cardiovascular, and psychiatric consequences of physical inactivity in children and adolescents as compared to adults [12, 15–17]. Thus, understanding the predictors of physical activity is important, and motivation is one important precursor to physical activity engagement [18].

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One framework that is of particular use in examining the relationship between motivation and physical activity is self-determination theory (SDT), which can be used to explain behavior based on individual differences in motivation [19]. SDT makes the distinction between autonomous (self-determined) and controlled (nonself-determined) forms of motivation, suggesting that motivation lies on a continuum ranging from amotivation to intrinsic motivation with four levels of extrinsic motivation in between, each reflecting increasing levels of self-determination [20]. Intrinsic motivation, or engaging in a behavior out of inherent enjoyment of the activity itself, is considered to be the prototype of self-determined motivation. Intrinsic motivation is most likely to occur when an individual's needs for autonomy, competence, and relatedness are met [19, 20]. Integrated regulation represents the most self-determined form of extrinsic motivation and refers to behaviors done for personal value. Identified regulation occurs when a behavior is freely chosen because an individual values an outcome of the behavior (rather than the behavior itself). Introjected regulation is a form of motivation driven by feelings of guilt and pride. External regulation refers to engaging in a behavior to achieve an outcome separable from the activity, such as a reward [20]. External regulation is the least self-determined form of motivation. Intrinsic motivation, integrated regulation, and identified regulation are all considered to be autonomous forms of motivation, with identified regulation being conceptualized as the threshold of autonomy [21], while introjected regulation and external regulation are controlled [20]. Amotivation is a complete lack of motivation or is referred to as nonregulation. The theory posits that more autonomous motivation, as opposed to controlled, leads to increased behavioral initiation and persistence.

As it relates to physical activity, SDT suggests that regular physical activity is most likely when motivation is autonomous [22]. Research in adults has supported the notion that autonomous motivation precedes exercise behavior [11, 23–25]. Understanding motivation for physical activity in adolescence is crucial, yet research in this population is more limited. Studies on these constructs in adolescents that do exist suggest that findings in adolescent samples are similar to those found in adults. Gillison et al. found that having intrinsic goals for exercise positively predicted self-determined exercise motivation, which positively predicted exercise behavior, while having extrinsic exercise motives led to lower levels of self-determined motivation, leading to less exercise [26]. Similarly, autonomous motivation has been shown to positively predict exercise behavior [27]. Because much of the adolescent research occurs in the school setting, many of the findings encompass both school and leisure-time activity. In a sample of 11–15 year olds, intentions to exercise, measured in a physical education setting, predicted actual leisure-time exercise when motivation was autonomous but not when it was controlled [28]. Standage et al. found that self-determined motivation positively predicted intent to engage in physical activity outside of physical education [29]. Self-determined motivation has also been positively associated with physical activity during both physical education lessons and leisure time [30]. These results support the theoretical implications of SDT in studies of physical activity in adolescents.

However, additional research is needed in order to gain a more complete understanding of what drives adolescents' physical activity behaviors. For instance, many of the existing studies have been conducted in a school setting (e.g., [28–30]); yet, it is possible that motivation differs across settings, especially in those that allow for more autonomy than the school setting. The context in which physical activity occurs is important and examining singular settings or global physical activity may obfuscate differential effects. Additionally, much of the existing research on adolescents has utilized convenience sampling and has been conducted outside of the USA [26, 28–30]. These study designs limit the generalizability of the results, and future research would benefit from using a larger, random sample in order to increase power and generalizability.

The purpose of the current study was to examine the utility of using an SDT perspective to examine the variation in moderate-to-vigorous physical activity (MVPA) engagement in a sample of adolescents in the USA. This study addresses gaps in the literature by utilizing a large, national sample that was balanced to be similar to the U.S. population on several key demographics, including sex, income, age, household size, and region. Utilizing a large sample yields a narrow confidence interval (CI) and, therefore, more precise estimates of the associations amongst these variables than has been attained by past research. The national distribution of the survey allows for greater generalizability of the results. The findings of this study also provide novel insight regarding how the relationship between motivation and physical activity varies across settings as no known studies have examined physical activity in three settings concurrently: in school, out of school, and on weekends. In line with SDT and the available literature, it was hypothesized that physical activity motives associated with more autonomous behavioral regulations would be positively associated with physical activity, while physical activity motives associated with more controlled behavioral regulation would be negatively associated with physical activity. It was also hypothesized that intrinsic motivation, as the most autonomous motive, would have the strongest positive association with physical activity. Similarly, it was

hypothesized that external regulation, or the least autonomous motive, would have the strongest negative association with physical activity.

Methods

Participants and Procedures

The current study was a secondary data analysis of data from the National Cancer Institute's (NCI) cross-sectional, internet-based Family Life, Activity, Sun, Health, and Eating (FLASHE) study [31, 32]. The data set is publicly available at https://cancercontrol.cancer.gov/brp/hbrb/flashe-files.aspx. In addition to physical activity, this data set also contains other health-related variables, including variables related to sedentary time, weight, neighborhood factors, screen time, sun safety, sleep, diet, and smoking. FLASHE was approved by the Office of Management and Budget, the NCI Institutional Review Board (IRB), and the Westat IRB. Data were collected between April and October 2014. Participants (N = 1,661) were recruited through the Ipsos Consumer Opinion Panel, which invites potential participants to join the panel through print ads, Internet ads, and panelist referral. Adolescents were identified through parent membership on the panel. The recruited sample was selected using balanced sampling so that the sample distributions approximate the U.S. population on several key demographics, such as sex, income, age, household size, and region. Adolescents were eligible to participate in the study if they were between the ages of 12 and 17. Parental consent and adolescent assent were obtained via the study website.

Once enrolled, participants were able to access two study surveys: one measuring diet-related constructs and the other measuring physical activity-related constructs. Half of the participants were assigned to complete the diet survey first, while the other half were assigned to complete the physical activity survey first. Upon completion of both surveys, participants were mailed a card with compensation, thanking them for their participation (for more details on study design, see Nebeling et al. [31] and Oh et al. [32]).

Measures

Self-report measures were selected from the demographic and physical activity FLASHE surveys and were, therefore, limited to the measures selected by the NCI team. All measures are available at https://cancercontrol.cancer.gov/brp/hbrb/flashe.html. At the beginning of the physical activity survey, participants were instructed to think of physical activity as "things that involve a lot of walking, running or moving around. It includes biking and dancing as well as sports or outdoor play that involves a lot of moving around."

Motivation

There are few questionnaires that measure the determinants of physical activity in adolescents and even fewer that have been psychometrically evaluated. As such, items representing the full continuum of motivation were adapted from existing scales. From the available items, one item was selected to represent each form of motivation on the continuum. The definition of physical activity as "any play, game, sport, exercise or transportation (e.g. walking or biking) that gets you moving and breathing harder" preceded the scale items. Participants were then asked to indicate their agreement with different motives for physical activity done most days of the week. Specifically, items assessing identified regulation ("If I were to be physically active most days of the week it would help me cope with stress") and intrinsic motivation ("If I were to be physically active most days of the week it would be fun") to participate in physical activity were adapted from a five-item scale measuring motivation for regular, leisure-time engagement in physical activity [33]. Items assessing introjected ("I would exercise most days of the week because I would feel bad about myself if I didn't"), external ("I would exercise most days of the week because others would be upset with me if I didn't"), and integrated regulation ("I would exercise most days of the week because it's an important thing for me to do") were adapted from the Exercise Self-Regulation Questionnaire (SRQ-E; 34). Similar items have been used to assess motivation for physical activity in adolescents in previous research [28, 35]. Responses to all items were on a 5 point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Physical activity

Physical activity was measured using the Youth Activity Profile (YAP), a self-report measure that contains items about activity in school, out of school, and on weekends that have been shown to approximate objective physical activity levels [36]. There were five questions about in-school activity, including, "During lunch break, how often were you moving around, walking, or playing?" to which participants responded on a scale from 1 (*I didn't have lunch breaks*) to 6 (*almost all of the time*). There were three questions about out-of-school activity, including, "How many days after school (between 3:00 and 6:00 PM) did you do some form of physical activity for at least 10 min? This can include playing with your friends/family, team practices or classes involving physical activity, but NOT walking or biking home from school," to which participants responded on a scale from 0 (*0 days*) to 4

(*4–5 days*). Two questions assessed weekend activity. For example, one question asked, "How much physical activity did you do last Saturday? This could be for exercise, work/chores, family outings, sports, dance, or play. If you do not remember, try to estimate." Response options were: 1 (*no activity [0 min]*), 2 (*small amount of activity [1–30 min]*), 3 (*small to moderate amount of activity [31–60 min]*), 4 (*moderate to large amount of activity [1–2 hr]*), or 5 (*large amount of activity [more than 2 hr]*).

Accelerometer data were also obtained for a subsample of participants using the Actigraph 3TGX+. Actigraph accelerometers have been shown to be reliable [37], and they outperform other accelerometer models [38]. The YAP was calibrated to predict total minutes per week of MVPA in school, out of school, and on weekends for each participant by regressing the subsample of participants' accelerometer data on their YAP scores [39]. The algorithms obtained from the calibration process produced minutes of activity estimates that were within 10%–20% of the values obtained from the accelerometers.

Demographics

Demographic information was collected on race, ethnicity, age, gender, and height and weight, as well as any condition that interferes with being physically active. Race/ethnicity, age, and body mass index (BMI) were all considered as potential covariates in the analytic models. Race/ethnicity was considered because differences in activity levels have been found in non-Hispanic White, non-Hispanic Black, and Mexican American youth [40]. Dummy codes were created for race/ethnicity such that there were variables for non-Hispanic Black, Hispanic, and other, and non-Hispanic White was the reference group. Age was considered because physical activity levels have been shown to decline through adolescence [5]. BMI was considered because associations have been found between BMI and exercise behavior [27]. Gender was considered because differences in physical activity levels [41, 42], as well as in motivation for physical activity, have been found among boys and girls [26, 43, 44].

Analyses

All analyses were conducted in SPSS (v24). *z*-score transformations were created for each outcome variable to assess for outliers (outcome variables in the primary models were retained in their original metric). Cases with *z*-scores of 3.29 are typically considered to be potential outliers; however, in large samples, some *z*-scores above 3.29 are expected [45]. Using these criteria, no significant outliers were identified; therefore, no corrections were made to the data. Frequencies were used to examine the distributions of the outcome variables and revealed that minutes of MVPA in school were positively skewed, minutes of MVPA out of school were normally distributed, and minutes of MVPA on weekends were negatively skewed. According to the central limit theorem [46], as sample size increases, it approaches the actual population distribution. To test this, analyses were conducted with multiple distributions in generalized linear modeling, such as gamma regression and Poisson regression, and the results were found to be robust. Therefore, for ease of interpretation, three standard linear regression models were employed to examine the association between motivation for physical activity and MVPA, with minutes of MVPA in school, minutes of MVPA out of school, and minutes of MVPA on weekends as outcome variables, making it easier to examine results across models. In all models, items representing intrinsic motivation and identified, integrated, introjected, and external regulation were simultaneously entered as the independent variables. Race/ethnicity, age, BMI, and gender were also included in the models as covariates as they were found to be significant at the $p < .05$ level in bivariate correlations with the outcome variables or in the overall models. Standardized and unstandardized (and corresponding standard errors [*SE*s] and 95% CIs) are reported. Unstandardized parameter estimates are interpreted as a 1 point change in independent variable corresponding to minutes of MVPA per week. Squared semipartial correlation (sr^2) was calculated as a measure of effect size. In multiple regression, sr^2 represents the unique contribution of an independent variable to the total variance on the dependent variable [45]. The models were also run with the settings combined to represent controlled versus volitional MVPA as outcomes, and a similar pattern of results emerged; however, our results indicated some differences between all three settings. Thus, the original models were retained. Gender and BMI were also examined as moderators between type of motivation and MVPA, but no significant interaction effects were found; thus, for parsimony, the interaction terms have been excluded from the final models. Sensitivity analyses were conducted removing participants that had a condition limiting physical activity, and the pattern of results remained unchanged; thus, the full sample was retained.

The total sample was $N = 1{,}661$. Due to missing data, the sample sizes for the analytic models for MVPA in school, MVPA out of school, and MVPA on weekends were reduced to $N = 1{,}402$, $N = 1{,}399$, and $N = 1{,}416$, respectively, and 17.76% ($n = 295$) of the cases were missing. The percentage of missing values across the variables varied between 0.2% and 11.3%. Multiple imputation was used to generate and analyze 15 imputed data sets, corresponding to the approximate percentage of missing cases. All variables in the models were used as predictors to impute only the outcome variables as no

other variables reached over 5% missing. In large data sets, 5% or less missing data are considered to be tolerable [45]. The multiple imputation resulted in an analytic sample of $N = 1{,}570$ for all three models.

Results

Descriptive Statistics

See Table 1 for sociodemographic characteristics of the sample and descriptive statistics of the study variables. SDT suggests that the correlations between the types of motivation should form a simplex pattern, which occurs when theoretically adjacent constructs along the continuum correlate more highly than those more distant on the continuum [47]. For example, intrinsic motivation should correlate more with integrated motivation than with identified or introjected. Results indicated that the data formed a quasi-simplex pattern, generally supporting the continuum of motivation set forth by SDT. All motives were more highly correlated with motives more theoretically similar on the continuum, though the strength of associations was occasionally reversed. However, the degree to which these correlations varied was low, and the reversals always occurred in motives adjacent on the continuum. See Table 2 for bivariate correlations between the types of motivation and all other study variables. Tests of collinearity indicated that multicollinearity was not a concern as Variance Inflation Factor values for all variables across the three models were below 1.5 [45]. See Table 3 for all associations between study variables.

Table 1. Descriptive statistics of study variables

Variable	*n*	%
Gender		
Female	814	50.2
Male	806	49.8
Race/ethnicity		
Non-Hispanic White	1,033	64.2
Non-Hispanic Black	266	16.5
Hispanic	162	10.1
Other	148	9.2
	Range	*M* (*SD*)
Age (years)	12–17	14.47 (1.61)
BMI	12.20–51.21	22.15 (4.87)
Motivation		
Others upset (external)	1–5	2.49 (1.25)
Feel bad (introjected)	1–5	3.01 (1.22)
Cope with stress (identified)	1–5	3.75 (1.10)
Important (integrated)	1–5	4.08 (0.96)
Be fun (intrinsic)	1–5	4.11 (0.93)
MVPA (minutes)		
In School	192–521	284.69 (63.28)
Out of School	165–395	289.70 (52.74)
Weekend	84–270	209.27 (38.95)

BMI body mass index; *MVPA* moderate-to-vigorous physical activity, *SD* standard deviation.

Physical Activity Outcomes

MVPA in school

The overall model was significant (F[11, 1,558] = 439.99, $p < .001$), with an R^2 of .756. External regulation was positively associated with MVPA ($\beta = 0.034$, $b = 1.75$, $SE = 0.75$, 95% CI = 0.28, 3.22, $p = .020$, $sr^2 = .001$). Introjected regulation was positively associated with MVPA ($\beta = 0.055$, $b = 2.86$, $SE = 0.84$, 95% CI = 1.21, 4.51, $p = .001$, $sr^2 = .002$). Identified regulation was positively associated with MVPA ($\beta = 0.054$, $b = 3.07$, $SE = 0.91$, 95% CI = 1.30, 4.85, $p = .001$, $sr^2 = .002$). Integrated regulation was not statistically significantly associated with MVPA ($\beta = 0.004$, $b = 0.26$, $SE = 1.03$, 95% CI = −1.77, 2.30, $p = .829$, $sr^2 < .0001$. Intrinsic motivation was positively associated with MVPA ($\beta = 0.035$, $b = 2.39$, $SE = 1.07$, 95% CI = 0.28, 4.50, $p = .022$, $sr^2 = .001$). Collectively, the motives explained 0.6% of the variance on MVPA in school. A 1 unit increase in various motivations corresponded to 2–3 min increases of MVPA per week.

MVPA out of school

The overall model was significant (F[11, 1,558] = 367.60, $p < .001$), with an R^2 of .722. External regulation was negatively associated with MVPA out of school ($\beta = -0.032$, $b = -1.38$, $SE = 0.65$, 95% CI = −2.35, 0.10, $p = .035$, $sr^2 = .001$). Introjected regulation was positively associated with MVPA ($\beta = 0.081$, $b = 3.49$, $SE = 0.71$, 95% CI = 2.09, 4.90, $p < .001$, $sr^2 = .005$). Identified regulation was positively associated with MVPA ($\beta = 0.059$, $b = 2.84$, $SE = 0.79$, 95% CI = 1.28, 4.40, $p < .001$, $sr^2 = .003$). Integrated regulation was positively associated with MVPA ($\beta = 0.077$, $b = 4.24$, $SE = 0.89$, 95% CI = 2.50, 5.97, $p < .001$, $sr^2 = .004$). Intrinsic motivation was positively associated with MVPA ($\beta = 0.120$, $b = 6.79$, $SE = 0.94$, 95% CI = 4.94, 8.63, $p < .001$, $sr^2 = .010$). Collectively, the motives explained nearly 2% of the variance on MVPA out of school. A 1 unit increase in various motivations corresponded to 3–7 min increases in MVPA per week or, in the case of external regulation, a 1 unit increase corresponded to a 1 min decrease in MVPA per week.

Table 2. Bivariate correlations of study variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Others upset (external)	–													
2	Feel bad (introjected)	0.37***	–												
3	Cope with stress (identified)	0.14***	0.30***	–											
4	Important (integrated)	0.19***	0.42***	0.33***	–										
5	Be fun (intrinsic)	0.05*	0.23***	0.43***	0.37***	–									
6	Gender	−0.06*	0.05	0.07**	0.01	−0.05	–								
7	Non-Hispanic Black[a]	−0.8***	0.01	0.07**	0.05	0.11***	−0.02	–							
8	Hispanic[a]	0.06*	0.04	−0.01	−0.01	0.01	−0.01	−0.15***	–						
9	Other[a]	0.03	−0.01	−0.01	0.01	−0.01	−0.02	−0.14***	−0.11***	–					
10	Age	−0.09***	−0.02	0.09***	−0.03	−0.09***	−0.03	0.02	−0.02	−0.05*	–				
11	BMI	0.05	0.04	0.04	0.01	−0.10***	−0.01	0.11***	0.01	−0.04	0.20***	–			
12	MVPA in school	0.14***	0.11***	0.01	0.10***	0.16***	−0.02	0.05*	0.05	0.06*	−0.86***	−0.18***	–		
13	MVPA out of school	0.10***	0.16***	0.08**	0.19***	0.27***	−0.02	−0.01	0.01	0.01	−0.82***	−0.20***	0.78***	–	
14	MVPA weekend	0.09***	0.13***	0.09***	0.19***	0.27***	−0.04	−0.05*	0.02	−0.06*	−0.57***	−0.21***	0.55**	0.73***	–

BMI body mass index; *MVPA* moderate-to-vigorous physical activity.

[a]All race/ethnicity variables were coded as 1 and dichotomized with non-Hispanic White coded as 0.

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

Table 3. Associations between study variables

Variable	*b* (*SE*)	95% CI
MVPA in school		
Others upset (external)	1.75 (0.75)*	[0.28, 3.22]
Feel bad (introjected)	2.86 (0.84)***	[1.21, 4.51]
Cope with stress (identified)	3.07 (0.91)***	[1.30, 4.85]
Important (integrated)	0.26 (1.03)	[−1.77, 2.30]
Be fun (intrinsic)	2.39 (1.07)*	[0.28, 4.50]
Female	−6.61 (1.66)***	[−9.85, −3.36]
Non-Hispanic Black	13.01 (2.31)***	[8.48, 17.55]
Hispanic	8.42 (2.82)**	[2.89, 13.95]
Other	6.13 (2.98)*	[0.28, 11.98]
Age	−33.52 (0.54)***	[−34.59, −32.47]
BMI	−0.32 (0.18)	[−0.68, 0.04]
MVPA out of school		
Others upset (external)	−1.38 (0.65)*	[−2.35, 0.10]
Feel bad (introjected)	3.49 (0.71)***	[2.09, 4.90]
Cope with stress (identified)	2.84 (0.79)***	[1.28, 4.40]
Important (integrated)	4.24 (0.89)***	[2.50, 5.97]
Be fun (intrinsic)	6.79 (0.94)***	[4.94, 8.63]
Female	−5.88 (1.50)***	[−8.82, −2.94]
Non-Hispanic Black	−3.23 (2.05)	[−7.25, 0.79]
Hispanic	−2.18 (2.54)	[−7.15, −2.80]
Other	−7.01 (2.69)**	[−12.28, −1.73]
Age	−26.59 (0.48)***	[−27.53, −25.65]
BMI	−0.33 (0.16)*	[−0.64, −0.02]
MVPA on weekends		
Others upset (external)	−0.45 (0.69)	[−1.80, 0.90]
Feel bad (introjected)	1.48 (0.77)	[−0.02, 2.99]
Cope with stress (identified)	1.33 (0.86)	[−0.36, 3.02]
Important (integrated)	3.48 (0.99)***	[1.53, 5.42]
Be fun (intrinsic)	6.78 (0.97)***	[4.87, 8.69]
Female	−4.83 (1.62)**	[−8.00, −1.65]
Non-Hispanic Black	−7.92 (2.15)***	[−12.13, −3.71]
Hispanic	−1.90 (2.75)	[−7.30, 3.51]
Other	−13.87 (2.84)***	[−19.44, −8.30]
Age	−13.31 (0.52)***	[−14.33, −12.29]
BMI	−0.69 (0.18)***	[−1.03, −0.35]

BMI body mass index; *CI* confidence interval; *MVPA* moderate-to-vigorous physical activity, *SE* standard error.

*$p \le .05$; **$p \le .01$; ***$p \le .001$.

MVPA on weekends

The overall model was significant, (F[11, 1,558] = 98.83, $p < .001$), with an R^2 of .411. External regulation ($\beta = -0.014$, $b = -0.45$, $SE = 0.69$, 95% CI = −1.80, 0.90, $p = .518$, $sr^2 = .0{,}002$), introjected regulation ($\beta = 0.047$, $b = 1.48$, $SE = 0.77$, 95% CI = −0.02, 2.99, $p = .054$, $sr^2 = .002$), and identified regulation ($\beta = 0.038$, $b = 1.33$, $SE = 0.86$, 95% CI = −0.36, 3.02, $p = .123$, $sr^2 = .001$) were not statistically significantly associated with MVPA. Integrated regulation was positively associated with MVPA ($\beta = 0.086$, $b = 3.48$, $SE = 0.99$, 95% CI = 1.53, 5.42, $p < .001$, $sr^2 = .005$). Intrinsic motivation was positively associated with MVPA ($\beta = 0.163$, $b = 6.78$, $SE = 0.97$, 95% CI = 4.87, 8.69, $p < .001$, $sr^2 = .019$). Collectively, the motives explained nearly 3% of the variance on MVPA on weekends. A 1 unit increase in various motivations corresponded to 3–7 min increases in MVPA per week.

Discussion

This is the first known study to examine the motivation for physical activity in adolescents from an SDT perspective across three settings: in school, out of school, and on weekends. Previous research has primarily been conducted in only one setting or examined only total MVPA (e.g., [24, 26]). For adolescents, in particular, much of the research has been conducted in the school setting [28–30]. Yet the school setting may differ from other settings. For example, physical activity in the school setting may be less autonomous than in other settings. As previous studies have primarily used convenience samples (e.g., [26, 28–30]), the current study also extends previous research on motivation for physical activity in adolescents by utilizing a large, national sample balanced to match the U.S. population on several key demographics. Improving current understanding of the determinants of adolescent physical activity is crucial as there are population-wide declines in physical activity across this developmental time [8, 9, 48, 49], and motivation is an important precursor to behavior [18].

Results from the current study indicated that intrinsic motivation was statistically significantly and positively associated with MVPA in school, out of school, and on weekends. These findings support the hypothesis that physical activity motives associated with more autonomous behavioral regulations would be positively associated with physical activity. The hypothesis was also supported by the findings that integrated regulation was statistically significantly and positively associated with MVPA out of school and on weekends. However, integrated regulation was not significantly associated with MVPA in school. To the extent that integrated regulation is related to adolescents' sense of self or identity, it

is possible that increasing academic pressures in middle and high school cause adolescents' roles as students to be a more salient part of their identities in the school setting than someone who engages in physical activity [50]. Because adolescents have less autonomy in school and may be required to participate in a specific amount of physical activity at school through physical education classes, parts of their identities related to physical activity may become even less salient. Additionally, because there is less opportunity for free-time physical activity (e.g., recess) for this age group, it may not be possible for adolescents who do feel as if physical activity is part of their identities to engage in extra physical activity at school outside of physical education. The finding that identified regulation was positively associated with MVPA in school and out of school also supports this hypothesis. Identified regulation was not statistically significantly associated with MVPA on weekends. Perhaps adolescents are less likely to engage in physical activity to achieve a particular outcome on weekends as weekends offer more unstructured leisure time. For example, adolescents may be less likely to be physically active to cope with stress on weekends as weekends may be less stressful than weekdays. The finding that external regulation was negatively associated with MVPA out of school supported the hypothesis that physical activity motives associated with more controlled behavioral regulations would be negatively associated with physical activity, yet it did not represent a significant barrier to MVPA as it was associated with only a 1 min decrease in MVPA per week out of school.

Other than external regulation with MVPA out of school, no controlled behavioral regulations were negatively associated with MVPA. Further, for the outcome variable MVPA on weekends, none of the associations with less self-determined forms of motivation (i.e., introjected, and external) were statistically significant, perhaps because physical activity on weekends may be more autonomous than on weekdays in or out of school. This may exert its influence on motivation through psychological needs fulfillment as autonomy is one of the three psychological needs, and SDT posits that greater needs fulfillment leads to more self-determined motivation [19, 20]. Indeed, autonomy has been shown to predict self-determined motivation for physical activity in adolescents [51].

Contrary to the hypotheses that controlled forms of motivation would be negatively associated with MVPA, external regulation was positively associated with MVPA in school. This finding may be driven by the fact that adolescents are likely to be required to participate in physical education classes, and this requirement is unique to the school setting. Nonparticipation may lead to consequences; therefore, adolescents' desire to avoid punishment may drive the positive association between motivation and MVPA in this setting. The association between introjected regulation and MVPA was also statistically significant and positive for the in-school and out-of-school outcome. As introjected regulation is related to guilt and shame, it is possible that this finding is related to greater expectations in and out of school than there are on weekends, such as expectations to participate in physical education or after-school sports. More expectations may lead adolescents to strive to avoid guilt and shame related to said expectations in these settings. Studies examining other SDT constructs in different samples and contexts have also suggested some variation in how the different motives along the continuum relate to behavior [52, 53]. Such variations may be reflected in the present findings.

Because this study uniquely examined all five types of motivation across three different settings, it is difficult to compare these findings to previous work examining motivation for physical activity in adolescents. Rather than examining each type of motivation as a unique predictor of physical activity, many studies have used composite scores of motivation or excluded one or more types of motivation from analyses [26, 35, 54, 55]. Similar to the current findings that external, introjected, and identified regulations were not statistically significantly associated with MVPA on weekends in this sample, Chatzisarantis et al. found that there was no direct effect of external or identified regulation on leisure-time physical activity in adolescents in the UK [28]. In a longitudinal study of swimming behavior in Canadian adolescents, Pelletier et al. found that intrinsic motivation and identified regulation positively predicted swimming behavior at 10 and 22 month follow-ups, and introjected regulation positively predicted swimming behavior at 10 month follow-up [56]. These findings are in line with the current study's findings that intrinsic motivation, identified regulation, and introjected regulation were positively associated with MVPA out of school. While it is possible that comparison to findings in these studies may be limited as neither was conducted in the USA, Canada and the UK are similar to the USA culturally; thus, it is likely that these associations are generalizable outside of the USA. Nevertheless, the present study was also novel in that it was the first known to examine the full continuum of motivation set forth by SDT in a sample of adolescents in the USA.

Collectively, these findings highlight how the association between motivation and MVPA varies across settings and the importance of research that examines motivation for physical activity in a variety of settings. Additionally, these results underscore the strength of the associations between motivation and physical activity as the statistically significant associations found between

motivation and MVPA are unique contributions of each type of motivation to MVPA over and above all other forms of motivation and the included covariates. A 1 point increase in motivation corresponded with anywhere from a 1 to 7 min increase in MVPA per week, and these incremental increases may lead to large increases in total MVPA. Indeed, moving from external regulation to intrinsic motivation such that there is a 5 point increase in intrinsic motivation may lead to nearly a 35 min increase in physical activity per week in one setting alone. Further, although each motive uniquely accounted for a modest amount of variance in each model, R^2 was large, indicating that the shared variance among the IVs accounted for a significant portion of variance.

Limitations and Future Directions

Findings from the current study should be interpreted with consideration of some limitations. Because this was a secondary data analysis of archival data, it was not possible to select the scales used or wording of variables. As such, each form of motivation was only assessed with a single item, and there were no items representing amotivation available. It may be important to examine amotivation in this population as one study found that amotivation in physical education positively predicted intentions to engage in physical activity outside of school [52]. Variables representing the basic psychological needs (i.e., competence, autonomy, and relatedness) were also not available in the data set from which variables were selected. Future research would benefit from repeating these analyses with established measures of exercise motivation that have been validated in adolescents, which may more fully measure each type of motivation, as well as examining the satisfaction of psychological needs as an antecedent to motivation. Additionally, it is important to conduct a more thorough examination of the association between race and ethnicity with MVPA in these settings as the two were combined into one variable in the original study. However, the use of this archival data set was a strength of the present study given the large and balanced sample; the resulting strength of the data is of benefit to this study as it enables greater generalizability and power of the findings. Although NCI collected accelerometer-measured physical data from a subset of the current sample, this objective physical activity data were not available at the time this study was conducted. Subjective measures have been shown to both underestimate and overestimate physical activity levels in comparison to objective measures [57]. As such, it may be important to conduct the current analyses with the accelerometer data upon its release, and future research may wish to utilize more objective measures of physical activity. However, the measures of weekly physical activity used in this study were obtained by regressing the obtained accelerometer data on each participant's self-reported physical activity data, a method of improving the accuracy of self-report data and were shown to approximate objective physical activity levels [39]. It should be noted that results from a recent meta-analysis did not support the inclusion of integrated regulation in the continuum [58]. However, integrated regulation was retained in the current sample as it was only moderately correlated with identified and intrinsic regulation, as well as for comparisons to past research on this topic. There were also no statistical tests available within the current analytic approach to compare effect size across contexts; thus, the conclusions that can be drawn about the strength of effects across contexts are limited. Finally, because the current study was cross-sectional in nature, caution must be taken when making causal interpretations of the results. Future research could examine temporal relationships between motivation and physical activity by utilizing a longitudinal design, providing insight into the association of motivation and physical activity across a longer time span. Such analyses would also make it possible to identify bidirectional relationships of the study variables, in which greater physical activity may also influence subsequent motivation.

Implications

These findings have implications for the utility of using an SDT perspective to examine the motivation for physical activity in adolescence. The hypotheses, based on SDT tenets, were only partially supported suggesting SDT may function uniquely in adolescence possibly due to differences in psychological need satisfaction during this developmental period. Additionally, the current findings indicate that motivation exerts different influences on physical activity across settings, and this too may result from differences in psychological need satisfaction across settings. For instance, it may be that perceptions of autonomy account for varying associations in different contexts. Future research that examines the role of need satisfaction in relation to the present constructs is warranted. While these findings help to provide a theoretical base for the application of SDT to adolescents' physical activity behavior, the current study may also lead to some insights in increasing physical activity engagement in adolescents. The current findings that only one form of motivation was negatively associated with MVPA, which align with SDT's predictions, indicate that there were almost no motivational barriers to physical activity in any setting. As such, it may be important to shift focus from addressing barriers to physical activity and instead

concentrate efforts on fostering more self-determined levels of motivation (i.e., identified, integrated, and intrinsic). One strategy may be to promote adolescents' perceived autonomy by providing more opportunities for choice in physical activity across contexts, such as a greater selection of activities. By also promoting connectedness to others through group activities and teams, as well as focusing on skills improvement to increase perceptions of competence, practitioners can address the factors that SDT suggests will move motivation through the continuum toward intrinsic motivation. However, which type of motivation to target may depend on the intended setting. Practitioners seeking to improve overall physical activity in adolescents may wish to focus on cultivating intrinsic motives, which may lead to the greatest increases in physical activity across all settings. It is also possible for multiple motives to be associated with physical activity simultaneously; thus, multicomponent interventions directed at several forms of motivation may be the most fruitful in leading to gains in physical activity.

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Compliance with Ethical Standards

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Authors' Contributions K.A.N. was responsible for the conception and design of the study as a master's thesis. A.J.B. served as thesis committee chair, while A.A.V. and S.S.L. served as committee members, with all contributing to the final study design. K.A.N. organized the data, performed statistical analysis (under the supervision of A.J.B.), and wrote the first draft of the present manuscript. All authors contributed to manuscript revisions and read and approved the submitted version.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent For this type of study formal consent is not required.

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