Published in final edited form as:

Addict Behav. 2015 December ; 51: 177–183. doi:10.1016/j.addbeh.2015.07.032.

All Physical Activity May Not Be Associated with a Lower Likelihood of Adolescent Smoking Uptake

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Abstract

Objective—Research has documented that physical activity is associated with a lower risk of adolescent smoking uptake, yet it is unclear whether this relationship exists for all types of physical activity. We sought to determine whether certain types of physical activity are associated with a decreased or an increased risk of adolescent smoking uptake.

Methods—In this longitudinal cohort study, adolescents (n=1,356) were surveyed every six months for four years (age 14 – 18 years old). Smoking and physical activity were measured at each of the eight time-points. Physical activity that was negatively associated with smoking across the eight waves was considered positive physical activities (i.e., PPA; linked to not smoking such as racquet sports, running, and swimming laps). Physical activity that was positively associated with smoking across the eight waves were considered negative physical activities (i.e., NPA; linked to smoking such as skating, walking, bicycling, sport fighting, and competitive wrestling).

Results—Associative Processes Latent Growth Curve Modeling revealed that each 30-minute increase in NPA per week at baseline was associated with a 4-fold increased odds of smoking progression (OR=4.10, 95% CI=2.14, 7.83). By contrast, each 30-minute increase in PPA at baseline was associated with a 51% decrease in the odds of smoking progression (OR=.49, 95% CI=.25, .93).

Conclusions—The type of physical activity that an adolescent engages appears to be important for the uptake of cigarette smoking among adolescents. These associative relationships warrant consideration in interventions to increase overall physical activity and those promoting physical activity to prevent smoking uptake.

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Contributors

Dr. Audrain-McGovern conceived of the study, wrote the introduction and discussion, oversaw analyses and the interpretation of the results, and edited the entire manuscript. Dr. Rodriguez undertook the statistical analysis and wrote the first draft of the methods and results sections. All authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

Keywords

Adolescent; Smoking; Physical Activity

1. INTRODUCTION

Almost 20% of adolescents regularly smoke cigarettes with the percentage of regular smokers doubling from mid to late adolescence (Kann et al., 2014). Longitudinal research suggests that physical activity may protect adolescents from smoking (Adachi-Mejia et al., 2009; Kujala et al., 2007). Greater physical activity has been associated with a 50% reduction in the odds of adolescent smoking initiation and progression (Audrain-McGovern et al., 2003a). Similarly, consistent involvement in team sports is associated with a three-fold lower likelihood of becoming a regular smoker three-fold (Rodriguez and Audrain-McGovern, 2004).

However, the inverse relationship between physical activity and smoking may be due to more than just the amount of physical activity. A recent study characterized adolescent tobacco use across distinct physical activity trajectories (Audrain-McGovern et al., 2012). Adolescents in certain physical activity trajectories averaged an hour of physical activity a day across mid to late adolescence, but nonetheless, showed an increased risk of cigarette smoking (Audrain-McGovern et al., 2012). This raised the question as to whether some types of physical activity are not protective or possibly even linked with smoking. Although not well delineated, there is some evidence from cross-sectional research to suggest that sports with more risk (e.g., snowboarding, skateboarding, skiing) are associated with cigarette smoking (Peretti-Watel et al., 2002).

The purpose of the present study was to determine whether certain types of physical activity are associated with a decreased likelihood of adolescent smoking uptake, while other types are associated with an increased likelihood. Identifying such relationships are critical for the planning of interventions to increase overall physical activity and those promoting physical activity to prevent smoking uptake. As public health messages are aimed at increasing overall physical activity, the results may help refine these messages to minimize involvement in physical activity that is linked to smoking.

2. METHODS

2.1. Participants and Procedures

Participants were high school students (51% female and 73% White) taking part in a longitudinal study of the relationship between adolescent physical activity and smoking uptake. Participants were enrolled in one of four public high schools in suburban Philadelphia, PA. This cohort was drawn from the 1,517 students identified through class rosters at the beginning of ninth grade. Students were ineligible to participate in this study if they had a special classroom placement (e.g., severe learning disability) or if they did not speak fluent English. Based on the selection criteria, a total of 1,487 (98%) students were eligible to participate. Parents were mailed a study information letter (active information)

with a telephone number to call to obtain answers to any questions and to decline consent for their adolescent to participate. Of these 1,487 eligible teens, 1,478 (99%) had a parent's passive consent to participate. Thirty adolescents were absent on the assent/survey days and 19 did not provide assent due to lack of interest in the study. Thus, 1,429 of 1,478 teens with parental consent (97%) provided their assent to participate and completed a baseline survey. Adolescents who declined assent or who were absent on the baseline survey day did not differ on race and gender from those who provided assent and completed the baseline survey.

The adolescent cohort was formed in the 9th grade and followed until the end of 12th grade. A self-report 40-minute survey was administered every six months (fall and spring semesters) on-site during compulsory classes each year of high school for a total of eight surveys. The sample size was the $n=1,356$ participants with complete data for the covariates in the model. University Institutional Review Board approval of the study was obtained. We previously reported on the overall physical activity patterns and tobacco use in this sample (Audrain-McGovern et al., 2012).

2.2. Measures

2.2.1. Smoking—Smoking progression was derived from evaluating smoking practices with a series of standard epidemiological questions regarding smoking such as, “Have you ever tried or experimented with cigarette smoking, even a few puffs?”, and “Have you smoked a cigarette in the past 30 days?” (Audrain-McGovern et al., 2009; Eaton et al., 2006). The 6-category ordered categorical smoking variable was coded as 0 = never smoked, 1 = puffed but did not smoke a whole cigarette, 2 = smoked a whole cigarette but not in the past month, 3 = smoked in the last month, 4 = smokes weekly, 5 = smokes daily. Smoking was measured all eight waves.

2.2.2. Physical Activity—Minutes of moderate-vigorous physical activity was assessed with the 7-day Physical Activity Recall (PAR) (Sallis, 1997; Sallis et al., 1985; Sallis and Owen, 1999; Sallis et al., 1999). The PAR has excellent test-retest reliability ($r=0.81$) and validity ($r = 0.72$ against heart rate monitors) in adolescents (Sallis et al., 1993). It is a widely used measure of habitual activity in observational studies (Gordon-Larsen et al., 2000; Sallis et al., 1985; Young et al., 1993). Physical activity was measured all eight waves.

To determine the relationships between type of physical activity and smoking, we first assessed the bivariate associations between minutes of each of the 35 different physical activities for each of the eight study waves on a randomly selected 40% of the sample. Those showing significant negative associations with smoking ($p < .05$) were considered positive physical activity (PPA - physical activities linked to not smoking). Those showing significant positive associations with smoking ($p < .05$) were considered negative physical activity (NPA - physical activities linked to smoking).

PPA included tennis, racquetball, soccer, track and field, yoga, aerobics, running, jogging, jumping rope, and swimming laps. Thus, PPA included organized team sports as well as individual and partner-based sports. NPA included social and recreational dancing (does not

include jazz, tap, ballet, or modern dance), skating (ice, roller, inline, and skateboarding), cheerleading, walking for exercise, walking for transport, using an exercise machine, bicycling, chores, bowling, fighting (karate, judo, boxing), and competitive wrestling. Each type of physical activity was summated, providing independent measures of minutes of PPA and NPA per week. We then tested the relationships between NPA, PPA and smoking with the remaining 60% of the sample. NPA was positively associated with smoking ($p < .05$) and PPA was negatively associated with smoking ($p < .05$).

2.2.3. Covariates—We controlled for gender (1=female), race (1=white, 0=else), and parental education (0=both parents have greater than a high school education, 1= one parent has a high school education or less, 2=both parents have a high school education or less). We controlled for peer and household smoking exposure with a single exposure variable (0=no exposure to peer or household smoking, 1=exposure to either peer and/or household smoking) (Audrain-McGovern et al., 2004; Choi et al., 1997; Tercyak et al., 2002). Marijuana use and alcohol use were each assessed with one item asking “During the past 30 days, how many times did you use marijuana?” (1=“0 times” to 6=“40 or more times”) and “During the past 30 days, on how many days did you have at least one drink (not just a sip) of alcohol?” (1=“0 days” to 7=“All 30 days”) (Audrain-McGovern et al., 2004; Eaton et al., 2006). Perceived parental monitoring was assessed with a 5-item Likert-style scale that evaluates adolescent perceptions of parental knowledge of whereabouts, activities, and friendships (DiClemente et al., 2001; Fletcher et al., 2004; Kodl and Mermelstein, 2004; Simons-Morton, 2004). Unstructured free time was assessed with a single item “In an average week, how much unstructured time (free time outside of school, homework, clubs, work and community involvement) do you have?” Scores ranged from 0= “none” to 3= “a lot”. Finally, we controlled for impulsivity using the impulsivity subscale of the Temperament & Character Inventory (5 True/False items) (Cloninger et al., 1994).

2.3. Data Analysis

Univariate statistics were generated to describe the study population in terms of demographics, smoking and physical activity. Univariate estimates were generated with SAS 9.1.3 software.

2.3.1. Latent Growth Curve Modeling (LGCM)—Associated-processes LGCM were conducted to assess the longitudinal relations of repeated measures of negative and positive physical activity and smoking. LGCM is a Structural Equation Modeling (SEM) method that models repeated observed measures (measured variables) on factors (latent variables) representing random effects (η s) (Duncan and Duncan, 1995). A level factor is used to represent baseline level and trend factors are used to represent rate of change across time (i.e., each unit change in time is associated with a η change in a given process). Latent variables define the form of rate of change across time (e.g., linear, quadratic, cubic). Factor loadings (i.e., correlations between the observed and latent variables) are fixed to define baseline or level (factor loadings are restricted to equal 1 from the level/intercept factor to each observed measure) and trend. For a linear trend, the factor loadings are set so they increase uniformly with each unit increase in time (six months in the present study). In the present model, the factor loading from the linear trend factor to the first observed measure

was constrained to equal zero as the first observed measure is the baseline level. The second factor loading is constrained to equal one, indicating a unit increase in the rate of change in each process (i.e., negative physical activity, positive physical activity, and smoking) for a unit increase in time. The remaining factor loadings for the linear trend factor were constrained similarly to define a linear growth form (i.e., 2, 3, 4, 5, 6 and 7, for waves 3 through 8, respectively).

Associated processes LGCM is a multivariate method that allows testing paths among random effects (i.e., levels [η_0] and trends [$\eta_{1,2,\dots}$]) from two or more LGCMs (Duncan et al., 1999). A three-process associated processes LGCM was conducted in the present study to assess the impact of repeated observed measures of positive and negative physical activity (continuous variables) on smoking (ordered categorical variable). Specifically, we were interested in whether initial (baseline) levels of positive and negative physical activity affected smoking trend (smoking progression). We also controlled for the effects of baseline smoking on both positive and negative physical activity trends. Finally, smoking and positive and negative physical activity trends (residual variances) were naturally allowed to co-vary.

As smoking is a categorical variable, we estimated model parameters with a Weighted Least Squares estimation technique (WLSMV) in which the diagonal weight matrix uses robust standard errors, and the chi-square test statistic is Mean and Variance adjusted (Muthén and Muthén, 2004). Suggested criteria for model fit are non-significant model chi-square, CFI above .95, RMSEA below .05 –.08, and a WRMR value below .9 (Loehlin, 2004; Muthén, 2001). LGCM were conducted using *Mplus* version 7.11 software (Muthen and Muthen, 2012).

2.3.2. Missing Data—To account for missing data, multivariate modeling used all available data. *Mplus* allows modeling with missing data using maximum likelihood estimation of the mean, variance, and covariance parameters, when requested, using a Full Information Maximum Likelihood (FIML) estimating procedure which employs the Expectation Maximization (EM) algorithm, assuming data are missing at random (Muthén, 2004). However, this only accounts for missing data on the repeated measure of smoking, and positive and negative physical activity, not the covariates. Thus, cases with missing data on these variables were not included in the analysis. As such, the analyses were based on 1,356 participants after excluding those participants with missing data on the covariates.

3. RESULTS

3.1. Descriptive Statistics

Table 1 presents the frequency distributions for all categorical variables, and the means and standard deviations for the continuous model variables in all three models. Table 2 presents the univariate statistics for smoking, PPA and NPA. Twenty-one percent of adolescents progressed along the smoking uptake continuum across four years. The amount of positive physical activity (PPA) decreased significantly over the same time period from an average of 201.22 (SD=345.62) minutes a week at baseline to 113.62 (SD=246.19) at last follow up, $t\text{-test}_{(1066)}=8.19$, $p<.0001$. Similarly, the number of minutes of negative physical activity

(NPA) a week also decreased significantly from baseline ($M=416.56$, $SD=500.75$) to last follow up ($M=248.63$, $SD=379.00$), $t\text{-test}_{(1066)}=8.87$, $p<.0001$. The median number of minutes of PPA per week across the eight waves was 60, 64, 40, 45, 0, 20, 0, and 0. The median number of minutes of NPA per week across the eight waves was 210, 210, 155, 130, 120, 140, 90, and 120.

3.2. Multivariate Models

To determine the effects of negative and positive physical activity on adolescent smoking uptake, an associative processes model with three processes (positive and negative physical activity and smoking) was fit to the data, $X^2_{(480, 1356)} = 853.66$, $p<.0001$, CFI=.99, RMSEA=.02; (90% CI=.02, .03), WRMR=1.09. The non-standardized path coefficients, standard errors, z-statistic values, and p-values are presented in Table 3. We present the results for the effects of covariates on baseline smoking and smoking trend in terms of odds ratios to facilitate interpretation. Figure 1 presents the associated processes LGCM with standardized path coefficients for the significant path effects only.

3.2.1. Baseline Smoking—Baseline alcohol (OR=1.30, 95% CI=1.19, 1.41) and marijuana use (OR=1.33, 95% CI=1.22, 1.44) were both associated with an increased odds of smoking at baseline. Likewise, peer (OR=1.25, 95% CI=1.21, 1.29) and household smoking (OR=1.75, 95% CI=1.51, 2.02), and having parents with a high school education or less (OR=1.15, 95% CI=1.05, 1.26) were both associated with an increased odds of smoking at higher levels at baseline. By contrast, parental monitoring (OR=.96, 95% CI=.94, .99) and unstructured free time (OR=.90, 95% CI=.83, .97) were both associated with decreased odds of smoking at baseline.

3.2.2. Smoking Trend—To highlight the practical significance of our findings, we present the effects of baseline NPA and PPA on smoking progression in terms of 30-minute changes in each type of physical activity. Each 30-minute increase in NPA per week at baseline was associated with a 4-fold increase in the odds of smoking progression (OR=4.10, 95% CI=2.14, 7.83). By contrast, a 30-minute increase in baseline PPA was associated with a 51% decrease in the odds of smoking progression (OR=.49, 95% CI=.25, .93). Regarding the effects of covariates on smoking trend, being White was associated with a 6% increase in the odds of smoking progression (OR=1.06, 95% CI=1.01, 1.12), whereas baseline marijuana use (OR=.97, 95% CI=.94, .996) and parental monitoring (OR=.99, 95% CI=.98, .997) were both associated with decreased odds of smoking progression.

3.2.3. Baseline Positive Physical Activity (PPA)—Being female ($b=.23$, $z=1.98$, $p=.047$) and parental monitoring ($b=.05$, $z=2.33$, $p=.02$) were associated with higher levels of baseline PPA. In contrast, baseline marijuana use ($b=-.20$, $z=-2.40$, $p=.016$) and peer ($b=-.06$, $z=-2.08$, $p=.038$) and household ($b=-.60$, $z=-4.76$, $p<.0001$) smoking were negatively associated with baseline PPA.

3.2.4. Positive Physical Activity Trend—Baseline NPA was associated with an increased acceleration in PPA from baseline ($b=.06$, $z=4.65$, $p<.0001$). Baseline marijuana use was the only covariate significantly associated with PPA trend ($b=.05$, $z=2.03$, $p=.043$).

3.2.5. Baseline Negative Physical Activity (NPA)—Peer smoking ($b = .06$, $z = 2.60$, $p = .009$), parental monitoring ($b = .06$, $z = 3.30$, $p = .001$), and unstructured free time ($b = .14$, $z = 2.54$, $p = .01$) were each positively associated with NPA at baseline.

3.2.6. Negative Physical Activity Trend—Baseline PPA was associated with an increased acceleration in NPA over time ($b = .03$, $z = 2.99$, $p = .003$). Regarding the covariates, baseline marijuana use ($b = .04$, $z = 2.02$, $p = .04$) and being female ($b = .11$, $z = 4.29$, $p < .0001$) were each associated with increased acceleration in NPA over time. By contrast, impulsivity was associated with a decreased acceleration in NPA over time ($b = -.02$, $z = -2.76$, $p = .01$).

4. DISCUSSION

This is the first longitudinal study to show that some types of physical activity are associated with a decreased risk of adolescent smoking uptake, while other types of physical activity are associated with an increased risk of smoking uptake. Indeed, the findings indicated that adolescents with higher levels of NPA had four times the odds of smoking progression, while adolescents with higher levels of PPA were half as likely to progress along the smoking uptake continuum from mid to late adolescence. While both types of physical activity declined across time, NPA remained higher than PPA. These findings suggest that the types of physical activity that an adolescent engages in each week could be more important for cigarette smoking than simply the amount of physical activity. These associations warrant attention in planning interventions to increase overall physical activity and those promoting physical activity to prevent smoking uptake.

This study extends the epidemiological research showing an overall inverse relationship between the amount of physical activity and adolescent smoking uptake by parsing physical activity into those that are associated with a higher risk and those that are associated with a lower risk of adolescent smoking progression. A growing body of evidence provides a strong case for smoking prevention trials to evaluate whether physical activity interventions prevent adolescent smoking initiation and progression (Aveyard and Ussher, 2007). However, the types of physical activity that should be targeted to optimize their impact on smoking behavior have not been previously defined. Here, we show that PPA such as racquet sports, soccer, track and field, and aerobic activities (e.g., running, jogging, jumping rope, and swimming laps) are physical activities that should be promoted. These types of physical activity might lessen the likelihood of smoking through biological or social mechanisms (Audrain-McGovern et al., 2013; Audrain-McGovern et al., 2003b; Audrain-McGovern et al., 2006b; Melnick et al., 2001). PPA at age 14 was associated with fewer peers who smoke, less exposure to smoking in the household and greater parental monitoring, all of which support fewer smoking influences. Research in Norwegian youth has documented that participation in organized sport, regardless of whether it was team or endurance sport predicted a reduced likelihood of tobacco use (Wichstrom and Wichstrom, 2009). These findings add to the literature by suggesting that the physical activity may not necessarily need to be part of an organized sport framework to be beneficial, in so far as it is the type of physical activity that is not associated with smoking.

NPA are physical activities that may hinder efforts to prevent smoking. These include social and recreational dancing, skating (ice, roller, inline, and skateboarding), walking, using an exercise machine, bicycling, chores, fighting (karate, judo, boxing), and competitive wrestling. It is important to note that this relationship was significant even when we controlled for key smoking risk factors such as peer smoking, household smoking, substance use, impulsivity, and parental monitoring. NPA may be associated with an increased likelihood of smoking uptake because of the motivation behind engaging in the activity (e.g., transportation, weight loss) or the use of cigarettes to facilitate participation in a physical activity (e.g., using cigarettes to help meet weight cut-offs for wrestling). Certain motives for engaging in physical activity have been shown to predict smoking initiation (Rockafellow and Saules, 2006; Verkooijen et al., 2009). It is also plausible that both participation in NPA and smoking are due to common dispositional factors. For example, sensation or novelty-seeking behavioral style is associated with cigarette smoking (Audrain-McGovern et al., 2006a; Wilkinson et al., 2012) and involvement in physical activity with a greater level of risk (Jack and Ronan, 1998; Zuckerman, 1983). While our research has found that the reward or enjoyment derived from physical activity is an important mechanism by which physical activity is associated with a lower risk of smoking uptake (Audrain-McGovern et al., 2013), reward will need to be balanced with the type of activity to ensure benefit with respect to smoking.

The present study has several strengths. These strengths include a large sample of adolescents, eight measurement waves across four years, and the inclusion of important covariates. One potential limitation is that, we relied on self-reports of smoking. Biochemical verification of smoking status is not typically implemented in epidemiological studies as adolescent self-reports have been determined to be valid and sufficient, especially when confidentiality is assured (Velicer et al., 1992; Wills and Cleary, 1997). Further, the standard cotinine cutoff of 15 ng/ml cannot validate definitions of adolescent regular smoking (e.g., 1 cigarette in the past 30 days) (Dolcini et al., 2003). Also, as in previous epidemiological investigations of physical activity [e.g., (Kahn et al., 2008)], the outcome variable of physical activity was based on self-report. Assessing physical activity using objective measures such as accelerometry would have been difficult given the large sample size. The current public health recommendations for physical activity are based on decades of research linking self-reported physical activity with health outcomes (Haskell, 2012; USDHHS, 1996). Finally, the levels of physical activity reported in the present study are comparable to (Aaron et al., 2002) or greater than (Nader et al., 2008) previous studies that have reported minutes of MVPA. Nonetheless, our data are consistent with the epidemiological literature showing that, on average, adolescent physical activity declined across time.

5. CONCLUSIONS

The present study documents that some types of physical activity are associated with a lower likelihood of adolescent smoking uptake, whereas other types of physical activity are associated with a higher likelihood. As physical activity typically declines across adolescence, with less than one-third of adolescents meeting the recommended 60 minutes of physical activity every day (Kann et al., 2014), any type of physical activity may seem

beneficial for adolescent health outcomes. However, the present findings suggest that the type of activity matters for cigarette smoking. These relationships, although associative in nature, are important to consider in planning interventions to increase overall physical activity and those promoting physical activity to prevent smoking uptake.

Acknowledgements

Role of Funding Source

This study was supported by National Cancer Institute RO1 CA126958. The funding agency had no role in the design and conduct of the study, collection, management, analysis, and interpretation of the data or in the preparation, review or approval of the manuscript, or in the decision to submit the paper for publication.

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Highlights

- Some types of physical activity are associated with a lower likelihood of adolescent smoking uptake
- Other types of physical activity are associated with a higher likelihood of smoking uptake
- These associations may be important to consider in smoking prevention interventions

Figure 1. The association between positive and negative physical activity and adolescent smoking uptake
presents the associated processes LGCM with standardized path coefficients for the significant path effects only.

Table 1

Descriptive statistics

Variable	Level	N	%
Gender	Male	670	49
	Female	686	51
Race	White	1206	73
	Non-White	150	27
Household smoking	No household smoking	751	55
	Household smoking	605	45
Parental education	Both parents > High school education	802	59
	1 parent High school education	320	24
	Both parents High school education	234	17
Marijuana use	0 times	1235	91
	1 or 2 times	57	4
	3 or more times	64	5
Alcohol use	0 days	1037	76
	1 or 2 days	208	15
	3 to 30 days	111	9
Smoking progression	Progressed along continuum	284	21
		Mean	SD
Peers smoking		1.55	2.34
Impulsivity		8.00	1.43
Unstructured free time		1.77	.86
Parental monitoring		12.35	2.66

Table 2

Descriptive statistics for smoking, positive physical activity (PPA) and negative physical activity (NPA)

Variable	Level	Wave 1	Wave 8
		N (%)	N (%)
Smoking	Never smoked	964 (72)	666 (63)
	Smoked but not a whole cigarette	194 (14)	158 (15)
	Smoked but not in the past month	63 (5)	78 (7)
	Smoked in the past month	33 (2)	33 (3)
	Smokes weekly	32 (2)	21 (2)
	Smokes daily	60 (5)	105 (10)
		Mean (SD)	Mean (SD)
PPA	Minutes per week	201.22 (345.62)	113.63 (246.19)
NPA	Minutes per week	416.56 (500.75)	248.63 (379.00)

Table 3

Parameter estimates, standard errors (SE), test statistic, and p-values for regressions within the multivariate model.

	Smoking							
	Level				Trend			
	estimate	SE	Z	p-value	estimate	SE	Z	p-value
Baseline NPA level	-	-	-	-	0.047	0.011	4.285	<.0001
Baseline PPA level	-	-	-	-	-0.024	0.011	-2.265	0.024
White race	0.067	0.087	0.768	0.443	0.06	0.026	2.334	0.02
Alcohol use	0.26	0.042	6.219	<.0001	0.012	0.013	0.992	0.321
Marijuana use	0.283	0.043	6.578	<.0001	-0.031	0.014	-2.31	0.021
Female	0.021	0.073	0.285	0.776	0.014	0.019	0.737	0.461
Peers smoking	0.221	0.016	14.07	<.0001	-0.002	0.005	-0.358	0.72
Household smoking	0.56	0.074	7.57	<.0001	0.02	0.022	0.922	0.356
Parental monitoring	-0.035	0.013	-2.759	0.006	-0.011	0.004	-2.826	0.005
Unstructured free time	-0.108	0.039	-2.755	0.006	0.011	0.011	1.012	0.311
Impulsivity	0.041	0.027	1.497	0.134	0.006	0.007	0.807	0.42
Parent education	0.141	0.046	3.104	0.002	-0.008	0.012	-0.634	0.526
Positive Physical Activity (PPA)								
	Level				Trend			
	estimate	SE	Z	p-value	estimate	SE	Z	p-value
Baseline NPA level	-	-	-	-	0.061	0.013	4.654	<.0001
Baseline smoking	-	-	-	-	-0.024	0.018	-1.364	0.173
White race	0.226	0.131	1.725	0.085	-0.041	0.029	-1.419	0.156
Alcohol use	0.086	0.079	1.083	0.279	0	0.021	-0.006	0.995
Marijuana use	-0.202	0.084	-2.403	0.016	0.052	0.026	2.026	0.043
Female	0.23	0.116	1.985	0.047	-0.035	0.025	-1.373	0.17
Peers smoking	-0.058	0.028	-2.077	0.038	-0.001	0.008	-0.188	0.851
Household smoking	-0.596	0.125	-4.764	<.0001	0.035	0.029	1.23	0.219
Parental monitoring	0.051	0.022	2.333	0.02	0	0.005	0.004	0.996
Unstructured free time	-0.075	0.067	-1.12	0.263	-0.01	0.015	-0.641	0.521
Impulsivity	0.054	0.042	1.298	0.194	-0.016	0.009	-1.753	0.08
Parent education	-0.124	0.076	-1.629	0.103	-0.006	0.017	-0.349	0.727

	Negative Physical Activity (NPA)							
	Level				Trend			
	estimate	SE	Z	p-value	estimate	SE	Z	p-value
Baseline PPA level	-	-	-	-	0.034	0.012	2.987	0.003
Baseline smoking	-	-	-	-	0.016	0.016	1.01	0.312
White race	0.099	0.121	0.815	0.415	-0.054	0.028	-1.892	0.058
Alcohol use	0.015	0.072	0.202	0.84	-0.026	0.02	-1.29	0.197
Marijuana use	-0.134	0.075	-1.792	0.073	0.042	0.021	2.016	0.044
Female	-0.038	0.106	-0.358	0.72	0.112	0.026	4.294	<.0001
Peers smoking	0.062	0.024	2.603	0.009	-0.004	0.007	-0.502	0.616
Household smoking	0.2	0.109	1.828	0.068	0	0.027	0.016	0.987
Parental monitoring	0.065	0.02	3.301	0.001	-0.006	0.005	-1.188	0.235
Unstructured free time	0.144	0.057	2.541	0.011	0.005	0.014	0.349	0.727
Impulsivity	-0.022	0.039	-0.561	0.575	-0.025	0.009	-2.759	0.006
Parent education	0.073	0.068	1.063	0.288	0.005	0.017	0.315	0.752