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EXPLORING PATHWAYS TO SUBSTANCE USE: A LONGITUDINAL EXAMINATION OF ADOLESCENT SPORT INVOLVEMENT, AGGRESSION, AND PEER SUBSTANCE USE

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Abstract

The relationship between adolescent sport involvement and later substance use (SU) has been unclear. Understanding the pathways through which sport involvement influences SU may help identify targets for prevention. Using a sample of 535 adolescents from the Michigan Longitudinal Study (MLS; 67.29% male, 78.13% European American), this study prospectively examined whether aggression during late adolescence mediated the association between sport involvement during early adolescence and alcohol, marijuana, and cigarette use during early adulthood. In addition, perceived peer SU during early adolescence was tested as a potential moderator in the association between sport involvement on SU. High sport involvement was associated with more alcohol use. In contrast, the indirect effect of sport involvement on SU via aggression was significant for cigarette use, and marginally significant for marijuana use. Lastly, peer SU was a significant moderator in the cigarette model, indicating low peer SU was somewhat protective among high sport-involved adolescents. Prevention targeting alcohol use and associated consequences, as well as aggressive behaviors may help address future substance use.

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Author Contribution Statement

Julie Cristello: conceptualization, methodology, formal analysis, data curation, writing – original draft. Dr. Elisa Trucco: methodology, formal analysis, writing – review & editing, supervision. Dr. Robert Zucker: methodology, writing – review & editing.

Declarations of Interest

Declarations of interest: none.

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1. Introduction

Physical activity is an important component of adolescent health and wellness. In 2000, identifying ways to use physical activity to promote health among youth became a national priority (US Department of Health and Human Services & Department of Education, 2000). More recently, Michelle Obama developed an initiative to ensure students engage in physical activity ("Active Schools," 2013). For adolescents, sport involvement may be one avenue for physical activity (Moore & Werch, 2005). While sport involvement is associated with components of adolescent development (e.g., self-esteem, team-work skills, time management; Clark, Camiré, Wade, & Cairney, 2015; US Department of Health and Human Services & Department of Education, 2000) and academic performance (Fredricks & Eccles, 2006), prior research has also found assocations between sport involvement and substance use (SU; Kwan, Bobko, Faulkner, Donnelly, & Cairney, 2014; Lisha & Sussman, 2010). Yet, previous studies have not examined *why* there is an association or *for whom* this association exists. This study assesses possible pathways through which sport involvement impacts later alcohol, cigarette, and marijuana use. This study will examine whether aggression in late adolescence mediates the association between early adolescent sport involvement and SU in early adulthood and whether the association between sport involvement and SU differs by level of pereceived peer SU.

Sport involvement has been shown to increase alcohol use (Veliz, Boyd, & McCabe, 2015), and binge drinking (Terry-McElrath & O'Malley, 2011). While mechanisms have not been examined, researchers have hypothesized reasons, including perceived social norms of athletes (Dams-O'Connor, Martin, & Martens, 2007), coping with injuries (Veliz, Schulenberg, et al., 2017), and alcohol advertising during sporting events (Madden & Grube, 1994). Alcohol brands fund teams (Duff, 2005), and alcohol is the most advertised beverage during televised sporting events (Madden & Grube, 1994). Social learning theory suggests that learning occurs through observation, imitation, and modeling (Bandura, 1977). Given increased exposure to SU, it is not surprising that collegiate athletes believe others drink at higher rates than they do, which then predicts personal use (Dams-O'Connor et al., 2007).

In contrast, sport involvement has been shown to be protective against cigarette use (Kwan et al., 2014). Adolescent athletes are less likely to smoke cigarettes than non-athletes (Veliz, McCabe, McCabe, & Boyd, 2017). Cigarette smoking is typically viewed as deviant behavior (Lisha & Sussman, 2010) that can impact health. Therefore, cigarette use among adolescent athletes may be less normative as it can directly influence athletic performance (Lisha & Sussman, 2010).

Findings on the relationship between sport involvement and marijuana use have not been as consistent. The most common finding has been an inverse association between sport involvement and illicit drug use (Lisha & Sussman, 2010). While few studies have found a positive relationship between sport involvement and illicit drug use (Kwan et al., 2014), or

marijuana use specifically (Lisha & Sussman, 2010), others have found no relationship (Kwan et al., 2014). Other research has found that adolescents participating in high contact sports are more likely to use marijuana than those participating in noncontact sports (Veliz, Schulenberg, et al., 2017). Mixed findings may be due in part to a lack of differentiation between marijuana and other drugs (Kwan et al., 2014). Investigating marijuana use specifically will address these gaps.

Understanding mechanisms through which sport involvement impacts later SU could help identify targets for interventions among athletes (Kwan et al., 2014). One possible mediator is aggression. The frustration-aggression hypothesis suggests that among athletes, competition is a source of frustration that can prevent winning (a goal-directed response) from being achieved (Berkowitz, 1988). A result of frustration is aggression (Berkowitz, 1988). Thus, competition, which occurs during sporting events, is likely to cause aggression. Additionally, through instrumental learning, adolescents involved in sports learn to perform aggressive acts to achieve a goal, which are then reinforced through winning (Weiner, 1974). Athletes are often taught to use aggressive tactics during games (Sonderlund et al., 2014). For example, 28% of youth athletes believe “sending a message” to opponents is acceptable (Ferguson & Green, 2014). Sports that involve violent contact may normalize violence and risk (Bloom & Smith, 1996). Adolescents may view their body as something they can gamble with in order to win (Veliz, Schulenberg, et al., 2017). As such, there is evidence to support a high prevalence of on-field aggression among adolescent athletes (Sonderlund et al., 2014), which may lead to off-field aggression. Among male college athletes, participating in a team sport and hurting other athletes was associated with physical aggression in non-sport contexts (Nixon, 1997). Participation in a contact sport was associated with increased physical aggression for males and females (Nixon, 1997). Given this, aggression may be a possible mediator in the association between adolescent sport involvement and SU.

Dynamic cascade models (Dodge et al., 2009) are helpful in understanding why aggression may lead to subsequent SU. Namely, cascade models posit that there is a sequential progression from aggressive behavior early in life to more problematic behavior, like illicit drug use, later in life. Overall, aggression as a more reactive form of externalizing behavior diminishes in middle childhood and is replaced by a more planful form of externalizing behavior, such as SU (Tremblay & Szyf, 2010). Empirical studies confirm this sequence of behavior as aggression has been shown to predict SU initiation (Ernst et al., 2006) and frequency of use (Pulkkinen & Pitkänen, 1994). In a longitudinal study conducted with adolescents (Ernst et al., 2006), aggression predicted subsequent smoking status and marijuana use, but not alcohol use. In addition, compared to nonaggressive adolescents, research has found that aggressive adolescents were six times more likely to regularly drink and five times more likely to have tried illicit drugs (Wagner, 1996).

Furthermore, peer SU may influence the strength of the association between sport involvement and SU. Sport involvement could increase exposure to normative behaviors, or peer groups, that facilitate SU (Hughes & Coakley, 1991). Peer SU is one of the strongest predictors of adolescent SU (Oxford, Harachi, Catalano, & Abbott, 2001), as peers can provide access, opportunity, and reinforcement for SU behaviors (Kirke, 2004). This

potential moderator will help to determine which individuals may be most at risk for SU during early adulthood.

While much of this work occurs at the collegiate level, the present study will prospectively examine whether aggression during late adolescence mediates the association between amount of sport involvement during early adolescence on alcohol, cigarette, and marijuana use during early adulthood. This study will also examine whether the association between sport involvement and SU differs by level of peer SU. We hypothesized that high sport involvement would be associated with increased alcohol use, but decreased cigarette use. We hypothesized that aggression would mediate the association between sport involvement and SU whereby high sport involvement would predict greater aggression, and in turn high aggression would predict greater SU. Finally, we hypothesized that the association between sport involvement and later SU would be stronger among adolescents with peers that use. Since few studies have examined marijuana use, specific hypotheses were not made for this substance.

2. Methods

2.1. Participants

Participants were youth enrolled in the Michigan Longitudinal Study (MLS), a prospective study examining the development of SU disorders (SUDs) among high-risk families. For a full description of the MLS methods, see Zucker et al., 2000. The MLS has maintained an 89% retention rate since beginning recruitment in 1985. Families consisted of three SU risk categories. High risk families had fathers convicted of drunk driving with a high blood alcohol concentration, and an alcohol use disorder (AUD; 23.18%). Moderate risk families were community-identified fathers with an AUD diagnosis, but no drunk driving offense (40.37%). Low risk families were a control sample of families from similar neighborhoods (36.45%). The recruitment protocol also required the father to be living with a 3–5-year-old son (the male target child) and the boy's biological mother. Due to the original recruitment protocol, the sample was largely male (n=360, 67.29%) and European American (n=418, 78.13%; 10.09% African American, 6.92% White Hispanic, 4.86% Biracial).

2.2. Procedure

Youth, parents, and teachers completed assessments following enrollment (Wave 1, ages 3 to 5) with follow-up assessments occurring every three years. Reporters also completed annual assessments beginning at age 11. Informed consent was obtained from parents and teachers, as well as assent from youth participants. For this study, analyses were conducted on measures from wave 2 (ages 6 to 8), wave 3 (ages 9 to 11), wave 4 (ages 12 to 14), wave 5 (ages 15 to 17), and wave 6 (ages 18 to 20). Analyses focused on participants with available sport involvement data at wave 4 (n=535). Youth with available sport data significantly differed by sex (χ^2=4.46, $p < .05$), family AUD-risk status (χ^2=7.08, $p < .01$), and lifetime SU (χ^2=76.58, $p < .01$) from the

larger sample. Specifically, those with available sports data were more likely to be female, come from a low-risk family, and report less lifetime SU. The Institutional Review Board where this study took place approved study procedures.

2.3. Measures

2.3.1. Sport Involvement.—Sport involvement was assessed at wave 4 (ages 12 to 14) using Acenbach's Youth Self-Report (Achenbach, 1991). Participants listed sports in which they take part. Level of sport involvement was defined by the number of sports listed (range 0 to 6).

2.3.2. Peer SU.—Involvement with peers that use substances at wave 4 (ages 12 to 14) and annual assessments conducted at ages 12, 13, and 14 was measured with the Peer Behavior Profile (Hirschi, 1969). Participants were asked how many of their peers engage in specific activities, including SU. Using a fourteen-item subscale, participants reported the proportion (0 = *almost none* to 5 = *nearly all)* of their friends that use alcohol, drugs, or cigarettes. The score reflects the mean value across assessments. The internal consistency was high (Cronbach's alpha=0.96).

2.3.3. Aggression.—In order to minimize shared method variance, aggressive behavior at wave 5 (ages 15 to 17) and annual assessments conducted at ages 15, 16 and 17 was assessed using Achenbach's Teacher Report Form (Achenbach, 1991). The subscale is based on 25 items (e.g., "argues," "mean to others"), that are rated on a 3-point Likert scale (0 = *not true* to 2 = *very true or often true).* The score reflects the mean value across assessments. The internal consistency was high (Cronbach's alpha=0.95).

2.3.4. SU.—SU was assessed at wave 6 (ages 18 to 20), and annual assessments conducted at ages 18, 19, and 20 using the Drinking and Drug History Form (Zucker, Fitzgerald, & Noll, 1990). A mean for each substance across the four assessments was derived. Alcohol use was assessed with a single item capturing the number of days the participant used per month during the past six months. Past month cigarette use was assessed with a single item (0 = *not at all* to 6 = *two packs or more per day).* Past month marijuana use was assessed with a single item (0 = *never* to 9 = 500 times and above).

2.3.5. Covariates.—Biological sex (0=girls, 1=boys) and race were included as covariates, as aggression and SU can vary across these variables (Chen & Jacobson, 2012). Family AUD-risk status was also included, as youth of parents with an SUD are at higher risk for SU (Barnow, Schuckit, Lucht, John, & Freyberger, 2002). Consistent with prior research (Trucco et al., 2016), "moderate" and "high-risk" families were combined to form a dichotomous variable (i.e., low [0] vs. moderate or high risk [1]). Lifetime SU was also included as a covariate, as prior use can influence future use (Hall & Degenhardt, 2007). Lifetime SU was calculated using data from wave 4 (ages 12 to 14), and annual assessments conducted at ages 12, 13, and 14. Lastly, a mean of teacher-reported childhood aggression from waves 2 and 3 (ages 6 to 11) was included as a covariate, as aggression may impact an adolescent's decision to play sports.

2.4. Data Analysis

Structural equation modeling (SEM) using *Mplus* 8.1 (Muthén & Muthén, 2017) was used to estimate path models examining whether aggression mediated the association between sport involvement and SU. Separate models were tested for alcohol, cigarettes, and marijuana, and direct and indirect effects were examined. Covariances were added between exogenous variables. Lastly, models were conducted that included peer SU as a potential moderator of the direct path between level of sport involvement and SU (see Figure 1 for conceptual model). Study variables were standardized to minimize multicollinearity when estimating the interaction term. Cohen and Cohen's (Cohen & Cohen, 1983) recommended guideline of using values corresponding to one standard deviation above and below the sample mean was used to probe significant interactions. Study variables were all normally distributed, except for lifetime SU (skewness=4.52, kurtosis=23.51), adolescent aggression (skewness=3.92, kurtosis=24.82), and peer SU (skewness=4.10, kurtosis=19.55). Thus, maximum likelihood parameter estimates with robust standard errors (MLR) were calculated to account for non-normality. In terms of testing mediation, there are multiple ways to assess indirect effects in *Mplus,* including the product-of-coefficients approach using the IND command and calculating bias-corrected bootstrap confidence intervals (BBCIs), which is more robust (Preacher & Hayes, 2008). However, in *Mplus* it is not possible to estimate BBCIs when using MLR. Therefore, indirect effects using the IND command and MLR estimation were compared to BBCIs. Although results provided similar results, path estimates are presented using MLR while indirect effects reflect BBCIs.

3. Results

Table 1 includes descriptive statistics and correlations for study variables. Of interest, sex was correlated with all SU variables whereby boys reported significantly more alcohol, cigarette, and marijuana use. Sport involvement was only associated with alcohol use, and aggression was only associated with cigarette and marijuana use.

In the first model, we tested the prospective association between sport involvement and alcohol use via teacher-reported aggression. This model accounted for 10% of the variance in the frequency of alcohol use (see Figure 2, Panel A). There was a direct effect of sport involvement on alcohol use ($p < .001$), such that high sport involvement was associated with more alcohol use. Sport involvement as a predictor of aggression was marginally significant ($p = 0.058$), while aggression did not predict alcohol use. Thus, the indirect effect was not significant.

In the second model, we tested the prospective association between sport involvement and cigarette use via teacher-reported aggression. This model accounted for approximately 25% of the variance in the frequency of cigarette use (see Figure 2, Panel B). The direct effect was not significant. From a statistical perspective, a direct effect between the independent variable and the outcome is not necessary to establish indirect effects (Hayes, 2009). In fact, there was support for the hypothesized mediational pathway. High sport involvement significantly predicted high teacher-reported aggression ($p < 0.05$). In turn, high aggression predicted more cigarette use ($p < 0.01$). The indirect effect using BBCIs was significant (estimate = 0.029, 95% CI [0.001, 0.079]).

In the third model, we tested the prospective association between sport involvement and marijuana use via teacher-reported aggression. This model accounted for approximately 21% of the variance in the frequency of marijuana use (see Figure 2, Panel C). The direct effect was not significant. Sport involvement as a predictor of aggression was marginally significant ($p = .051$). In turn, high aggression predicted more marijuana use ($p < 0.05$). Yet, the indirect effect did not meet the cutoff for statistical significance (estimate = 0.025, 95% CI [−0.002, 0.081]).

Lastly, we included peer SU as a moderator of the direct pathway between sport involvement and SU. There was no evidence of a two-way interaction (sport involvement x peer SU) for the alcohol and marijauna models. However, the interaction term was significant ($p < 0.01$) in the cigarette use model. To facilitate interpretation, the simple slopes were probed and plotted (Figure 3). Findings indicate that high peer SU may be a risk factor for cigarette use regardless of sport involvement. In contrast, low peer SU may be a protective factor among youth involved in sports. That is, youth involved in sports that also affiliate with peers low in SU have the lowest rates of cigarette use. It is important to note that the simple slope of sport involvement was not statistically significant at high (b=0.05, p=0.52) or low levels of peer SU (b=−0.14, p=0.19).

4. Discussion and Conclusions

Consistent with prior research (Kwan et al., 2014; Lisha & Sussman, 2010), high sport involvement was directly associated with alcohol use. Other pathways not assessed, such as social norms, may explain this association. Social norms theory suggests individuals overestimate the amount of alcohol peers consume, which influences individual use (Prentice & Miller, 1993). Student athletes usually overestimate peer alcohol use, which then predicts personal use (Dams-O'Connor et al., 2007). Consequently, student athletes report consuming almost double the amount of alcohol as non-athletes (Leichliter, Meilman, Presley, & Cashin, 1998), and are more likely to binge drink (Terry-McElrath & O'Malley, 2011). Media images promoting use and advertising at sporting events (Lisha & Sussman, 2010; Madden & Grube, 1994) are likely reinforcing this relationship (Moore & Werch, 2005).

While the consequences of alcohol use are less immediate, cigarette use can quickly impact athletic performance (Lisha & Sussman, 2010). Thus, it is likely that cigarette use is not normative among adolescent athletes. This may explain the lack of a direct effect between sport involvement and cigarette use. Similarly, there was not a direct effect between sport involvement and marijuana use. Marijuana use is typically viewed as a more deviant behavior compared to alcohol use (Kaplan, Martin, Johnson, & Robbins, 1986), and can cause respiratory problems (Moore, Augustson, Moser, & Budney, 2005). Given this, marijuana use may not be normative in the sports context. Increased sport involvement, however, was associated with increased aggression. In turn, aggression, a risk factor for SU (Ernst et al., 2006), was associated with later cigarette use. This is in line with dynamic cascade models, which suggest that externalizing behavior in childhood and adolescence, including aggression, can lead to problematic behaviors, like SU, in adulthood (Dodge et al., 2009).

There was only support of peer SU as a moderator in the association between sport involvement and cigarette use. Findings indicate that low peer SU is likely protective for those highly involved in sports. Among those highly involved in sports, low peer SU may not provide the same opportunities to use compared to youth with high peer SU. Cigarette use among peers of adolescents highly involved in sports may be less normative due to negative outcome expectancies (e.g., smoking will impact my breathing) that can influence athletic performance.

The current study provides a greater understanding of the pathways through which sport involvement influences SU using multiple reporters. Despite this, there are limitations. The sample demographic was predominantly White and male. Since rates of SU are higher among males (Johnston et al., 2018), these results may not generalize. Future work should examine whether sex moderates these associations, and obtain a more diverse sample. Testing sex as a potential moderator in this study was not possible given the relatively low (~33%) percentage of girls in the sample. While a strength of the study is the prospective design, there are other factors that could have influenced SU, as there are three years between assessments. While this study focuses on an externalizing pathway (i.e., aggression), more longitudinal work is needed to assess other behaviors (e.g., internalizing) or pathways that may explain this association. Future work may examine social norms theory, which may be particularly true for student athletes.

Additionally, adolescent SU trends during the timeframe the study was conducted (1985–2007) may not represent current trends. Study replication may clarify how trends impact this association. Also, sport participation was assessed at ages 12–14. Since team sports are more developed and competitive in high school, a different set of relationships may exist at a later time point. Lastly, there are limitations to the measures used. Sport involvement did not account for level of contact, type of sport, or level. As researchers continue to examine the association between sport involvement and SU, a standardized measure should be developed to properly assess sport involvement (Kwan et al., 2014). Moreover, while this study assesses peer SU, it is unclear whether peers were also athletes. Future work should identify whether one's peers are athletes, as they may be influenced by social norms in this context.

Despite these limitations, this work extends prior work on the impact that adolescent sport involvement has on SU in early adulthood. The pathways between sport involvement and SU differ by substance, providing target risk factors that may prevent later use. However, many prevention programs for athletes occur at the collegiate level (Grossman, Gieck, Fang, & Freedman, 1993). For high school athletes, prevention programs focus primarily on steroids and nutrition (Elliot & Goldberg, 2012; Goldberg et al., 1996). This study highlights the need for programs that address alcohol, cigarette, and marijuana use. The team environment can be an effective way to intervene (Goldberg & Elliot, 2005). Education on alcohol use and associated consequences may help address future use, while interventions targeting aggressive behaviors may prevent future cigarette use.

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Highlights

- We examined the pathways between adolescent sport involvement and substance use.
- High sport involvement was associated with increased alcohol use.
- Sport involvement on substance use via aggression was significant for cigarette use.
- Targeting alcohol use and aggressive behaviors may reduce substance use for athletes.

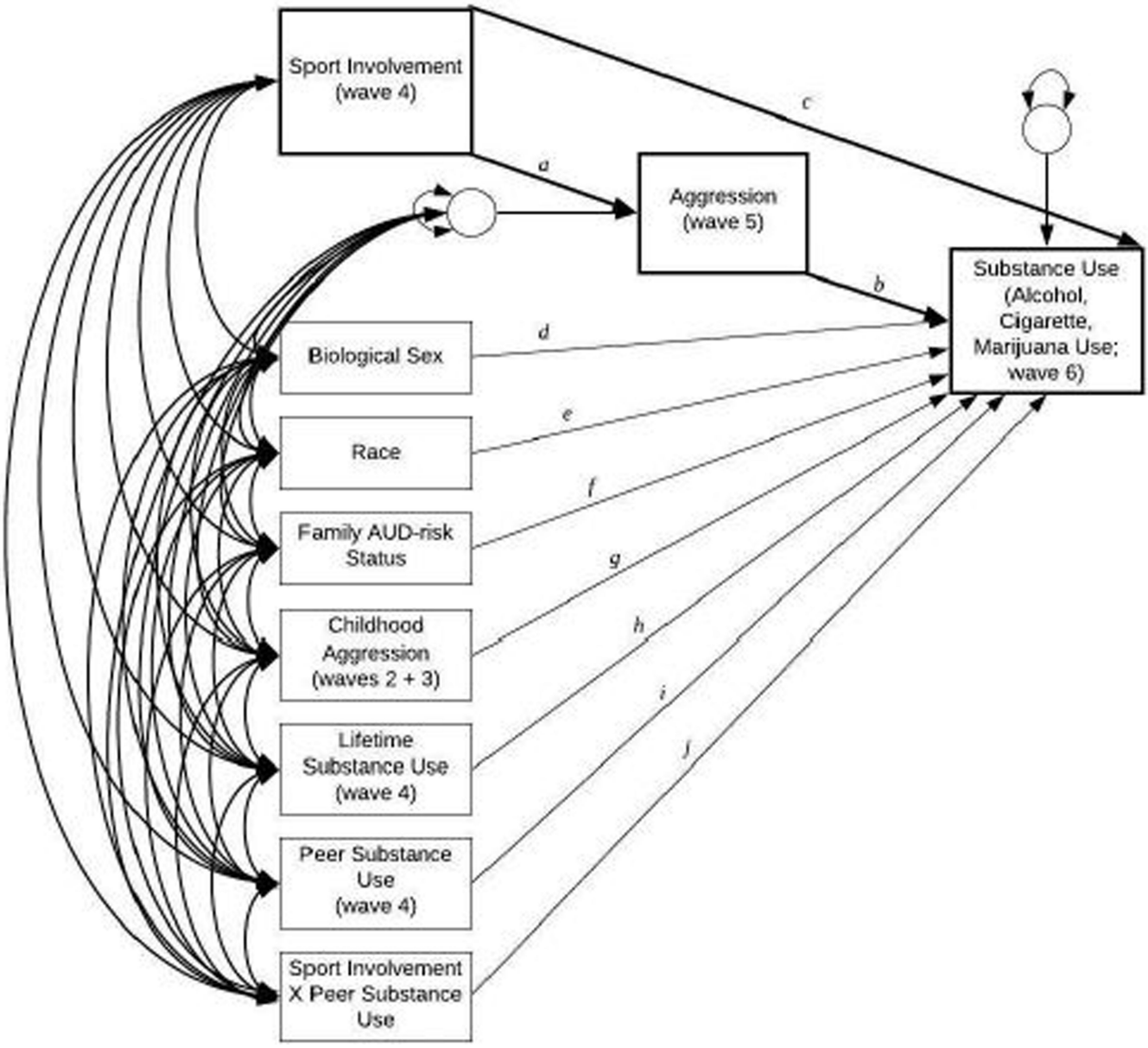

Figure 1.

Proposed model for substance use (alcohol, cigarette, and marijuana use). First-order effects model: Only main effects on the mediator and outcome variables (i.e, paths *a, b,* and *c*). Moderation model: sport involvement x peer substance use (i.e, first order model plus paths *i* and *j*). All models were just-identified.

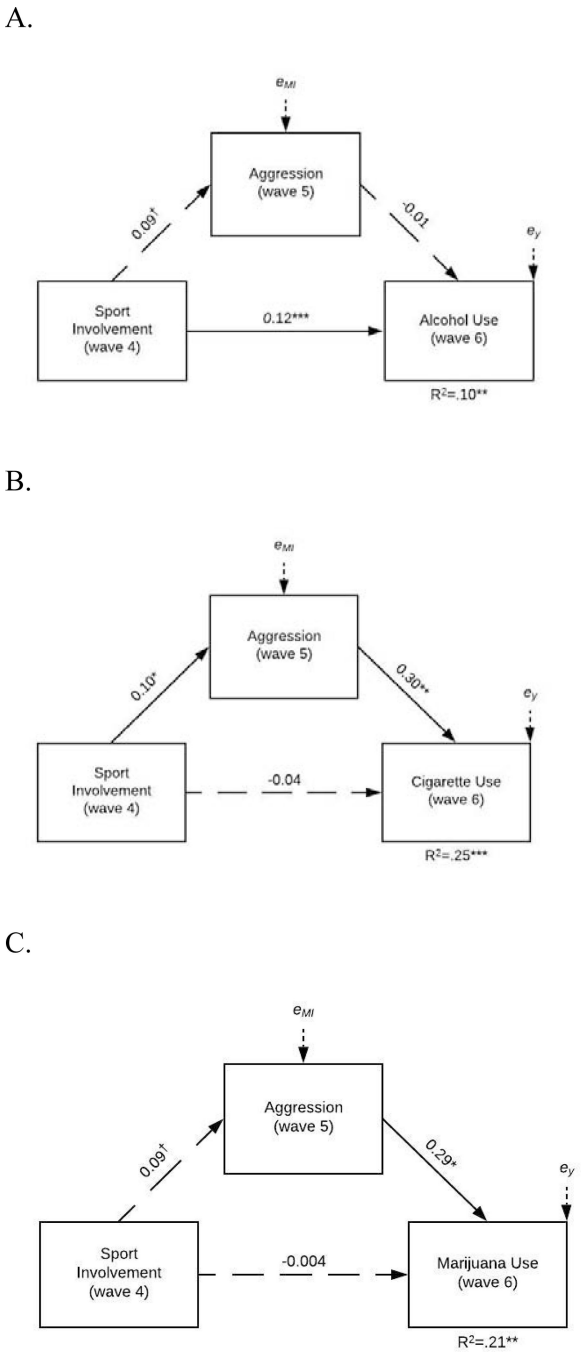

Figure 2.

Path models for alcohol, cigarette, and marijuana use. Values represent standardized path coefficients, and standard errors. Significant paths ($p < .05$) are presented with a solid line; * $p < .05$, ** $p < .01$, *** $p < .001$, † indicates a marginal association ($p < .06$). Covariates and covariances are not depicted. Panel A includes alcohol use as the outcome, Panel B includes cigarette use as the outcome, and Panel C includes marijuana use as the outcome. All models were just-identified; thus, model fit indices are not provided.

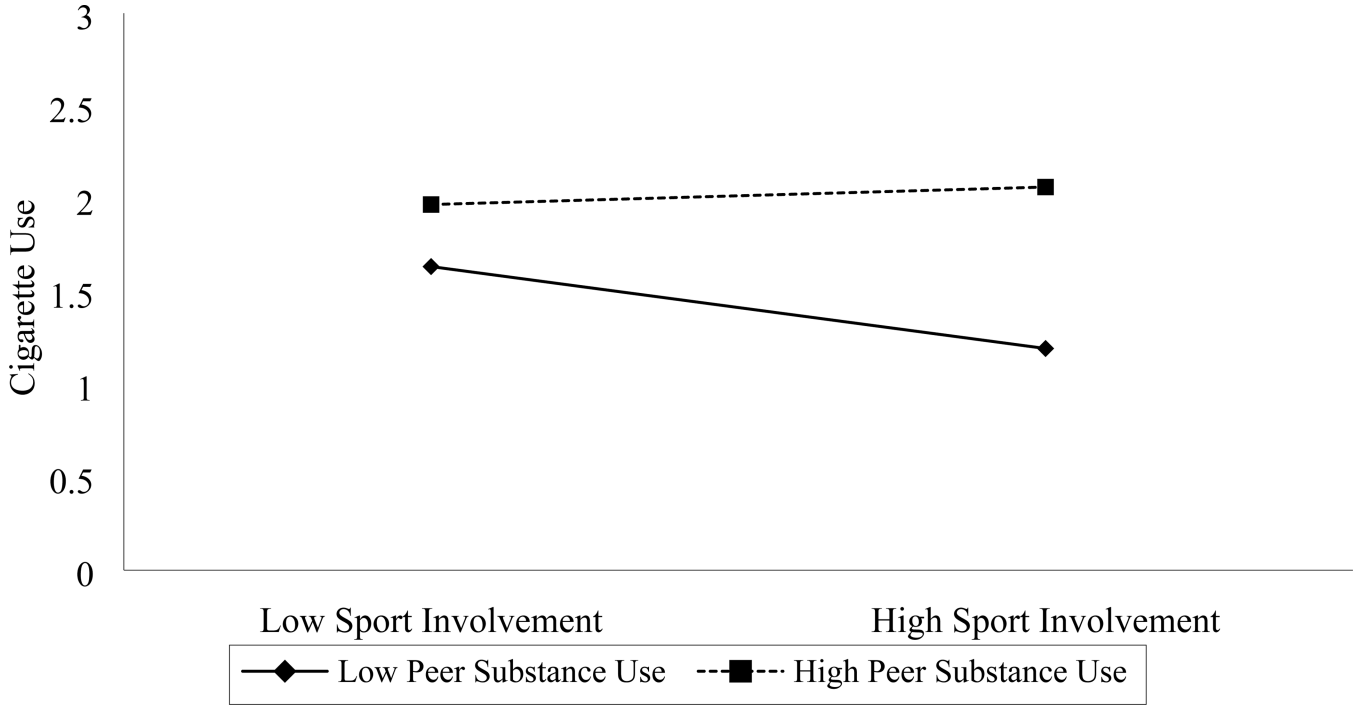

Figure 3.
Simple slopes of cigarette use regressed on sport involvement, at different levels of peer SU (i.e., one standard deviation above and below the mean).

Table 1.

Means, standard deviations, and correlations of study variables

	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Biological sex	0.67	0.47										
2. Family AUD-risk status	0.64	0.48	−0.08									
3. Race	2.32	3.38	−0.07	**0.13**								
4. Lifetime SU (wave 4)	0.61	1.80	0.02	**0.17**	−0.02							
5. Prior aggression (waves 2 + 3)	53.84	5.86	0.02	**0.12**	0.04	**0.17**						
6. Sport involvement (wave 4)	2.48	0.91	0.03	−0.01	**−0.10**	−0.02	−0.04					
7. Peer SU (wave 4)	1.16	0.38	−0.05	**0.13**	0.04	**0.55**	**0.13**	−0.06				
8. Aggression (wave 5)	52.43	5.00	−0.05	**0.19**	**0.24**	**0.20**	**0.23**	0.05	**0.21**			
9. Alcohol use (wave 6)	3.10	4.12	**0.12**	0.08	**−0.14**	**0.22**	0.03	**0.16**	**0.14**	0.02		
10. Cigarette use (wave 6)	1.63	1.55	**0.15**	**0.24**	−0.13	**0.31**	**0.18**	0.03	**0.28**	**0.30**	**0.08**	
11. Marijuana use (wave 6)	2.16	2.33	**0.15**	0.04	0.07	**0.21**	**0.33**	0.01	**0.25**	**0.30**	**0.20**	**0.29**

Note: Biological sex (0 = girls, 1 = boys); Family AUD-risk status (0 = low , 1 = moderate and high) ; SD=standard deviation; bold values = significant correlations ($p < .05$).