Team Sport Participation and Smoking: Analysis with General Growth Mixture Modeling

Daniel Rodriguez, PhD, and Janet Audrain-McGovern, PhD
University of Pennsylvania

Objective To assess the likelihood of smoking among adolescents with different patterns of team sport participation, grades 9–11. **Methods** Adolescents (N = 1,098) participating in a longitudinal study of the biobehavioral predictors of smoking adoption completed items assessing various health-related behaviors, including team sport participation and smoking practices. General growth mixture modeling (GGMM) was used to analyze the data. **Results** Four patterns of team sport participation were found. Adolescents with decreasing or erratic participation were nearly three times more likely than adolescents with high participation to be current smokers in eleventh grade. Nonwhites were at particular risk for decreasing and erratic patterns of participation, and later smoking. Females were at high risk for low team participation. **Conclusion** Results suggest that multiple patterns of team sport participation can be identified with GGMM and that these patterns may be useful in characterizing individuals at particular risk for future smoking.

Key words smoking; sport; trajectories; adolescent; gender.

Physical activity may be a protective factor in the prevention of adolescent smoking. In general, research has found a negative relationship between physical activity and cigarette smoking in adolescents, indicating that adolescents who participate in greater levels of physical activity are less likely to smoke, or they smoke fewer cigarettes (Aaron et al., 1995; Abrams, Skolnik, & Diamond, 1999; Coulson, Eiser, & Eiser, 1997; Pate, Heath, Dowda, & Trost, 1996; Thorlindsson & Vilhjalmsson, 1991). Because most smokers start smoking prior to age 18 (Kessler et al., 1997) and the critical period for experimentation with tobacco and development of regular smoking spans early to late adolescence (Botvin & Botvin, 1992), a thorough understanding of factors that may influence smoking behavior, like physical activity, is key to smoking prevention and intervention efforts.

Research suggests that team sport participation is one form of physical activity that may protect against adolescent smoking (Davis et al., 1997; Melnick, Miller, Sabo, Farrell, & Barnes, 2001; Peretti-Watel, Beck, & Legleye, 2002; Rainey, McKeown, Sargent, & Valois, 1996; Thorlindsson & Vilhjalmsson, 1991). The results of these cross-sectional studies reveal that greater sport participation is associated with a reduced likelihood or rate of smoking. However, cross-sectional methods reveal little about the effects of intraindividual change in team sport participation on smoking, interindividual differences in participation patterns, and the longitudinal patterns of team sport participation associated with the greatest risk for smoking.

In the present study, we sought to address this gap in the literature by assessing the relationship between change in team sport participation from ninth through eleventh grade, and eleventh-grade smoking status. We employed general growth mixture modeling (GGMM) as our method, since it allowed us to assess within-participant change in team sport participation, classify participants into specific participation patterns (trajectories), characterize trajectory membership on select

All correspondence should be sent to Daniel Rodriguez, Department of Psychiatry, University of Pennsylvania, 3535 Market Street, Suite 4100, Philadelphia, Pennsylvania 19104. E-mail: drodrig2@mail.med.upenn.edu.

Journal of Pediatric Psychology 29(4) pp. 299–308, 2004
DOI: 10.1093/jpepsy/jsh031

covariates, and estimate the likelihood of eleventh-grade smoking for members of each trajectory (Muthén & Muthén, 2002). We chose eleventh-grade smoking status because research has shown that most smokers start smoking before the age of 18 (Kessler et al., 1997).

We hypothesized that at least four trajectories of team sport participation would be found: low, high, decreasing, and increasing. Further, we hypothesized that eleventh-grade smoking level would be significantly higher among adolescents reporting low or decreasing participation than among those with high or increasing participation. The identification of trajectories of team sport participation, and the characterization of trajectory membership, would facilitate research efforts to better understand the mechanisms by which team sport participation affects smoking, and inform intervention and prevention efforts by identifying adolescents at particular risk for smoking. This is the first study to our knowledge to assess longitudinal team sport participation, attempt to classify participation patterns, and characterize trajectories of participation with respect to smoking.

Methods

Participants and Procedures

Participants were high school students (52% female) taking part in a longitudinal study of the biobehavioral predictors of adolescent smoking adoption. Participants were enrolled in five public high schools in northern Virginia. The racial distribution of the sample was 63% caucasian, 12% Hispanic, 11% Asian, 8% African American, and 6% other. The cohort was formed in the ninth grade and was followed until the end of the twelfth grade. Four data collection waves have been completed and comprise these analyses: ninth grade, spring 2000; tenth grade, fall 2000 and spring 2001; eleventh grade, spring 2002.

A total of 2,120 (89%) students were eligible to participate in this study. Of the parents of these students, 1,533 (72%) provided a response, of whom 1,151 (75%) consented to their teen's participation in the study, yielding an overall consent rate of 54%. Analysis for differences between parents who did and did not consent revealed a Race × Education interaction, indicating that the likelihood of consent was over twice as great for caucasian parents with more than a high school education than for caucasian parents with a high school education or less (Audrain, Tercyak, Goldman, & Bush, 2002).

Data were collected on site, during a class common to all students (e.g., health, science, history). A member of the research team distributed the survey. The completed survey contained only a numeral for identification. A member of the research team read aloud a set of instructions, emphasizing confidentiality to promote honest responding, and encouraged questions if survey items were not clear. Surveys took about 30 minutes to complete. Make-up sessions were held in the library for students absent during survey administration.

The following analyses used all available data for the dependent variable team sport participation (1,136 participants). However, there were missing data on the covariates for gender, race, baseline smoking, alcohol use, physical activity, extracurricular activity, and depressive symptoms, resulting in a final sample size of 1,098 participants for analysis. Differences between those with and without missing data on any covariate revealed significant differences for race, $\chi^2(1, N = 1{,}136) = 13.52$, $p < .001$. Non-caucasians were disproportionately overrepresented in the missing group, resulting in 62% of missing data, while accounting for only 37% of the sample. There were no other significant differences between those with and without missing data on any of the remaining covariates.

Measures

Demographics. Demographic variables assessed included gender and race.

Extracurricular Activity. Baseline extracurricular activity was assessed summing two items representing level of activity in school. Scores could range from 2 to 10.

Lifetime Alcohol Use. Baseline alcohol use was assessed with an item that asked, "During your life, on how many days have you had at least one drink of alcohol?" (*0 days* versus *else*).

Depressive Symptoms. Baseline depressive symptoms were assessed using the Center for Epidemiological Studies–Depression (CES-D) inventory. The CES-D is a 20-item self-report measure of depressive symptoms (Radloff, 1977). Scores can range from 0 to 60.

Physical Activity. Baseline physical activity was assessed with three items that measured intensity, duration, and frequency. Scores could range from 0 to 21.

Smoking Practices. Ninth- and eleventh-grade smoking practices were assessed with a three-level ordered-categorical variable representing increasing levels of smoking. The variable was generated from responses to a series of standard epidemiological questions regarding smoking (Kann et al., 1998). The three ordered categories

were: 1 = never smoker; 2 = experimenter (having smoked at least part of a whole cigarette but not having smoked within the last 30 days, or having smoked a whole cigarette and having smoked within the last 30 days but fewer than 100 cigarettes total in a lifetime); 3 = current smoker (smoked within the last 30 days and more than 100 cigarettes in a lifetime or at least 20 days, or smoked within the last 30 days and more than 100 cigarettes in a lifetime). Adolescents who smoked about 100 cigarettes in a lifetime but who have not smoked in the last 30 days are classified as experimenters.

Team Sport Participation. Team participation was assessed with a single 4-point scale item that requested the individual to give the number of teams on which he/she played during the past 12 months, including those run by the school or a community group, with 1 = no team participation and 4 = three or more teams.

All measures, with the exception of the CES-D, extracurricular activities, and demographic measures, were derived from standard epidemiological items employed in the Youth Risk Behavior Survey (Kann et al., 1998). We chose this set of covariates because of their association with smoking and team sport participation (Choi, Pierce, Gilpin, Farkas, & Berry, 1997; Kaplan et al., 2003; Kimm et al., 2002; Thorlindsson & Vilhjalmsson, 1991).

Statistical Analysis

General Growth Mixture Modeling

The data were analyzed using GGMM. In growth mixture modeling (GMM), a mixture of latent growth trajectory classes is hypothesized and tested (White, Pandina, & Chen, 2002). GMM estimates trajectory shapes, provides trajectory classification probabilities for each participant, classifies individuals in their most likely class based on these posterior probabilities, and allows regression of class membership on empirically derived covariates (Muthén & Muthén, 2002; Muthén & Shedden, 1999). GGMM is a special case of GMM, in which the probability of a distal outcome (e.g., eleventh-grade smoking) is estimated for each participant.

The optimal number of trajectories was determined by assessing selected fit indices, along with substantive theory. Although there is no agreed-upon fit index, the Bayesian information criterion (BIC) is suggested (Muthén et al., 2002; Muthén & Muthén, 2002; White et al., 2002). Low BIC values reflect model parsimony, favoring a high log likelihood estimate along with a low number of parameters (Muthén, 2002). A second useful index is the correct classification of individuals into their most likely trajectory. An *entropy* summary statistic is available to assess classification quality, with values ranging from 0 to 1, and values closer to 1 representing good classification quality (Muthén & Muthén, 2002; see also Muthén et al., 2002). All analyses were conducted with M*plus* software (Muthén & Muthén, 2001).

Results

Descriptive Statistics

Consistent with national statistics (Grunbaum et al., 2002), there was an overall increase in smoking from baseline to the eleventh grade, $\chi^2(4, N = 1{,}089) = 604.95$, $p < .0001$. A total of 8 participants decreased smoking level between the two time points, from current smoker to experimenter. Also consistent with national statistics (Grunbaum et al., 2002), overall team sport participation decreased significantly from grade 9 through 11 ($p < .05$).

Measurement Model

A single-trajectory latent growth model (LGM) for team sport participation fit the data well, $\chi^2(4, N = 1{,}140) = 7.56$, $p > .05$, comparative fit index = 1.00, root-mean-square error of approximation = .03. Consistent with the mean team participation values at the four waves, there was an overall significant decrease in participation across time indicated by a significant and negative linear trend (slope) value ($\beta_1 = -.01$, $z = -8.86$, $p < .0001$). Variances for intercept ($z = 19.02$, $p < .0001$) and trend ($z = 4.00$, $p < .0001$) were also significant, indicating variability in team sport participation baseline and trend. Analysis of the single-trajectory model for gender and race differences revealed that males ($\gamma_1 = -.25$, $z = -3.92$, $p < .0001$) and caucasians ($\gamma_2 = .69$, $z = -10.51$, $p < .0001$) were significantly higher on baseline team sport participation, whereas non-caucasians ($\gamma_1 = -.01$, $z = -2.65$, $p < .05$) exhibited greater longitudinal (trend) team participation. There was no significant difference for gender on team participation trend ($p > .05$).

Missing Data Analysis

To assess the effects of missing data, we regressed the intercept and trend factors on missingness (0 = no missing data on at least one covariate, 1 = missing data on at least one covariate), race, and the interaction of Race × Missingness. Race and its interaction with missingness were included because we found race differences in missing data on our covariates. The interaction was not significant ($p > .05$).

Table I. Correlations Among Independent Variables and Class Probabilities

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Gender[a]	_										
2. Race[b]	−.01	_									
3. Smoke, grade 9[c]	−.05	−.09***	_								
4. Smoke, grade 11[c]	−.06	−.11**	.63*	_							
5. Alcohol, grade 9[d]	−.02	.04	.38*	.34*	_						
6. PA, grade 9	−.15*	.14*	.06****	.06****	.11**	_					
7. CES–D, grade 9	.13*	−.06****	.14*	.12*	.09**	−.11**	_				
Team sport participation[e]											
8. Erratic	−.01	−.07***	.05	.04	.05	−.01	.00	_			
9. Decrease	−.08***	−.06****	.07***	.11**	−.03	.06****	.01	−.13*	_		
10. High	−.10***	.29*	−.08***	−.06****	.11**	.32*	−.13*	−.20*	−.29*	_	
11. Low	.15*	−.22*	.00	−.02	−.11**	−.35*	.12*	−.20*	−.30*	−.71*	_
Mean	.52	.63	.45	.71	.49	10.49	13.86	.08	.13	.40	.39
SD	.50	.48	.60	.75	.50	5.05	9.11	.23	.31	.47	.47

PA = physical activity; CES–D = Center for Epidemiological Studies–Depression inventory.

[a] 0 = male, 1 = female.

[b] 0 = nonwhite, 1 = white.

[c] 1 = never smoker, 2 = experimenter, 3 = current smoker.

[d] 0 = zero days, 1 = else.

[e] Values associated with the trajectories *erratic, decrease, high*, and *low* are probabilities of trajectory membership.

* $p < .0001$; ** $p < .001$; *** $p < .01$; **** $p < .05$.

Trajectories of Team Sport Participation

A total of four models were tested, beginning with a two-trajectory model, to determine the optimal number of trajectories of team sport participation. The BIC value was highest in the two-trajectory model (BIC = 12310.59), but decreased in the models of three (BIC = 12214.23), four (BIC = 12132.45), and five (BIC = 12126.73) trajectories. Although BIC decreased with addition of the fifth trajectory, the change was small and resulted from partition of a decreasing participation trajectory into two like trajectories. Further, *entropy* was highest in the four-trajectory model (*entropy* = .88), but decreased with addition of the fifth trajectory (*entropy* = .86), indicating that the former represented the optimal classification quality among the four models assessed; entropy values for the two- and three-trajectory models were (*entropy* = .82) and (*entropy* = .84), respectively. Therefore, we chose the four-trajectory model as the optimal representation of prospective team sport participation for these data.

Characteristics of the Four Trajectories

Trajectories of Team Sport Participation. The four trajectories were labeled *erratic* ($n = 74$), *decrease* ($n = 144$), *high* ($n = 447$), and *low* ($n = 433$). Correlations among the probabilities of trajectory membership and the covariates are presented in Table I. A graphic representation of participation patterns, along with means and standard deviations, is presented in Figure 1. All comparisons between trajectories at each wave were significant ($p < .05$), except for the comparison between the erratic and decrease trajectories at Wave 3. The *erratic* trajectory was named for the significant increase in participation between the first two waves, followed by a significant decrease between the next two waves and a nonsignificant decrease between the last two waves. The *decrease* trajectory was labeled for the significant patterns of decrease between the first two waves and between the last two waves.

Erratic Versus Low Team Sport Participation. Adolescents with higher extracurricular activity at baseline were 43% more likely to have erratic than low participation compared with adolescents with lower extracurricular activity (OR = 1.43, 95% CI = 1.15–1.79).

Decreasing Versus Low Team Sport Participation. Compared with males, females were 51% less likely (OR = .49, 95% CI = .32 to .76) to have decreasing than low participation. Adolescents higher on baseline physical activity were 12% more likely to have decreasing than low participation compared with individuals lower on baseline physical activity (OR = 1.12, 95% CI = 1.06–1.17). Adolescents with higher extracurricular activity at baseline were 28% more likely to have decreasing than

low participation versus adolescents with lower extracurricular activity (OR = 1.28, 95% CI = 1.06–1.54).

High Versus Low Team Sport Participation. Females were 41% less likely (OR = .59, 95% CI = .43 to .82) to have high than low team participation. Adolescents higher on baseline smoking status were 30% less likely to have high than low participation compared with adolescents lower on baseline smoking (OR = .70, 95% CI = .49 to .95). Adolescents who had had at least one alcoholic beverage by ninth grade were 84% more likely to have high than low participation compared with adolescents with no lifetime alcohol use (OR = 1.84, 95% CI = 1.29–2.55). Adolescents with higher physical activity in the eleventh grade were about 17% more likely to have high than low participation than were adolescents low in physical activity (OR = 1.17, 95% CI = 1.12–1.22). Adolescents higher on depressive symptoms were 3% less likely to have high than low participation than were adolescents lower on depressive symptoms (OR = .97, 95% CI = .96 to .99). Adolescents with higher extracurricular activity at baseline were 24% more likely to have high than low participation compared with adolescents with lower extracurricular activity (OR = 1.24, 95% CI = 1.06–1.44). Caucasians were three and a half times more likely to have high than low participation compared with non-caucasians (OR = 3.49, 95% CI = 2.44–4.99).

Erratic Versus High Team Sport Participation. Adolescents with higher physical activity at baseline were 9% less likely to have erratic than high participation compared with adolescents lower on physical activity (OR = .91, 95% CI = .84 to .99). Caucasians were 69% less likely to have erratic than high participation than non-caucasians (OR = .31, 95% CI = .16 to .60).

Decreasing Versus High Team Sport Participation. Adolescents with greater levels of smoking at baseline were 81% more likely to have decreasing than high participation compared with adolescents with lower levels of smoking (OR = 1.81, 95% CI = 1.17–2.81). Adolescents who had had at least one alcoholic beverage by ninth grade were 47% less likely to have decreasing than high participation versus adolescents with no lifetime alcohol use (OR = .53, 95% CI = .32 to .85). Caucasians were 65% less likely to have decreasing than high participation compared with non-caucasians (OR = .35, 95% CI = .22 to .56).

Erratic Versus Decreasing Team Sport Participation. There were no significant differences on this comparison.

We next assessed the effects of trajectory membership on eleventh-grade smoking status, controlling for gender, race, and baseline measures of smoking, alcohol use, physical activity, extracurricular activity, and depressive symptoms.

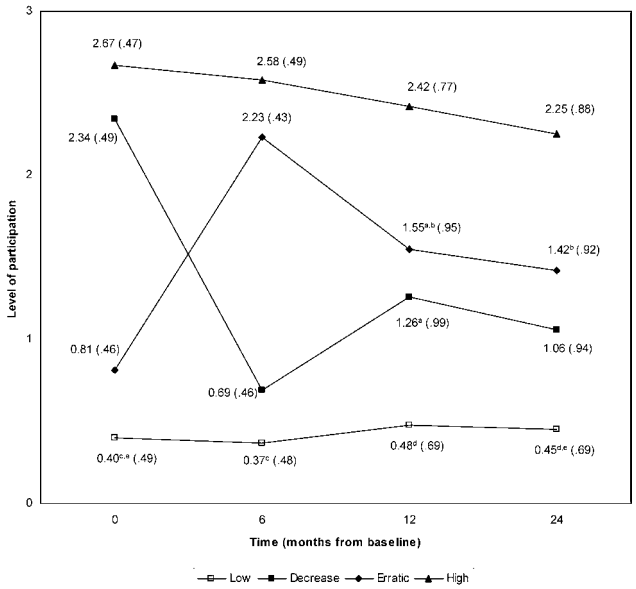

Figure 1. Mean level of team sport participation for each trajectory from Wave 1 to Wave 4. The values appearing next to the time markers for each trajectory are the mean levels of team sport participation at each wave, with standard deviation values in parentheses. The superscripts (a–e) represent nonsignificant comparisons within and between trajectories. Values in comparisons with the same superscripts are not significantly different, $p > .05$.

Likelihood of Smoking in Eleventh Grade

To assess whether team sport participation trajectory members differed on smoking at Wave 4, eleventh-grade smoking status was estimated for individuals belonging to each trajectory.

Current Smoking. Adolescents with decreasing participation were 90% more likely than adolescents with low participation (OR = 1.90, CI = 1.14–3.15) and nearly three times more likely than adolescents with high participation (OR = 2.95, CI = 1.80–4.85) to be current than never smokers or experimenters in the eleventh grade. Adolescents with erratic participation were almost three times more likely to be current smokers than never smokers or experimenters in the eleventh grade than were adolescents with high participation (OR = 2.87, CI = 1.24–6.64). There were no differences between adolescents with erratic and decreasing sport participation.

Experimentation. There were no significant differences in any comparison among the trajectories for experimentation versus never smoking in the eleventh grade.

Discussion

The present investigation assessed the developmental trajectories of team sport participation in grades 9 to 11 with a sample of adolescents, and estimated the likelihood that members of each trajectory experimented with smoking or smoked currently in the eleventh grade. The main goal of this study was to test the hypothesis that team sport participation is a protective factor in adolescent smoking.

A key feature of this study was the use of GGMM to analyze possible heterogeneity of team sport participation. In contrast to the findings of our LGM, which suggested an overall decrease in participation over time, with some variability in change, the results of our GGMM revealed four distinct trajectories, not all of which were characterized by consistently decreasing participation. This finding is consistent with our first hypothesis of four patterns of team sport participation. However, contrary to our hypothesis that one pattern would represent an increase in participation, we found a trajectory of erratic participation, with an overall increasing linear trend between Waves 1 and 4. We recommend that researchers interested in modeling health behaviors prospectively employ latent class analysis methods like GGMM to attain a greater understanding of developmental processes (especially when behavioral heterogeneity is suspected), assess both actual and predicted values for each wave to attain an accurate picture of development, and use this information to estimate the effects of class membership on select outcomes (e.g., smoking).

Another key finding was that adolescents with two participation patterns were at particular risk of later smoking. Adolescents with decreasing and erratic team sport participation were more likely than adolescents with either low or high participation to be current than never smokers or experimenters in eleventh grade. This finding supports our hypothesis that adolescents with decreasing team sport participation are at increased risk of later smoking. Analysis revealed that non-caucasians were at particular risk of decreasing or erratic participation, placing them at special risk for eleventh-grade smoking in our study. These findings are especially interesting given that statistics reveal that non-caucasians generally smoke less than caucasians during adolescence, but smoking levels for different race groups are more comparable in adulthood (CDC, 2002; Grunbaum et al., 2002; Grunbaum et al., 2000; Rainey et al., 1996). Perhaps decreasing or erratic team sport participation and eventual inactivity are factors that put these adolescents at risk for later smoking in adulthood. This is an empirical question that may warrant further investigation.

We did not find support for our hypothesis that individuals with low team sport participation will be higher on eleventh-grade smoking than individuals with high levels of team sport participation. Several key differences between the two trajectories were identified. Adolescents with higher participation were more likely to be caucasian and male, to have had at least one alcoholic beverage by ninth grade, and to have smoked in ninth grade. Interestingly, statistics reveal that among adolescents, males generally smoke more than females, and caucasians generally smoke more than non-caucasians (Grunbaum et al., 2002), though caucasian males show high team sport participation in our study. Further, research has shown that alcohol consumption is positively related to smoking and greater team sport participation (Flay, Hu, & Richardson, 1998; Rainey et al., 1996). Perhaps controlling for alcohol consumption, gender, race, and baseline smoking attenuated the expected difference in eleventh-grade smoking between high and low team sport participation. This suggests that covariates should be carefully selected to reduce the likelihood of misleading results, particularly when research findings may have important implications for policy and practice.

Although the high and low participation trajectories did not differ on eleventh-grade smoking, the finding that females and non-caucasians were more likely to have low than high team sport participation is quite troubling, given that Title IX, the federal law mandating nondiscrimination in federal funding for education programs, has increased opportunities for all girls to participate in high school sports (Gill, 1999). Generally, adolescent girls participate in less physical activity, including team sport, than males, and racial differences are more pronounced for females than males (Gordon-Larsen, McMurray, & Popkin, 2000). One study found that although both African American and caucasian females declined 83% in physical activity over a 10-year period ending in later adolescence, declines among the former and latter were 100% and 64%, respectively (Kimm et al., 2002). Interestingly, factors related to these declines were smoking for caucasians, pregnancy for African Americans, and higher body mass index for girls of both races. Because we did not assess pregnancy or issues related to body weight in our study, we cannot compare our findings with these results. However, the low-participation trajectory in our study was 42% more

likely to smoke at baseline. Perhaps baseline smoking and factors associated with body weight resulted in consistent low participation for the female members of this trajectory.

Another factor that may account for the gender difference in sport participation is motivation. Research has found gender difference in sport competence beliefs, one facet of motivation, with males having higher beliefs than females (Marsh, Richards, Johnson, Roche, & Tremayne, 1994; Wigfield et al., 1997). Competence beliefs are a proxy for successful behavioral performance, with greater levels of success associated with higher competence beliefs (Marsh & Sutherland-Redmayne, 1994). One theory suggests that individuals decrease the value of sport participation to compensate for low competence beliefs associated with perceived or actual failures in sport (Rodriguez, Wigfield, & Eccles, 2003). The goal is to maintain self-esteem and increase positive affect by valuing only those activities that result in success. Perhaps some females in our study were less likely to participate in sport because they sought to decrease subjective failure experiences, inadvertently opening themselves to less healthy alternatives like smoking that may be equally useful in self-esteem management, particularly if their peers support smoking. Future research should assess the effects of potential barriers to sport involvement, such as sport competence beliefs, the value of sport, and self-esteem, on team sport participation and smoking.

Although the results of this study do not clearly demonstrate a causal relationship between team sport participation and smoking, they suggest some potential benefit in participation. However, it is unclear why participation may be beneficial. Several explanations can be advanced (Melnick et al., 2001). First, team members are likely to be exposed to more information about the detrimental effects of smoking, from a variety of adult sources including coaches, health care providers, and athletic directors. Second, athletes are less prone to engage in activities like smoking that may interfere with high performance. Third, like cigarettes, athletic performance provides stress reduction and may elevate mood. Fourth, athletes enjoy high social status and are thus less likely to smoke for status elevation. Fifth, smoking is not consistent with the athlete's identity. Future research should investigate what factors best explain the relationship between team sport participation and smoking in adolescents.

The factors listed above may also indicate why adolescents with decreasing or erratic participation were at particular risk for eleventh-grade smoking in the present study. Perhaps the loss of their identity as athletes, with its cultural norms, and the adoption of new peer groups with different values opened former athletes to behavioral options antithetical to sport participation. For instance, factors such as peer smoking, peer approval of smoking, and being offered cigarettes—generally not associated with sports—increase the likelihood of experimentation and then escalation to regular smoking (Abrams et al., 1999; Flay et al., 1998; Wills & Cleary, 1999). Further, many high school sport programs actually suspend or terminate student athletes caught smoking, increasing the likelihood that the now former athletes will identify with the subculture associated with smoking, particularly given that adolescence is a period of role experimentation, identity formation, and peer influence (Harter, 1998).

Implications for Practice and Policy

These findings have several practice and public policy implications for adults working with children and adolescents. Because it appears that adolescents with decreasing and erratic patterns of team sport participation are at risk for smoking, individuals working with youth sport programs should focus on limiting sport attrition. Several factors thought to contribute to attrition in youth sport include parental pressure, an overemphasis on winning instead of learning and having fun, lack of playing time, and poor coach behavior (Greendorfer, 1992; Rodriguez et al., 2003). It is suggested that coaches focus on skill development and not introduce competition prematurely (Weiss, 1991). This approach is particularly important given our race and gender findings and the findings of research on gender and race differences in participation goals (Duda, 1985, 1989). For instance, research has found that although adolescent males tend to be more competitive and to prefer competition to learning more than females, adolescent girls are just as interested in achievement and just as motivated to be physically active (Gill, 1999). Further, gender differences in preferences for competition and learning tend to disappear among elite athletes, as they become more similar in their pursuit of athletic goals. This suggests that focusing on skill development and individual mastery goals is particularly important during the earliest stages of learning in sport to allow all adolescents, regardless of gender or race, to achieve elite levels. Therefore, reducing the emphasis on competition, particularly at the earliest stages of skill development (e.g., freshman year, junior varsity), and emphasizing

the importance of skill development instead may help females and non-caucasians with mastery, and cooperative motives maintain participation.

Regarding public health policy implications, efforts should be made to increase accessibility of sport participation to adolescents, in both community and school settings, particularly for adolescents at highest risk for low participation (e.g., non-caucasians, females). For instance, neighborhood planning should emphasize parks and recreation centers that make physical activity and sport participation an accessible and attractive alternative to less healthy reinforcers like smoking that are often more easily accessible than sport (Sallis, 2003). Interestingly, one study found that accessibility of physical activity resources in a small Midwestern U.S. city was lower in areas of low and medium than in areas of high socioeconomic status (SES) (Estabrooks, Lee, & Gyurcsik, 2003). There were significantly fewer resources that were free of charge (e.g., municipal parks) in low- and medium-SES neighborhoods than in high-SES neighborhoods. More important, there were significant differences in race composition by SES, with a greater percentage of non-caucasians (Hispanics and African Americans) in medium- and low-SES communities than in high-SES communities. Although these findings do not explain why race differences in team sport participation were found in our study, they suggest that accessibility may play a role. Other factors that may influence non-caucasians to be less involved in team sport should be investigated in future studies.

Limitations

There were several limitations to this study. First, although covariates were chosen that were empirically meaningful for this analysis, it is possible that other factors not assessed in this study may have affected trajectory membership and adolescent smoking. For instance, one study (Lee & Cubbin, 2002) found that low SES was associated with lower levels of adolescent physical activity. Second, the overall consent rate of 54% suggests that some caution is warranted in generalizing the results of this study. However, although there were some differences between those who did and did not provide consent, differences were relatively small, and there were no significant differences on smoking variables (Audrain et al., 2002) between those adolescents who had parental consent to participate and those who did not. Finally, although our results suggest that decreasing or erratic team sport participation impacts smoking behavior, the converse may be true. That is, smoking may impact team sport participation. Thus, although these findings suggest a protective relationship between these two health-related behaviors, we cannot make specific conclusions regarding the direction of their influence.

In summary, this study assessed the trajectories of team sport participation with a sample of ninth- to eleventh-grade adolescents, and how the trajectories differed on smoking behavior. We found four trajectories of team sport participation. Our results indicate that adolescents with decreasing and erratic levels of participation were more likely to smoke in grade 11 than individuals with high participation. Future research should carefully examine other factors that discriminate trajectories of team sport participation, evaluate the mechanisms by which team involvement impacts smoking behavior, and investigate trajectories of other forms of physical activity.

Acknowledgment

This study was supported by National Cancer Institute and National Institute on Drug Abuse grant P50 CA/DA 84718.

Received February 24, 2003; revisions received April 21, 2003, and July 16, 2003; accepted September 2, 2003

References

Aaron, D. J., Dearwater, S. R., Anderson, R., Olsen, T., Kriska, A. M., & Laporte, R. E. (1995). Physical activity and the initiation of high-risk health behaviors in adolescents. *Medicine and Science in Sports and Exercise, 27,* 1639–1645.

Abrams, K., Skolnik, N., & Diamond, J. J. (1999). Patterns and correlates of tobacco use among suburban Philadelphia 6th- through 12th-grade students. *Family Medicine, 31,* 128–132.

Audrain, J., Tercyak, K. P., Goldman, P., & Bush, A. (2002). Recruiting adolescents into genetic studies of smoking behavior. *Cancer, Epidemiology, Biomarkers & Prevention, 11,* 249–252.

Botvin, G. J., & Botvin, E. M. (1992). Adolescent tobacco, alcohol, and drug abuse: Prevention strategies, empirical findings, and assessment issues. *Journal of Developmental and Behavioral Pediatrics, 13,* 290–301.

CDC [Centers for Disease Control and Prevention]. (2002). Cigarette smoking among adults—United

States, 2000. *MMWR, 51,* 642–645. Retrieved June 26, 2003, from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5129a3.htm

Choi, W. S., Pierce, J. P., Gilpin, E. A., Farkas, A. J., & Berry, C. C. (1997). Which adolescent experimenters progress to established smoking in the United States? *American Journal of Preventative Medicine, 13,* 385–391.

Coulson, N. S., Eiser, C., & Eiser, J. R. (1997). Diet, smoking and exercise: Interrelationships between adolescent health behaviors. *Child: Care, Health and Development, 23,* 207–216.

Davis, T. C., Arnold, C., Nandy, I., Bocchini, J. A., Gottlieb, A., George, R. B., et al. (1997). Tobacco use among male high school athletes. *Journal of Adolescent Health, 21,* 97–101.

Duda, J. L. (1985). Goals and achievement orientations of Anglo and Mexican-American adolescents in sport and the classroom. *International Journal of Intercultural Relations, 9,* 131–150.

Duda, J. L. (1989). Relationship between task and ego orientation and the perceived purpose of sport among high school athletes. *Journal of Sport and Exercise Psychology, 11,* 318–335.

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioral Medicine, 25,* 100–104.

Flay, B. R., Hu, F. B., & Richardson, J. (1998). Psychological predictors of different stages of cigarette smoking among high school students. *Preventative Medicine, 27,* A9–A18.

Gill, D. (1999). Gender issues: Making a difference in the real world of sport psychology. In Gary G. Brannigan (Ed.), *The sport scientists: Research adventures* (pp. 133–147). New York: Longman.

Gordon-Larsen, P., McMurray, R. G., & Popkin, B. M. (2000). Determinants of adolescent physical activity and inactivity patterns. *Pediatrics, 105,* E83.

Greendorfer, S. L. (1992). Sport socialization. In T. S. Horn (Ed.), *Advances in sport psychology* (pp. 201–218). Champaign, IL: Human Kinetics Publishers.

Grunbaum, J. A., Kann, L., Kinchen, S. A., Williams, B., Ross, J. G., Lowry, R., et al. (2002). Youth risk behavior surveillance—United States, 2001. In *MMWR Surveillance Summaries, 51*(SS04). Retrieved August 13, 2002, from http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5104a1.htm

Grunbaum, J. A., Lowry, R., Kann, L., & Pateman, B. (2000). Prevalence of health risk behaviors among Asian American/Pacific Islander high school students. *Journal of Adolescent Health, 27,* 322–330.

Harter, S. (1998). The development of self-representations. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3, Social, emotional, and personality development* (5th ed.). New York: Wiley.

Kann, L., Kinchen, S. A., Williams, B. I., Ross, J. G., Lowry, R., Hill, C. V., et al. (1998). Youth risk behavior surveillance—United States, 1997. *MMWR, 47*(SS-3), 1–89.

Kaplan, C. P., Zabkiewicz, D., McPhee, S. J., Nguyen, T., Gregorich, S. E., Disogra, C., et al. (2003). Health-compromising behaviors among Vietnamese adolescents: The role of education and extracurricular activities. *Journal of Adolescent Health, 32,* 374–383.

Kessler, D. A., Natanblut, S. L., Wilkenfeld, J. P., Lorraine, C. C., Mayl, S. L., Gernstein, I. B. G., et al. (1997). Nicotine addiction: A pediatric disease. *Journal of Pediatrics, 130,* 518–524.

Kimm, S. Y., Glynn, N. W., Kriska, A. M., Barton, B. A., Kronsberg, S. S., Daniels, S. R., et al. (2002). Decline in physical activity in black girls and white girls during adolescence. *New England Journal of Medicine, 347,* 709–715.

Lee, R. E., & Cubbin, C. (2002). Neighborhood context and youth cardiovascular behaviors. *American Journal of Public Health, 92,* 428–436.

Marsh, H. W., Richards, G. E., Johnson, S., Roche, L., & Tremayne, P. (1994). Physical self-description questionnaire: Psychometric properties and a multitrait-multimethod analysis of relations to existing instruments. *Journal of Sport and Exercise Psychology, 16,* 270–305.

Marsh, H. W., & Sutherland-Redmayne, R. (1994). A multidimensional physical self-concept and its relations to multiple components of physical fitness. *Journal of Sport and Exercise Psychology, 16,* 43–55.

Melnick, M. J., Miller, K. E., Sabo, D. F., Farrell, M. P., & Barnes, G. M. (2001). Tobacco use among high school athletes and nonathletes: Results of the 1997 Youth Risk Behavior Survey. *Adolescence, 36,* 727–747.

Muthén, B. O. (2002). Beyond SEM: General latent variable modeling. *Behaviormetrika, 29,* 81–117.

Muthén, B., Brown, C. H., Masyn, K., Jo, B., Khoo, S-T., Yang, C-C., et al. (2002). General growth mixture modeling for randomized prevention interventions. *Biostatistics, 3,* 459–475.

Muthén, B. O., & Muthén, L. K. (2001). *Mplus user's guide* (2nd ed.). Los Angeles: Muthén & Muthén.

Muthén, B. O., & Muthén, L. K. (2002, September). *Mplus short course: Traditional latent variable modeling using Mplus.* Material presented the first day of a 4-day workshop on Mplus, Washington, DC.

Muthén, B., & Shedden, K. (1999). Finite mixture modeling with mixture outcomes using the EM algorithm. *Biometrics, 55,* 463–469.

Pate, R. R., Heath, G. W., Dowda, M., & Trost, S. G. (1996). Association between physical activity and other health behaviors in a representative sample of U.S. adolescents. *American Journal of Public Health, 86,* 1577–1581.

Peretti-Watel, P., Beck, F., & Legleye, S. (2002). Beyond the U-curve: The relationship between sport and alcohol, cigarette and cannabis use in adolescents. *Addiction, 97,* 707–716.

Radloff, L. S. (1977). A CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385–401.

Rainey, C. J., McKeown, R. E., Sargent, R. G., & Valois, R. F. (1996). Patterns of tobacco and alcohol use among sedentary, exercising, nonathletic, and athletic youth. *Journal of School Health, 66,* 27–32.

Rodriguez, D., Wigfield, A., Eccles, J. S. (2003). Changing competence perceptions, changing values: Implications for youth sport. *Journal of Applied Sport Psychology, 15,* 67–81.

Sallis, J. F. (2003, April). *From individual to ecological perspectives: My personal evolution.* Master lecture conducted at the 24th Annual Meeting and Scientific Sessions of the Society of Behavioral Medicine, Salt Lake City, Utah.

Thorlindsson, T., & Vilhjalmsson, R. (1991). Factors related to cigarette smoking and alcohol use among adolescents. *Adolescence, 26,* 399–418.

Weiss, M. R. (1991). Psychological skill development in children and adolescents. *The Sport Psychologist, 5,* 335–354.

White, H. R., Pandina, R. J., & Chen, P. H. (2002). Developmental trajectories of cigarette use from early adolescence into young adulthood. *Drug and Alcohol Dependence, 65,* 167–178.

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A. J. A., Freedman-Doan, C., et al. (1997). Change in children's competence beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology, 89,* 1–19.

Wills, T. A., & Cleary, S. D. (1999). Peer and adolescent substance use among 6th–9th graders: Latent growth analysis of influence versus selection mechanisms. *Health Psychology, 18,* 453–463.