Running head: BINGE-DRINKING TRAJECTORIES, PUBERTAL TIMING, ACTIVITIES

Binge drinking trajectories across adolescence: For early maturing youth, extra-curricular activities are protective.

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Draft copy before final journal copy edits.

Citation: Modecki, K.L**.,** Barber, B.L., Eccles, J.E. (2014). Binge drinking trajectories across adolescence: Extra-curricular activities are protective for youth with early pubertal development. *Journal of Adolescent Health, 54* (1), 61-66.

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Acknowledgements. Portions of this research were supported through two grants to Bonnie Barber and Jacquelynne Eccles, and one grant to Bonnie Barber, Kathryn Modecki, and Jacquelynne Eccles from The Australian Research Council. We would like to thank the 39 High School principals, their staff, and the students who participated in the YAPS-WA study. We are grateful to everyone in the YAPS-WA team, with special thanks to Corey Blomfield Neira, Bree Abbott, Cathy Drane, Lynette Vernon, Stuart Watson, and Karina Annear for their contributions to data collection.

Abstract

Purpose: To describe adolescent binge drinking trajectories across grades 8-11 and examine their associations with pubertal timing, SES, and structured activity and sport involvement. Methods: Longitudinal data were analyzed from the Youth Activity Participation Study (YAPS) an annual survey of youth in 39 schools across Western Australia (N = 1, 342). Results: Latent class growth analysis revealed four binge drinking trajectory groups: *Accelerating* (early onset, increased frequency), *Steep Increase* (delayed onset, rapid escalation), *Slow Growth* (delayed onset, gradual increase) and *Stable Low* (abstinence). *Accelerating* was characterized by early pubertal timing, low SES, and more sport involvement in grade 8, relative to *Stable Low*. The groups did not significantly differ in their grade 8 activity participation. However, for early maturers, increased grade 8 activity participation was associated with a decreased probability of belonging to *Steep Increase* relative to *Stable Low*. Conclusions: Early pubertal timing and sports participation increased the odds of belonging to a problematic binge drinking trajectory. For youth at-risk due to early pubertal timing, structured activities appear to be protective against a problematic developmental course of binge drinking.

50-word implications and Contribution summary statement.

This longitudinal study shows that involvement in structured activities buffered youth at-risk due to early pubertal timing against following a problematic course of binge drinking. Structured activities are a *modifiable* protective factor and thus should be given increased consideration as a prevention tool.

Adolescent alcohol use is highly prevalent in the US and abroad. Recent data indicate that over 14% of US adolescents have been drunk in the last month and prevalence rates for risky drinking among Australian adolescents are analogous: 17% of adolescents report engaging in binge drinking on a monthly basis (AIHW, 2011; Johnston, O'Malley, Bachman, & Schulenberg, 2012). Furthermore, early pubertal development has been implicated as a key individual difference that amplifies susceptibility to early and risky alcohol use (Westling, Andrews, Hampson, & Peterson, 2008). Given the numerous negative long-term health repercussions associated with heavy alcohol exposure during adolescence, it is essential to identify contexts that protect vulnerable youth from problematic drinking.

Adolescent drinking represents a considerable health burden and there are growing concerns that exposure to alcohol early in adolescence puts youth at elevated risk for mental health issues, substance dependence, and social problems in adulthood (Brown et al., 2008). For instance, early exposure to alcohol has been linked to increased suicidal ideation and attempts (Swahn, Bossarte, & Sullivent, 2008). Further, Odgers and colleagues (2008) found that relative to propensity-matched youth, adolescents with multiple exposures to alcohol by age 15 were more likely to suffer from substance dependence and sexually transmitted disease infections in adulthood.

Mounting evidence also indicates that patterns of change in problematic drinking across adolescence may be especially important in determining later risk (Chassin et al., 2010). For example, Hill and colleagues (2000) found that youth who demonstrated early low levels followed by a rapid escalation in binge drinking were at greatest risk for substance abuse and dependence in young adulthood, relative even to early-onset binge drinkers. In their study of 6,000 youth, Tucker and colleagues (2005) identified a similar binge-drinking pattern. By young

adulthood, rapid increasers were characterized by high levels of alcohol and physical health problems similar to those of youth who began binge drinking during early adolescence.

Given the potential long term impact of adolescent binge drinking, researchers have worked to delineate individual factors that place youth at heightened risk for early heavy alcohol use (Windle et al., 2009). Although constellations of heavy drinking risks tend to co-occur, previous studies have yielded considerable evidence that early pubertal timing is a key individual risk factor for early and increased substance use, including binge drinking, (Westling, et al., 2008; Wichstrom & Wichstrom, 2008). Longitudinal research findings are mixed, however, as to whether early-timers remain at elevated risk for problematic drinking (Biehl, Natsuaki, & Ge, 2007) or if their risk is indistinguishable once average and late-timers "catch up" in their alcohol experimentation (Andersson & Magnusson, 1990; Dick et al. 2000). One explanation for these equivocal findings is that early pubertal timing may impel youth towards distinct patterns of risky alcohol use. Despite consensus that early pubertal timing represents a health-risk (Walvoord, 2010), research has not yet examined early maturation in relation to heterogeneity in patterns of change in binge drinking across adolescence.

Not all early maturing youth engage in binge drinking and the consequences of early maturation will vary according to adolescents' socio-ecological contexts. Social environments, in particular, may serve to either amplify or inhibit risks. Illustratively, some early maturing youth may experience a climate of relatively permissive behavioral expectations from peers or parents, (Stattin & Magnusson, 1990). Further, several studies have demonstrated that risky peer contexts serve to magnify early-maturers' risk for substance use (Costello, Sung, Worthman, & Angold, 2007; Ge et al., 2006).

Just as increased exposure to risky peers exacerbates substance use vulnerability in early maturing youth, positive social contexts can buffer these adolescents against risk. For instance, the link between pubertal timing and problem behavior or problematic peers is weaker for youth in protective relational contexts characterized by high parental monitoring or positive parenting (Ge et al., 2002; Westling et al., 2008). Positive peer settings, themselves, may also offer important protections for early maturing youth, given the increased salience of peer relationships during early adolescence (Modecki, 2009). More specifically, extracurricular activities have received growing attention as protective peer settings that facilitate healthy youth outcomes (Feldman & Matjasko, 2005).

There is strong theoretical and empirical support for structured activities as a macro-level intervention for improving adolescent health outcomes. Research has consistently indicated that participation in most structured activities facilitates healthy long-term physical and emotional health (e.g. Barber, Eccles, & Stone, 2001). Illustratively, participation in structured, non-sport activities predicts lower rates of alcohol use in late adolescence and early adulthood (Busseri et al., 2011; Eccles & Barber, 1999). However, not all extracurricular activities protect against heavy drinking, and some studies indicate that participation in organized sport leads to increases in alcohol use and getting drunk (Barber et al., 2001; Wichstrom & Wichstrom, 2008). Thus, protective effects against heavy drinking are more consistently found for structured non-sport activities than for sports.

The benefits of activity participation in reducing unhealthy behavior and promoting wellbeing may be particularly strong for at-risk youth. Mahoney (2000) identified youth at increased risk for problematic outcomes based on SES, social and academic competencies, aggression, and physical maturation. The benefits of activity participation for problem behavior

were most pronounced for youth characterized by multiple disadvantage. Because activities provide youth with structured time to build interpersonal skills, socialize with pro-social peer groups, and construct positive norms (Blomfield & Barber, 2009; 2011), they may also buffer youth who are characterized by individual risk beyond socioeconomic disadvantage. Thus, the positive social contexts that typify structured activities may serve to inhibit the negative effects of early maturation on adolescent binge drinking. However, no study to date has investigated structured activities as a modifiable protective factor for early maturing youth.

The current study examines the relations between pubertal timing, time in structured activity and in sport in early adolescence and binge drinking trajectories. Specifically, we test whether pubertal timing and hours of activity and sport participation in eighth grade predict binge drinking trajectory groups from grades 8-11. We also test the hypothesis that the protective effects of activities will be especially salient for early maturing youth.

Methods

Participants.

Longitudinal data were examined from 1342 Western Australian students (45% male) recruited from 39 schools for the Youth Activity Participation Study (YAPS). Participants were enrolled in the YAPS study beginning in eighth grade and were followed annually for four years. The mean age of participants in eighth grade was 13 years old (SD = .54 years; Range 12-14 years). Of the sample, 83.9% of participants were Caucasian, 7.2% Asian, 2.1% Aboriginal or Torres Strait Islander and 6.8% other. Participants were recruited from high schools selected to represent the school districts across Western Australia.

Procedure.

Ethics approval to conduct research was obtained from the university Human Research Ethics Committee. Study participation required active informed parent and student consent. The survey was administered using wireless-laptop computers. Participants were told that the survey was confidential and participation was voluntary.

Measures.

Eighth Grade Predictors.

Pubertal Timing. Pubertal timing was measured using one item, taken from Dubas, Graber, and Petersen (1991), and used in previously published studies from YAPS data (e.g. Modecki, Barber, & Vernon, 2012). This item asks: "Teenagers' bodies change a lot as they grow up, this is referred to as your physical development. Compared to other people your age do you think your physical development has started?" with responses indicated from (1) much later to (5) much earlier. Because we were interested in the effects of early maturation, we created a dichotomous variable so that 0 = average-late timing and 1 = early timing. This item was correlated positively with self-report weight (r (1340) = .23, $p < .001$) and negatively with menarche age for girls (r (743) = -.17, $p < .001$).

SES. SES for YAPS schools was obtained from the Department of Education and Training, which computes the Index of Community Socio-Educational Advantage (ICSEA) for each school in the state (see Blomfield & Barber, 2011). The ICSEA is calculated using data from the Australian Bureau of Statistics, and draws on the education, occupation, income, ethnicity, and single parent status of each student's household (Australian Curriculum, Assessment and Reporting Authority, 2010). We created an ordinal variable such that 1 = low SES, 2 = average SES, and 3 = high SES. School-level SES gauges relative community-level

advantage or disadvantage, and because this is the same level of context in which sports and activities are organized, this broader index is a useful indicator of access to opportunities.

Activity Hours. Youth were asked if they had participated in any organized school or non-school activities in the current school year. They were provided with a list of 24 non-sport structured extracurricular activities (e.g. band), and were asked to indicate the activities they participated in and how many hours per week they participated in each. The total number of hours in activities was calculated by summing the hours across activities. (M = 2.76 hours, SD = 4.70).

Sport Hours. Youth were asked if they had participated in any organized school or non-school sports/teams outside of physical education classes in the current school year. They were provided with a list of 30 sports (e.g. basketball), and were asked to indicate the sports they participated in and how many hours per week they participated in each. The total number of hours in sport was calculated by summing hours across all sports. (M = 7.84, SD = 9.0)

Longitudinal Outcome.

Binge Drinking. Binge drinking was measured annually across four waves using one item based on Fredericks and Eccles (2006), which has been shown to have strong validity. The item was measured on an eight point scale from (1) = None to (8) = 31 or more times. In the past six months, how often have you had more than 5 alcoholic drinks on one occasion?" In grade 8, binge drinking was positively correlated with having been drunk (r (1340) = .56, p < .001) and contact with the police (r (1340) = .49, p < .001). The binge drinking means (and standard deviations) were 1.11 (.54), in grade 8; 1.35 (.97) in grade 9; 1.78 (1.49) corresponding with roughly once in six months in grade 10; and 2.26 (1.90) corresponding with between once and two-three times in the past six months in grade 11.

Analytic Strategy

Latent class growth analysis (LCGA) is a type of finite mixture modeling that readily incorporates covariates into model selection, and decomposes variability in developmental trajectories to identify homogeneous, mutually exclusive groups that exist within a heterogeneous population (Nagin, 1999). Trajectory classes are operationalized as collections of individuals who follow approximately the same developmental trajectory.

All models were run in Mplus 6.1 (Muthén & Muthén, 2010), using maximum likelihood estimation with standard errors robust to non-normality. The best-fitting model was determined based on 1) the Vuong-Lo-Mendell-Rubin test (Lo, Mendell, & Rubin, 2001), a significant result indicates that the current class model fits the data better than a model with one fewer class; 2) Bayesian Information Criterion (BIC; Schwartz, 1978), generally a lower relative BIC indicates better model fit; 3) model parsimony and class size.

First, unconditional latent class growth modelling without covariates was used to classify individuals into groups based on similarities in growth trajectories. Next, we added pubertal timing, gender, SES, sport and activity hours as predictors of class membership through the use of multinomial regression within the LCGA. One theoretically meaningful class is chosen as the reference class so that each parameter can be interpreted as the change in log odds of being in a given class for a one unit increase of the corresponding predictor. For the last step of the analyses, we included the pubertal timing x activity hours interaction to the conditional model.

Results

We examined quadratic trajectories of binge drinking over time, and a four class solution was the best fit to the data (Table 1.) Binge drinking values for our preferred four class solution are displayed graphically in Figure 1.

The first group, *Accelerating* (17.2% of sample), starts higher in grade 8 binge drinking relative to the other classes, and accelerates across the four years of the study. The second group, *Steep Increase* (6.0%) starts low in binge drinking but in grade 9 begins a rapid increase in binge drinking, so that by grade 11 this groups has the highest reported rate of binge drinking. The third and largest group, *Stable Low* (65.7%), abstained from binge drinking across grades 8-11. Finally, S*low Growth* (11.1%) remained fairly low in binge drinking, though showed some increases in binge drinking across time.

Within the LCGM model, we next examined whether youth following different binge drinking trajectories significantly differed in their pubertal timing and sport and activity participation hours in grade 8, controlling for gender and SES. Results revealed significant differences in comparison to the *Stable Low* class, described at the top of Table 2. Focusing on *Accelerating* (top of column 1) every one unit increase in SES decreased the odds of belonging to Accelerating by .70, holding other covariates constant. Likewise, the odds of belonging to *Accelerating* was 1.94 larger for early maturers relative to average-to late maturers, holding other predictors constant. Further, every hour increase in sports participation hours increased the odds of belonging to *Accelerating* by 1.05. For *Steep Increase* (top of column 2), the odds of belonging to *Steep Increase* group relative to *Stable Low* was .48 times smaller for males than for females, and every one unit increase in SES decreased the odds of belonging to *Steep Increase* by .58. Finally, the top of column 3 examines *Slow Growth* in comparison to the

reference *Stable Low* class and indicates that every one unit increase in SES decreased the odds of belonging to *Slow Growth* by .68.

Next, we examined whether the risk represented by early pubertal timing for binge-drinking pattern was attenuated by activity participation in grade 8. We ran LCGM's which included the predictors described above and with the activity hours x pubertal timing interaction. The results of the analyses examining the pubertal timing x activity hours interaction are described at the bottom of Table 2. The odds ratios of the *Steep Increase* group reveals a conditional effect for pubertal timing, such that 2.68 represents the ratio of the predicted odds for early maturers belonging to *Steep Increase* relative to the predicted odds for late maturers, when youth engage in zero activity hours. The interaction between pubertal timing and activity hours is also significant (OR = .67). The conditional odds ratio for activity hours indicates that for youth with average-late pubertal timing, there was a non-significant relation between activity hours and *Steep Increase* group membership. The interaction was further probed (Jaccard, 2001) and indicated that for early maturers, every one hour increase in activity decreased the odds of belonging to *Steep Increase* relative to *Stable Low* by .70 (95% CI: .52-.93).

Discussion

Given significant health concerns associated with adolescent binge drinking, it is essential to identify modifiable protective factors that decrease the odds that youth will follow a risky developmental course. The current study identified meaningful subgroups with varying trajectories of binge drinking across adolescence, two of which were particularly problematic: *Accelerating* (early onset, increased frequency) and *Steep Increase* (delayed onset, rapid escalation). The less risky groups were *Slow Growth* and *Stable Low* (abstinence from binge drinking). The latter group, *Stable Low,* was the largest group in the sample and was comprised

of roughly 65% of youth. The substantial number of youth belonging to a non-binge drinking trajectory is very much consistent with US research indicating that roughly 70% of youth follow a trajectory defined by never, or rarely, drinking heavily (Oesterle et al., 2004).

Relative to *Stable Low*, *Accelerating* was characterized by increased likelihood of early pubertal timing, low SES, and sport involvement in eighth grade. Unlike previous research that demonstrates a general protective effect from non-sport activity participation (e.g. Busseri et al., 2011), the groups did not significantly differ in their eighth grade activity participation. However, we also hypothesized that activity participation might be especially protective against problematic trajectories for youth at-risk based on relatively early pubertal timing. Our results supported this hypothesis. For early maturers, more eighth grade activity participation was associated with a lower probability of belonging to *Steep Increase* relative to *Stable Low*.

The current findings underscore the health risks associated with early pubertal maturation. Early maturers were more likely to belong to the *Accelerating* trajectory which was characterized by early drinking that increased over three years. Previous alcohol research indicates that youth who follow early onset binge drinking trajectories have higher drug and violence problems in emerging adulthood relative to more moderate/stable trajectories (Tucker et al., 2005). In tandem, these preliminary findings suggest that early pubertal maturation may incline youth towards problematic long-term health outcomes.

Consistent with several previous studies (Busseri et al., 2011; Eccles & Barber, 1999), our results indicate that supervised, organized sport involvement in eighth grade is also related to increased binge drinking risk. Specifically, youth in *Accelerating* were more heavily involved in sports relative to those who were *Stable Low*. Notably, *Accelerating* was the only group characterized by both early binge drinking and increased likelihood of early sport involvement,

suggesting that the two are linked. However, these analyses cannot decipher whether binge drinking youth seek out sport involvement or whether sport involvement has a causal role in the development of problematic alcohol use. Nonetheless, our results highlight unintended health risks associated with sport participation, at least in early adolescence. Organized sports offer many benefits, ranging from fighting obesity to increased academic engagement, but these findings suggest that organized sport is not a panacea against all of the health risks that adolescents face.

Surprisingly, the four binge drinking trajectory groups were not significantly predicted by their eighth grade activity involvement. A body of prior work suggests that activities are protective against a range of youth outcomes (e.g. Feldman & Matjasko, 2005). However, most prior studies have examined exposure to activities using categorical composites of activity involvement. In contrast to prior work, this study examined activity dosage. Our null findings suggest that the effects of activities may not be linearly incremental and simple exposure to activities may be enough to promote positive outcomes among low-risk adolescents.

One of the central study questions was whether for youth at-risk for heavier binge drinking due to early pubertal maturation, activity involvement would be especially protective. Our results indicate a dose effect for activities among those youth. More specifically, greater activity involvement decreased the likelihood that early maturing youth would belong to *Steep Increase* relative to *Stable Low*. This is important because in eighth grade *Steep Increasers* were indistinguishable from youth who followed more moderate drinking trajectories and thus would not stand out as youth in need of early intervention. Activities seem to provide a protective climate in early adolescence, that can "re-route" early-maturing youth away from a problematic developmental course. Future research should investigate whether activities are protective only

in early adolescence when early-maturers' binge-drinking is at-odds with their on-time and late maturing peers, or whether continued or later activity participation offers ensuing protection against binge drinking.

These results were present even after controlling for socio-economic status and gender. Across each comparison, students from low SES schools were more likely to belong to less auspicious trajectories. This is consistent with much previous research that has demonstrated the impact of economic disadvantage on adolescent's risky pathways (Ingoldsby & Shaw, 2002). Female adolescents were also more likely than males to belong to *Steep Increase* relative to *Stable Low*. Most previous research shows that girls are less likely to follow problematic binge drinking pathways than boys (Tucker, Orlando, & Ellickson, 2003). We conjectured, and subsequent post-hoc analyses confirmed, that the gender difference was attributable to a suppressor effect, related to the inclusion of sport-hours in the analyses.

Although this study offers unique insight into predictors of adolescent binge drinking pathways, it is not without limitations. First, although we controlled for SES, this was a school-level variable that we treated as individual-level and so standard errors may have been under-estimated. Second, our sample, though large and representative of the Western Australian adolescent population, may not be comparable to adolescents in other industrialized nations. Moreover, we did not examine the moderating effects of specific sports or activities and future research should consider the ways in which different types of structured activities protect or exacerbate adolescent risk. In the same vein, we were not able to disentangle the mechanisms by which activities decreased binge drinking risk for early maturers. We also cannot rule out other third variable explanations, including selection, for the links uncovered here.

However, our findings extend prior research on a number of fronts. Early pubertal timing and sport involvement were related to a risky *Accelerating* binge drinking trajectory. Further, an interaction between pubertal timing and activity participation decreased the likelihood of belonging to another problematic trajectory-*Steep Increase*-whose youth rapidly escalated in their binge drinking after early abstinence. This finding is particularly noteworthy in that analyses accounted for both low SES and sports involvement, which are themselves risk factors for problematic drinking.

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Table 1.

Model Fit Comparisons Classes 1 to 4.

	BIC	VLMR *p*	LMR *p*
Class 1	12847.68		
Class 2	10744.14	.00	.00
Class 3	10177.22	.22	.23
Class 4	9861.16	.03	.03
Class 5[+]	9566.03	.33	.33

Note. BIC = Bayes Information Criteria; VLMR = Vuong-Lo-Mendell-Rubin likelihood ratio test; LMR = Lo-Mendell-Rubin likelihood ratio test.

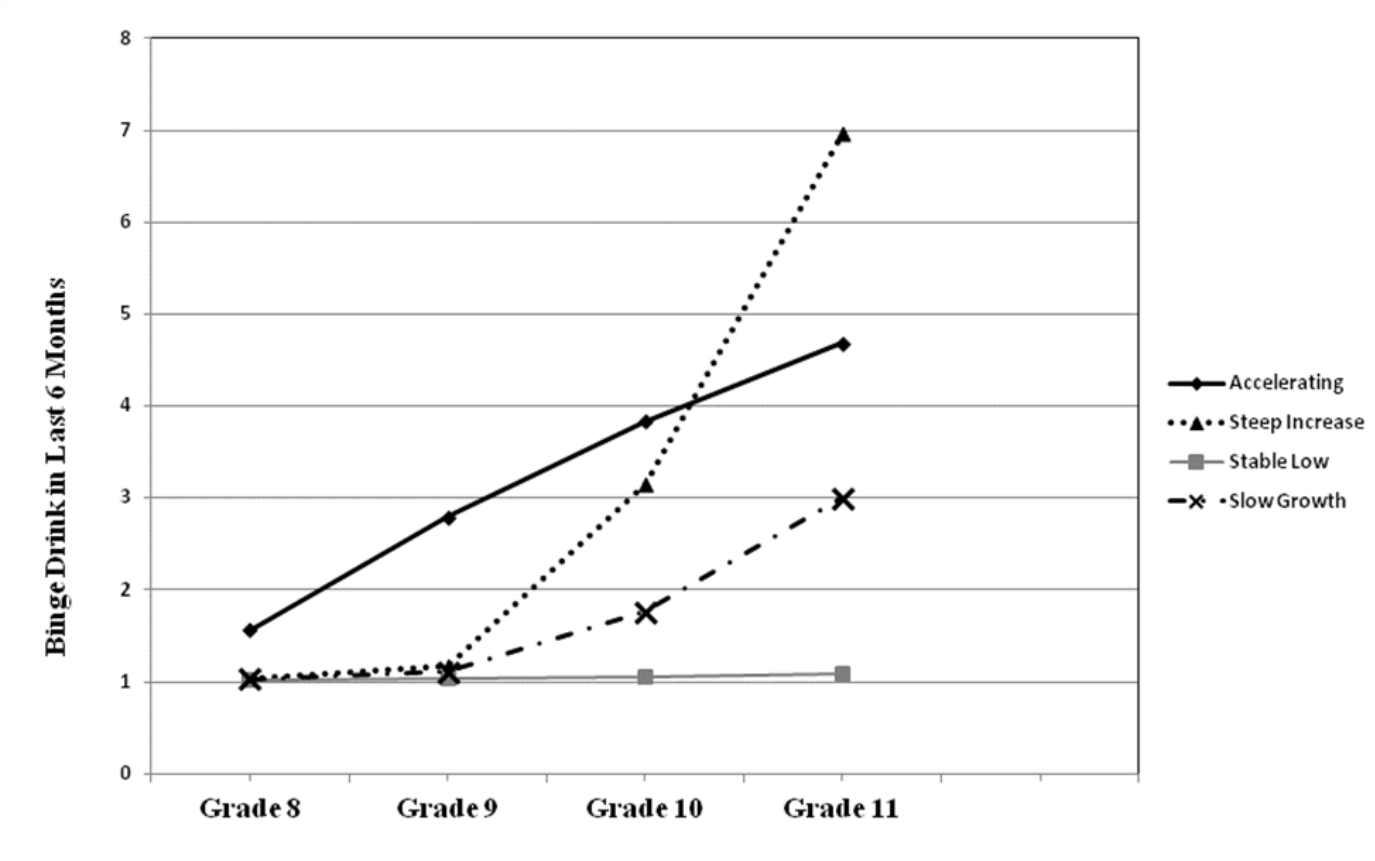
[+]Revealed a class comprised of less than 5% of the total sample.

Table 2. Odds Ratios and 95% Confidence Intervals for Multinomial Logistic Regression Models of Gender, SES, Pubertal Timing, Activity and Sport Predicting the Probability of Youth Membership In Latent Trajectory Group.

	Trajectory Group		
	Accelerating	Steep Increase	Slow Growth
Gender	.72(.47-1.12)	.48(.24-.99)*	.79(.47-1.30)
SES	. 70(.56-.88)**	.58(.38-.86)**	.68(.52-.89)**
Pubertal timing	1.94(1.24-3.04)**	1.33(.58-3.08)	1.16(.62-2.15)
Sport participation hours	1.05(1.02-1.07)**	1.03(.99-1.06)	1.03(1.0-1.06)
Activity participation hours	.98 (.94-1.03)	1.02(.97-1.07)	.97(.90-1.04)
Gender	.72(.47-1.12)	.49(.25-.88)*	.78(.47-1.30)
SES	.71**(.56-.89)	.60(.40-.85)*	.68(.52-.89)**
Pubertal timing	2.18**(1.24-3.85)	2.68(1.03-5.98)*	1.26(.60-2.67)
Sport participation hours	1.05**(1.02 -1.07)	1.03(1.0-1.06)+	1.03(1.0-1.06)+
Activity participation hours	.99(.94-1.04)	1.03(.99-1.07)	.97(.90-1.06)
Activity participation hours x pubertal timing	.96(.84-1.08)	.67(.48-.93)*	.97(.80-1.18)

Note. Stable Low serves as the reference group. Gender 0 = female, 1 = male; SES = 1 = low, 2 = ave, 3 = high; Pubertal timing 0 = average-late, 1 = early.

Figure 1. Latent class growth model of binge drinking among adolescents, grades 8-11 (n =1342).



Note. Binge drinking 1 = Never or abstinence from binge drinking, 8 = 31 or more times in past 6 months.