

Adolescent Alcohol Use Before and After the High School Transition

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Abstract

Background: An important question is whether the high-school entry is a critical developmental event associated with escalation of alcohol use. The present study examined trajectories of adolescent alcohol use as a function of a normative developmental event, the high-school entry. In addition, given that at-risk youth may be particularly vulnerable to the stress associated with this transition, we examined how these alcohol use trajectories may be shaped by a measure of early behavioral risk, early adolescent delinquency. **Methods:** Participants included 891 12-year olds from the prospective National Longitudinal Survey of Youth-1997 (NLSY97) for whom relevant longitudinal school data were available (51.2% boys; 61.4% White). **Results:** Alcohol use after high-school entry increased at a significantly greater rate than did use during the middle-school years, even after accounting for students' age at transition. In addition, early delinquency emerged as a risk factor such that differences in alcohol use existed prior to the transition. That is, children with early delinquency characteristics displayed more rapid progression in alcohol use, but this effect was evident only during middle school. **Conclusions:** High-school entry appears to be a critical developmental event associated with increased social risk for greater alcohol use that goes beyond the simple maturational (i.e., ageing) factors. Youth with behavioral problems appear to be at greater risk in middle school, in contrast to lower risk youth for whom high school entry may be a more critical event, in part because high school is a less restrictive environment and/or because alcohol use becomes more normative at that time. Adolescent substance use may be described as a series of distinct developmental stages that closely correspond to school transitions, and suggest a critical period for targeted intervention that may differ as a function of pre-existing risk.

Keywords: alcohol, adolescent, trajectory, high-school, transition

Introduction

Rates of alcohol involvement tend to increase during the adolescent years, with young adulthood comprising the period of peak prevalence for alcohol use (Johnston et al., 2010). Adolescence is arguably the time of greatest change: it includes key biological processes and major environmental transitions (Windle et al., 2008) which can contribute to early substance use (Abadi et al., 2011). Indeed, developmental science has recognized adolescence as a critical period of vulnerability during which alcohol and other substance use tends to escalate (Brown et al., 2008). Although both epidemiological and developmental literature support age-related increases in drinking, such changes may in fact be non-linear and discontinuous, with periods of stasis interspersed with periods of growth and decline.

The secondary school environment has been recognized as important social context of early alcohol use (Ennett et al., 2008) and a primary platform for substance use prevention efforts (Brown et al., 2005, Ellickson et al., 2003). However, less attention has been paid to normative developmental changes and shifts associated with school transitions – or how such transitions may shape risky behaviors such as alcohol use. An important developmental transition, or “turning point” (Elder, 1998), that may lead to escalation in alcohol use is the transition from lower to higher educational level, which is generally a time of movement from a more controlled to less restrictive school environment. Although the increase in alcohol involvement that occurs during the transition from high school to college is well-documented (Baer et al., 1995, Johnston et al., 2010), less is known about the patterns of alcohol use during the transition from middle school to high school; i.e., after high-school entry.

A handful of studies have examined changes in alcohol use across the middle school and high school ages. Duan et al. (2009) showed a relatively constant increase in drinking frequency

24 from grades 6 through 12, but did not note a discrete shift in drinking during the transition from
25 middle school to high school. A study by Guo et al. (2000) revealed increases in heavy drinking
26 in the transition from the middle school years (ages 13 and 14) to the high-school years (ages 15,
27 16, and 17); however, this study did not explicitly capture the high school transition. Guilamo-
28 Ramos and colleagues failed to detect grade effects in progression from light experimentation to
29 heavy drinking after one year among 7-11th graders (Guilamo-Ramos et al., 2004), but again, this
30 study did not focus specifically on the transition between middle school and high school. Finally,
31 Simons-Morton (2004) showed that drinking prevalence more than doubled from fall to spring of
32 sixth grade (5.5% vs. 12.6%) but alcohol use was not examined beyond 6th grade in this study.
33 Several studies examining change in alcohol use from adolescence to early adulthood have
34 modeled growth separately for the middle school and high school years (Brown et al., 2005,
35 Capaldi et al., 2009, Crawford et al., 2003, Li et al., 2001). These studies recommend use of
36 piecewise models of growth across these two developmental periods (although there is no
37 empirical evidence cited in support of this recommendation); these piecewise models tend to
38 show a discontinuity in growth rate, suggesting that there is in fact a shift in drinking at the point
39 of the high school transition. Thus, an important research question is whether the high school
40 transition is a critical period for escalation in adolescent alcohol use.

41 In addition, the transition from middle school to high school has been described as a
42 period of increased vulnerability when negative outcomes may be especially apparent among
43 youth who are already at risk (Sullivan and Farrell, 1999). Difficult temperament and early
44 antisocial tendencies (i.e., aggression and delinquent behaviors) are noted independent risk
45 factors for adolescent substance use (Tan et al., 2012). Numerous reports document the strong
46 and unique association between early adolescent delinquency/conduct problems and problematic

47 substance use (Prince and Maisto, 2012, Mason et al., 2010, Wiesner and Windle, 2006). The
48 association between early conduct problems and substance use often persists even after early
49 substance use is accounted for (Rossow and Kuntsche, 2013), and it frequently demonstrates a
50 class- or dose-response pattern where more specific and more severe antisocial problems are
51 associated with greater substance use problems (Eklund and af Klinteberg, 2009). Roeser and
52 colleagues noted in several reports that it is during the adolescent years and not later that some
53 individuals' life paths turn in the direction of antisocial activity, academic failure, and other risk
54 behavior such as drug use and abuse; that is, some youth are already on a pathway toward
55 negative outcomes in later adolescence (Roeser et al., 1999). Thus, it is reasonable to expect that
56 some children are particularly vulnerable to the stress associated with the high school transition
57 (Reyes and Hedeker, 1993). In support of this idea, Li and colleagues found that deviant
58 behavior prior to 9th grade predicted growth in drinking during high school (Li et al., 2001),
59 although this was shown to be true only among those with low (but not high) alcohol use in
60 middle school.

61 *Overview of the present study*

62 The present study draws on a national sample of youth to describe and examine the
63 changes in adolescent alcohol use before and during high-school years. As putative continuities,
64 discontinuities, and complex patterns in alcohol use may not always be fully described with
65 simple linear age models, we examined these behaviors among adolescents by treating time
66 flexibly. Specifically, we utilized an “event”-based approach, in which we examined the
67 expected non-linear changes in adolescent alcohol use as a function of a specific event (i.e.,
68 transition to high-school in this case) which is age-related but does not occur at the exact same
69 age for all participants.

70 We drew on a national prospective study that permitted decoupling of high-school
71 attendance from chronological age: that is, the confounding between school transition and age
72 could be pulled apart in this sample by capitalizing on data on school district regulations
73 regarding the grade of high school entry, as well as on individual student differences in grade
74 promotion and retention. We examined underage alcohol use in relation to timing of a specific
75 event, the high school transition, expecting that alcohol use would increase as adolescents get
76 older, but in a non-linear fashion.

77 Specifically, we were interested in detecting whether the specific ‘event’ of high-school
78 transition would shape adolescent alcohol use. We modeled trajectories of adolescent alcohol use
79 using a linear spline model, explicitly comparing alcohol use before and after the high-school
80 transition. In doing so, we implicitly examined alcohol use trajectories as a function of
81 adolescents’ ‘social’ age (i.e., whether or not the youth has transitioned into high-school) instead
82 of their simple ‘chronological’ age. Finally, we were interested in whether a measure of early
83 behavioral risk would alter trajectories of adolescent alcohol use. Specifically, we examined
84 whether children with early adolescent delinquency tended to have greater drinking rates, as well
85 as more rapidly increasing drinking trajectories over time, again using our approach of
86 delineating time into pre- and post- high-school periods.

87 Method

88 *Participants and Procedure*

89 Data used in this report were drawn from the publicly available National Longitudinal
90 Survey of Youth 1997 (NLSY97) data set, which was designed to describe the transition from
91 school to the labor market and into adulthood using a nationally representative youth sample
92 (Bureau of Labor Statistics, 2012). The NLSY97 utilized a complex sampling strategy and an

93 accelerated longitudinal design, where approximately 9,000 youth born between 1980 and 1984
94 were assessed for the first time in 1997 and then tracked over time through annual follow-up
95 surveys. The NLSY97 currently consists of 14 annual waves or “rounds” (R) of surveys; at each
96 round, youth completed an in-person or telephone-administered questionnaire. The present
97 longitudinal study only utilized data from the initial six rounds of NLSY because the high school
98 transition did not occur beyond the sixth assessment. Retention rates in NLSY97 were very high;
99 for example, 88% of the initial sample completed the first six assessments utilized in this report.

100 For the present study, we utilized data from the youngest cohort 12, i.e., from the
101 participants who were 12 years old at R1 (baseline assessment). There were two primary reasons
102 for this sub-sample selection. First, because our primary question concerned the effects of high-
103 school transition on youth alcohol use, the participants needed to have sufficient number of
104 observations for both the middle school and for the high-school period. This was most likely
105 among the youngest NLSY97 participants, i.e., among Cohort 12 members. Second, we were
106 interested in the potential moderating effects of other early problem behaviors (i.e., delinquency)
107 on adolescent alcohol use, and baseline assessment of delinquency at older cohorts would most
108 likely have a different developmental meaning than the baseline assessment of early delinquency
109 at the age of 12. For these reasons, we only retained those participants from Cohort 12 who had
110 the meaningful and complete data available: i.e., data points for both middle school and high
111 school, as well as the complete demographic and personality variables at R1. These inclusion
112 criteria resulted in the analysis sample of 891 12-year olds at R1. Approximately half of the
113 analysis sample (51.2%) were boys, and almost 2/3 (61.4%) were White. The majority reported
114 being either 13 (R2) or 14 (R3) years old at the first high-school assessment. Characteristics of
115 the selected analytic sample are shown in Table 1.

116 *Measures*

117 *Demographics.* Basic demographics were assessed in Round 1, and were re-coded into
118 dichotomous variables of sex (“1” = boy) and race (“1” = White, including Hispanic Whites).

119 *Early adolescent delinquency (R1, age 12).* Participants’ delinquent behaviors was a
120 count of ten criminal/delinquent activities such as purposely destroying property, running away
121 from home, and selling drugs. This was an overall low-delinquency sample, with an average of
122 0.9 (1.13) delinquent acts at baseline.

123 *Alcohol use.* At each round, participants reported the number of days they drank alcohol
124 during the past 30-day period (Frequency), as well as the average number of drinks per day
125 during the same period (Quantity); see Table 1. These two drinking indicators were used to
126 compute the alcohol use outcome – alcohol average volume – as a product of Quantity and
127 Frequency (QxF) items. Because of the skew, this QxF variable was first re-coded (by adding a
128 value of 1 to each variable to: a) avoid deleting youth who reported non-drinking on only one of
129 the items and b) to enable logarithmic recode) and then log-transformed.

130 *Analytic procedures*

131 Our central question concerned the changes in adolescent alcohol use over time, which
132 we modeled as a non-linear pattern marked by a critical developmental point. Thus, we treated
133 time somewhat flexibly (Singer and Willett, 2003) and examined alcohol use in relation to the
134 timing of a developmentally meaningful event: high-school (HS) entry which occurred at
135 different chronological ages for the participants.

136 To model hypothesized developmental discontinuity (Hernández-Lloreda et al., 2004)
137 and non-linearity of growth (Cudeck and Haring, 2007, Singer and Willett, 2003), we utilized a
138 simple linear spline model: a piece-wise linear regression model in which schooling time for

139 each participant was divided into two developmentally meaningful and distinct segments (i.e.,
140 before and after HS). This simple linear spline model (or the “broken-stick” model) is easily
141 extended to longitudinal growth models of behavioral development (Hernández-Lloreda et al.,
142 2004), and it allows flexibility in modeling of an otherwise non-linear pattern by dividing it into
143 a series of separate and easily comparable linear slopes. In our case, the pre- and post-HS
144 segments were modeled as two independent linear slopes and joined at a single “knot”
145 representing the timing of critical event (Chou et al., 2004, Fitzmaurice et al., 2004). Non-
146 equivalence of these slopes would demonstrate different rates of alcohol use growth during these
147 distinct periods, supporting hypothesized non-linearity in adolescent drinking patterns. In
148 addition, growth in alcohol use during these two time periods could be differentially affected by
149 (possibly different) predictors, which can also be empirically tested.

150 *Creation of pre- and post-high school time periods.* At each annual assessment round,
151 participants were asked to provide information about each school they attended that round. Based
152 on these reports, we were able to code for the round at which participants reported HS attendance
153 for the first time. Because the exact timing of this transition cannot be ascertained based on the
154 available NLSY data, the HS transition was estimated to have taken place between the two
155 known times: 1) the round of the first reported HS attendance, and 2) the previous round (i.e., the
156 last report of middle school attendance). The follow-up interviews were generally carried out
157 mid-school year (the majority of participants were assessed in January or the immediately
158 preceding/following month); thus, we defined the HS transition as the mid-point between the
159 first report of HS attendance and the previous assessment (although there were students for
160 whom this transition took place slightly earlier or slightly later). Consequently, the metric of time
161 was re-cast to reflect neither the simple chronological age nor the current reported grade, but the

162 estimated HS entry for each student and corresponding ‘before’ and ‘after’ periods.

163 All models were estimated as mixed longitudinal models with random intercept and
164 slopes and exchangeable covariance structure using the STATA statistical software. Before and
165 after-HS periods were created using the STATA *mkspline* command, which automatically
166 segmented and coded ‘time in relation to HS transition’ into ‘before’ and ‘after’ HS periods
167 based on time ‘0’ as the selected single knot. The utilized procedure and the general hierarchical
168 linear approach permit use of all available data under the Missing-at-Random (MAR) assumption
169 and the restricted maximum likelihood (REML) estimation method (Fitzmaurice et al., 2004).
170 Fit indices including Akaike’s Information Criterion (AIC) and Bayesian Information Criterion
171 (BIC), and Log Restricted Likelihoods were also reported to inform model evaluation.

172 Results

173 We fit a set of three nested mixed models predicting adolescent alcohol use. The base
174 model (Model 1) addressed whether and how adolescent alcohol use changed over time.¹
175 Putative effects of early delinquency on alcohol use were examined using Model 2 and Model 3.
176 Specifically, Model 2 built upon Model 1 and examined whether early delinquency elevated the
177 risk for alcohol use while controlling for basic demographics (i.e., sex and race); and Model 3
178 examined possible moderating effects of early delinquency by testing the hypothesis that
179 children who exhibited early delinquency problems followed different alcohol use trajectories.

180 *Complex, non-linear growth of adolescent alcohol use*

181 The simple effects of the HS transition (Table 2) are shown in the results for Model 1.
182 Significant increases in alcohol use were observed for both the period before HS ($\beta_{\text{Pre-HS}} = 0.10$,
183 $p = .004$) and after HS entry ($\beta_{\text{Post-HS}} = 0.26$, $p < .001$). However, even though the both periods
184 were marked by a statistically significant growth, alcohol use after HS entry increased more

185 rapidly and at a significantly greater rate than did drinking during the middle-school years ($\beta_{\text{Pre-}}$
186 $\text{HS} = 0.10$ vs. $\beta_{\text{Post-HS}} = 0.26$; *parameter estimate* = $-.15$, $p < .001$).

187 *The effects of early delinquency: Level of adolescent alcohol use*

188 Model 2 tested whether children with greater early delinquency also tended to drink more
189 and more often, after accounting for basic demographics. The results revealed a significant main
190 effect of early delinquency on alcohol use, such that with each additional delinquent act, alcohol
191 QxF scores increased by approximately one-third of a point ($\beta_{\text{Delinquency}} = 0.27$, $p < .001$).

192 Note that the models were relatively unaffected, as the slopes of alcohol use before and
193 after HS remained stable across Model 1 and Model 2; significantly different both from zero
194 ($\beta_{\text{Pre-HS}} = 0.13$, $p < .001$ vs. $\beta_{\text{Post-HS}} = 0.28$, $p < .001$) and from each other (*parameter estimate* = -
195 $.14$, $p < .001$). In other words, even after controlling for basic demographics and early
196 delinquency, delineation of alcohol use marked my HS transition remained stable.

197 *The effects of early delinquency: Changes over time in adolescent alcohol use*

198 Finally, Model 3 tested the hypothesis that children with early delinquency problems
199 would also exhibit differential and possibly the greatest increase in alcohol use over time.
200 Inclusion of an interaction term (Delinquency x Time) was used to test this proposition. We
201 observed significant interactions between early delinquency and time, as measured through the
202 timing of HS transition. Specifically, there was a significant interaction between delinquency and
203 time before HS transition ($\beta_{\text{Delinquency} \times \text{Pre-HS}} = 0.14$, $p < .001$), such that alcohol use before HS
204 transition increased at a greater rate for those children who had greater early delinquency
205 problems. Furthermore, we observed no significant interactions between delinquency and time
206 after HS transition ($\beta_{\text{Delinquency} \times \text{Post-HS}} = 0.002$, *ns*), indicating that during the high-school years
207 alcohol use increased at the same – perhaps more normative – rate for all adolescents, yet the

208 initial levels of alcohol use at the beginning of high-school were very different and shaped by
209 adolescents' early delinquency tendencies. Finally, after accounting for the possible interactions
210 of time and delinquency, the growth of alcohol use before HS was reduced to non-significance
211 ($\beta_{\text{Pre-HS}} = 0.03, p = .46, ns$) while it remained significant during HS years ($\beta_{\text{Post-HS}} = 0.28, p <$
212 $.001$). These overall slopes also significantly differed from one another (*parameter estimate* = -
213 $.24, p < .001$).

214 Following recommendations for probing interaction terms in growth models (Bauer and
215 Curran, 2005, Singer and Willett, 2003), we plotted alcohol use trajectories for those with
216 average delinquency problems (dotted line), for those who scored at the top 10th percentile (i.e.,
217 “high” delinquency group) and for those who scored at the bottom 10th percentile (i.e., “low”
218 delinquency group), with remaining covariates (gender, race) set at sample averages. Figure 1
219 summarizes the results from Model 3, showing the fitted trajectories for adolescent alcohol use
220 as a function of time before- and after- high-school transition and delinquency tendencies. Non-
221 linearity of alcohol use trajectories is demonstrated by the evident sharp ‘break’ in the regression
222 lines at the estimated time of HS transition, after which all adolescents appear to increase their
223 alcohol use at a significant, yet uniform rate. This was indicated by the significant main effect of
224 post-HS time ($\beta_{\text{Post-HS}} = 0.28, p < .001$), but non-significant interaction effect of post-HS time
225 and delinquency ($\beta_{\text{Delinquency} \times \text{Post-HS}} = 0.002, p = .80, ns$), which resulted in parallel slopes of
226 alcohol use for all adolescents during HS years (see Figure 1). In contrast, overall rates of
227 alcohol use before HS entry were relatively low and flat, save for children with high delinquency
228 problems. This was indicated by the non-significant main effect of pre-HS time ($\beta_{\text{Pre-HS}} = 0.03, p$
229 $= .46$), but significant interaction effect of pre-HS time and delinquency ($\beta_{\text{Delinquency} \times \text{Pre-HS}} = 0.14,$

230 $p < .001$), and the resulting differential slopes of alcohol use for three delinquency groups during
231 middle school years (see Figure 1).

232 Finally, an identical set of models was estimated with the addition of the chronological
233 age at transition as a covariate, in order to control for the possible age effects. Save for the
234 anticipated significant main effects of age – where a dose-response effect was observed, such
235 that alcohol use magnified with each additional year of age – the addition of this covariate did
236 not substantially change hereby reported results. For example, the model of most substantive
237 interest (Model 3) was unaffected by the addition of chronological age, as evidenced by identical
238 parameter estimates for the substantive predictors as in the original model reported above:
239 $\beta_{\text{Delinquency}} \text{ (s.e.)} = .25 \text{ (.02)}, p < .001$; $\beta_{\text{Delinquency} \times \text{Before HS}} \text{ (s.e.)} = .14 \text{ (.03)}, p < .001$; $\beta_{\text{Delinquency} \times \text{After HS}}$
240 $\text{ (s.e.)} = -.0007 \text{ (.01)}, ns$.

241 Discussion

242 The goal of this study was to examine trajectories of alcohol use during adolescence and
243 across a normative developmental event; the high-school entry. We found that adolescent alcohol
244 use increased over time, but in a complex fashion dependent on ‘social age’ marked by HS
245 transition. Further, increases in alcohol use were dependent both on the critical developmental
246 event (i.e., the HS entry) and on the children’s own early behavioral profiles. Specifically, our
247 results suggest the importance of critical yet “normative” ecological transitions (Seidman and
248 French, 2004) -- i.e., high-school entry and the associated transitions and changes -- and their
249 effect on the progression of alcohol use among adolescents. Our analytical approach may
250 tentatively be understood as an implicit test of the person-environment interaction in its focus on
251 individual-level delinquency in conjunction with two different and unique environments
252 corresponding to middle-school and high-school. The results underscore the importance of

253 “social age” resulting not only from maturation but also from the shifts in children’s social
254 environments, as well as the interaction of children’s own delinquent tendencies with those
255 unique environments.

256 There may be several explanations for why youth engage in increasingly risky behavior,
257 including substance use, upon high-school entry. This is arguably a potentially disruptive time
258 during which adolescents face increased social and academic stress (Benner, 2011, Eccles and
259 Roeser, 2009), including several specific factors that may elevate their risk for alcohol
260 involvement. High school is a less controlled environment than junior high school, usually with
261 a larger and more diverse student body, lessened adult monitoring, and greater personal freedoms
262 and opportunities (Gillock and Reyes, 1996). This also is a time when adolescents are redefining
263 themselves in terms of their roles (Roeser et al., 1999) and they may feel social pressure to
264 establish new peer groups – not only are preexisting peer groups disrupted, but youth can lose
265 status as they go from being the oldest in middle school to the youngest in high school. The
266 literature consistently shows that peers are one of the greatest influences on youth drinking
267 (Maxwell, 2002) and the importance of peers relative to family is heightened during adolescent
268 years (Zhang et al., 1997).

269 Further, extant literature demonstrates that norms and expectations regarding alcohol use
270 change over time, with high-school potentially being an important junction. For example, with
271 each additional grade, middle school students increased their perceptions of what is normative
272 substance use among their peers (Pedersen et al., 2013), and by high-school, students tend to
273 overestimate prevalence of peer substance use (Page et al., 2002), leading to an increased
274 tendency to drink more themselves (D’Amico and McCarthy, 2006). A study examining alcohol
275 use over the college transition showed that high school students who held the belief that heavy

276 drinking is typical in college were more likely to drink in college (Stappenbeck et al., 2010); a
277 similar phenomenon may occur in the transition from middle school to high-school. Finally,
278 alcohol access increases in high-school (Storvoll et al., 2008), and greater availability of alcohol
279 is associated with alcohol use and problems (Komro et al., 2007). A study comparing sources of
280 alcohol among 6th, 9th, and 12th graders found that whereas 6th graders predominantly obtained
281 alcohol from parents and other family members, friends and parties were much more frequently
282 endorsed for 9th and 12th graders (Harrison et al., 2000).

283 We hypothesized that children with early delinquency problems would show more
284 rapidly increasing drinking trajectories over time, with the expectation that youth who enter high
285 school with already elevated risk will be more sensitive to a range of changes generally
286 associated with high-school entry. However, the present study findings appear more complex.
287 There were indeed important differences in alcohol use as a function of the transition to a new
288 environment and pre-existing risk (early delinquency), but the elevated risk associated with early
289 delinquency was evident only in middle school. That is, alcohol use trajectories during the high-
290 school years were parallel, but youth with high delinquency entered the transition with
291 significantly greater alcohol use than their low-delinquency peers, and consequently remained at
292 elevated use trajectory. In a more restrictive environment such as that experienced by middle
293 schoolers, at a time when alcohol may be more difficult to obtain and its use may be less
294 normative, it was only those children with pre-existing behavioral problems who displayed rapid
295 progression in alcohol use. One might speculate that these youth are seeking out environments
296 that support alcohol consumption (deviant peers, identifying sources of alcoholic beverages).
297 Following the high school transition, however, all adolescents increased their alcohol use; this
298 may reflect the social reality of high-school environment, when alcohol use becomes more

299 accessible, acceptable, and perhaps even implicitly expected of all students. Although our study
300 cannot speak to these mechanisms, each of these possibilities is consistent with our findings and
301 with the literature showing high-school to be both a substantively distinct environment and a
302 unique developmental period. Future research using datasets that include measures such as
303 alcohol availability and alcohol-norms at the school level is necessary to make more concrete
304 inferences as to the processes underlying this phenomenon.

305 *Implications for Substance Use Prevention*

306 The present study pinpointed the timing of a critical period characterized by discontinuity
307 in development, and it implied specific person-environment interactions based on the risk of
308 early delinquency. Further, these findings characterize alcohol use trajectories for both high-
309 delinquency and for more “normative” adolescent behavioral profiles over this sensitive
310 developmental period, possibly suggesting differential prevention strategies – both in terms of
311 timing and targeted groups. The literature on universal interventions emphasizes the importance
312 of timing program implementation to occur during the developmental window when adolescents
313 are just beginning to initiate substance use (Spoth et al., 2009). Despite a lack of clear empirical
314 evidence showing a jump in substance use during the transition from middle school, many
315 prevention programs are initiated in the middle school years, including Project CHOICE
316 (D'Amico and Edelen, 2007), Project ALERT (Ellickson et al., 2003), the Family Check-Up
317 (Van Ryzin et al., 2012) and the Iowa Strengthening Families Program and Preparing for the
318 Drug Free Years Program (Spoth et al., 2009). Clearly, underage substance use interventions are
319 well-informed by considering the role of development upon behavior (D'Amico et al., 2005,
320 Weinstein et al., 1998).

321 The present study provides empirical support for a critical period of risk for targeted
322 interventions, supporting the idea that adolescent substance use is characterized as distinct
323 developmental stages of use that correspond to school transitions, rather than as one continuous
324 developmental trajectory (Crawford et al., 2003). Interventions tailored to stage of alcohol
325 acquisition have shown success (Werch et al., 1996) although clearly the value of using this
326 targeted approach lies in the ability to identify risk factors that predict movement among stages
327 (Weinstein et al., 1998). In addition, it is critical to evaluate the impact of prevention programs
328 among at-risk adolescents making a developmental transition because they are more liable than
329 others to progress to regular use of alcohol. As expected, early delinquency emerged as a general
330 risk factor for substance use (Hayatbakhsh et al., 2008, King et al., 2004, Goodman, 2010): our
331 results point yet again to children with externalizing behavioral problems as being the most
332 likely to progress into alcohol use both more rapidly and more severely. Most importantly,
333 perhaps, is that this elevated risk was manifested well in advance of the normative trends in
334 alcohol use that are characteristic of late adolescence. Clearly these youth are the strongest
335 candidates for targeted early interventions (Ialongo et al., 1999, van Lier et al., 2009,
336 Castellanos-Ryan et al., 2013), and programs that aim to reduce delinquency may result in
337 delayed drinking onset or reduced rates of risky drinking.

338 *Strengths and Limitations*

339 The present study drew on a large general population sample of adolescents and young
340 adults that permitted coding of school transition timing, and de-coupling of chronological age
341 and school attendance timing. This enabled us to conduct more precise examination of the
342 hypothesized transition effects by using linear spline models that explicitly compared the growth
343 in drinking before and after the high-school transition. Nevertheless, our analyses were

344 somewhat constrained by the NLSY study timing and design, including the somewhat dated data
345 (i.e., majority of the NLSY97 sample entered high-school during 1998-1999) and annual spacing
346 of assessments which did not permit a fine-grained consideration of transition effects (e.g.,
347 temporarily elevated drinking resulting from the stress of the transition). Similarly, one would
348 ideally examine these alcohol use trajectories for different ages and delinquency profiles;
349 however, that would require multiple time-varying covariates and multiple higher-order
350 interactions with time (i.e., age X delinquency X time, for both school-delineated segments).
351 There is also no information on characteristics of the transition itself (e.g., school size and
352 quality, stability of friends/peers across the transition). Further, as noted above, although the high
353 school transition is likely associated with changes in peer status, unfortunately the NLSY did not
354 obtain information on peer alcohol use beyond the first wave of the survey; this hindered our
355 ability to examine whether the uniform increase in alcohol-related behaviors observed after high-
356 school entry is due to contemporaneous beliefs and expectations of peer alcohol use as normative
357 during high-school years. We hope that these findings will stimulate future research that
358 considers this important turning point not only for identifying youth at greatest risk but also for
359 identifying potentially modifiable stage-specific mechanisms underlying various risk profiles.
360 Future research on the critical high school transition is necessary to further our understanding of
361 the processes and risk factors underlying patterns of underage alcohol use.

Footnotes

1. Note that Model 1 is also the unconditional means model, examining only the effects of time and whether there is a sufficient heterogeneity in adolescent alcohol use trajectories to warrant further study. Variance components were significantly different from zero, thus supporting further investigation of these temporal trends.

Table 1.

| Variable | <i>N</i> | % or <i>M</i> (<i>SD</i>) |
|--|----------|-----------------------------|
| Gender (% male) | 891 | 51.2% |
| White ^a | 891 | 61.4% |
| Delinquency at age 12 (R1) | 891 | .90 (1.32) |
| Age (round) at first high-school report ^b | | |
| 13 (R2) | 415 | 46.6% |
| 14 (R3) | 372 | 41.8% |
| 15 (R4) | 78 | 8.8% |
| 16 (R5) | 13 | 1.5% |
| 17 (R6) | 13 | 1.5% |
| Number of drinking days past month ^c | | |
| R1 | 890 | .18 (1.54) |
| R2 | 887 | .62 (2.03) |
| R3 | 877 | 1.08 (3.13) |
| R4 | 874 | 1.32 (3.28) |
| R5 | 851 | 1.67 (3.39) |
| R6 | 854 | 2.51 (4.55) |
| Number of drinks per day past month ^c | | |
| R1 | 890 | .19 (2.77) |
| R2 | 886 | .66 (3.55) |
| R3 | 875 | .93 (3.07) |
| R4 | 873 | 1.62 (5.04) |
| R5 | 851 | 1.83 (3.84) |
| R6 | 850 | 2.29 (4.59) |

^a About 1/3 (188/547) of the above defined “Whites” were ethnically Hispanic. The remaining sample was African American (24%), Asian (10%), and mixed race/other (4%).

^b Age (Round) at which participants from the selected cohort first reported attending high-school as part of the NLSY annual assessments.

^c Drinking indicators are hereby reported as distributed in the original NLSY data set -- across assessment waves (rounds), as opposed to across chronological ages or school years (as examined in this report).

Table 2.

| | Estimate (s.e.) | Estimate (s.e.) | Estimate (s.e.) |
|-------------------------|-----------------|-----------------|-----------------|
| | Model 1 | Model 2 | Model 3 |
| Intercept | .27*** (.02) | -.06 (.05) | -.02 (.04) |
| Time before HS | .10*** (.04) ↑ | .13*** (.04) ↑ | .03 (.04) |
| Time after HS | .26*** (.01) ↑ | .28*** (.01) ↑ | .28*** (.01) ↑ |
| Sex (boy) | | .04 (.04) | .04 (.04) |
| White | | .19*** (.04) | .18*** (.04) |
| Delinquency | | .27*** (.01) | .24*** (.02) |
| Delinquency x Before HS | | | .14*** (.03) ↑ |
| Delinquency x After HS | | | .002 (.01) |
| <i>Fit statistics</i> | | | |
| AIC/BIC | 16,733/16,773 | 16,416/16,475 | 16,398/16,470 |
| LL | -8,360 | -8,199 | -8,188 |

Note:

$N = 891$. * $p \leq .05$; ** $p \leq .01$, *** $p \leq .001$.

Arrows in all models indicate terms associated with statistically significant changes in adolescent alcohol use over time (a log-transformed Frequency x Quantity measure of past month alcohol use). Smaller AIC/BIC fit indices suggest a better model fit.

In the estimated spline models, parameter estimates for “Before HS” and “After HS” represent individual slopes for pre- and post-HS intervals (default coding by STATA *mkspline* command, without invoking the ‘*marginal*’ option), and the associated p -values show whether these individual slopes significantly differ from zero, or whether there is a significant growth in alcohol use over those distinct time periods. Additional probing of these effects was conducted, indicating a significant difference between these slopes for every ‘event-based’ model as well: parameter estimate β (s.e.) = $-.16$ (.04), $p < .001$ for Model 1; parameter estimate β (s.e.) = $-.14$ (.04), $p < .001$ for Model 2, and parameter estimate β (s.e.) = $-.24$ (.05), $p < .001$ for Model 3.

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Table Legends:

Table 1.

Sample demographics.

Table 2.

Changes over time in adolescent alcohol use using event-based approach, as a function of demographic and personality characteristics.

Figure Legends:

Figure 1.

Changes in adolescent alcohol use as a function of high-school transition and early delinquency.