Longitudinal Associations Between Depressive Symptoms and Alcohol Problems: The Influence of Comorbid Delinquent Behavior

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Abstract

Objective—Although numerous studies have demonstrated a positive association between depressive symptoms and alcohol problems and related disorders, it remains unclear whether this link can be explained by the joint co-occurrence of these disorders with delinquent behavior. This study examined the longitudinal associations between depressive symptoms and alcohol problems from early adolescence through early adulthood, while accounting for delinquent behavior and the potential interaction effects between delinquent behavior and each of these problems.

Method—The National Longitudinal Study of Adolescent Health sample of 20,728 adolescents, followed for 6 years, was used. Males and females were examined separately. Multilevel modeling was used to predict both initial levels and rate of change in alcohol problems based on levels of depressive symptoms and delinquent behavior (and their interaction), and initial level and rate of change in depressive symptoms based on alcohol problems and delinquent behavior (and their interaction).

Results—Once delinquent behavior was included in the model, the reciprocal positive associations between alcohol problems and depressive symptoms tended to remain significant. Some interactive effects between delinquent behavior and these problems were found, mainly in females.

Conclusions—The reciprocal positive associations between alcohol problems and depressive symptoms over time are not fully due to their joint co-occurrence with delinquent behavior, though delinquent behavior does moderate these links in some cases.

Keywords

comorbidity; alcohol; depression; delinquency; longitudinal; substance use

1. Introduction

The associations between depression and alcohol problems have been discussed for decades (e.g., Zucker, 1986). However, empirical evidence regarding how they relate is conflicting, with some studies finding that depression predicts alcohol problems (e.g., Abraham & Fava,

1999), other studies finding that alcohol problems (alone or in combination with other substances) predict depression (e.g., Bukstein, Glancy, & Kaminer, 1992; Rao, Daley, & Hammen, 2000; Rohde, Lewinsohn, Kahler, Seeley, & Brown, 2001; Stice, Burton, & Shaw., 2004), and some studies finding reciprocal prediction (e.g., Clark et al., 1997; Deykin, Buka, & Zeena, 1992; Hettema, Prescott, & Kendler, 2003; Marmorstein, 2009; Swendsen et al., 1998). Although there are many possible reasons for these conflicting findings, the joint co-occurrence of both types of problems with delinquent behavior is an important factor that may affect the apparent association between depressive symptoms and alcohol problems. Specifically, factor-analytic studies have shown that alcohol dependence falls on the "externalizing spectrum" and tends to occur together with other disorders and traits on this spectrum (specifically, drug dependence, conduct disorder, adult antisocial behavior, disinhibited personality style; e.g., Krueger et al., 2002). This externalizing factor among youth (defined as attention-deficit hyperactivity disorder, oppositional defiant disorder, and conduct disorder) has been shown to be distinct from, yet significantly correlated with, major depression (Lahey et al., 2008), raising the possibility that links between depressive symptoms and alcohol problems are merely an artifact of the joint correlations between delinquent behavior and alcohol problems and between delinquent behavior and depressive symptoms. This study examined the longitudinal associations between depressive symptoms and alcohol problems in a community-based sample of youth, while accounting for delinquent behavior and potential interactive effects between delinquent behavior and depressive symptoms and alcohol problems in the models. By using an analytic approach that examined within-person trajectories of each problem over time, we were able to examine the effect of each problem on both initial levels and change over time in the other problem, while simultaneously considering the potential main and interactive effects of delinquent behavior.

There has been a small amount of previous research addressing the question of whether the presence of delinquent behavior (or related constructs) moderates the association between depressive symptoms (or major depression) and alcohol problems (or problems related to substances in general). Cross-sectional studies have demonstrated that the presence of major depression and conduct disorder together is related to significantly higher levels of substance dependence symptoms than the presence of either disorder alone (Marmorstein & Iacono, 2001, 2003) and that there is a significant association between major depression and alcohol use disorders even once the effect of disruptive behavior disorders was adjusted for (Roberts, Roberts, & Xing, 2007). However, longitudinal studies are more conflicting. Among boys, Pardini, White, and Stouthamer-Loeber (2007) found that depression only predicted alcohol use disorders among boys with high levels of co-occurring conduct disorder symptoms. Recently, Mason, Hitchings, and Spoth (2008) reported a different interaction effect: conduct problems and depressed mood during adolescence interacted such that conduct problems were most strongly associated with substance use at age 18 among participants with *low* levels of depressed mood. Although there was no overall main effect of depressed mood, it was positively (though non-significantly) associated with later substance use at low levels of conduct problems and negatively (though non-significantly) associated with later substance use at high levels of conduct problems. Thus, the literature to date is conflicting regarding two related issues: (1) whether there is a significant association between depressive symptoms and alcohol problems once the effect of co-occurring delinquent behavior is accounted for, and (2) what the nature of any interaction effect between depressive symptoms and delinquent behavior in the prediction of alcohol problems may be.

The goal of this study was to examine how the inclusion of delinquent behavior affected multilevel models of the associations between alcohol problems and depressive symptoms over time. Specifically, two questions were addressed: (1) what is the effect of including delinquent behavior in the models (for example, does delinquent behavior account for enough of the variance in alcohol problems that depressive symptoms no longer predict alcohol problems?);

and (2) does delinquent behavior interact with depressive symptoms or alcohol problems in the prediction of alcohol problems or depressive symptoms, respectively (for example, do depressive symptoms predict growth in alcohol problems, but only at high levels of delinquent behavior?). It was expected that delinquent behavior would be positively associated with each outcome (depressive symptoms and alcohol problems) but that including it in the models would not eliminate the significant reciprocal associations between alcohol problems and depressive symptoms. It was also predicted that delinquent behavior would interact positively with both depressive symptoms and alcohol problems to predict even higher levels of the other problem; it was considered possible that these positive interaction effects would appear more strongly in the prediction of initial levels than in the prediction of change over time (slope terms).

2. Method

2.1 Participants

Participants were assessed as part of the National Longitudinal Study of Adolescent Health (AddHealth) data set (the restricted-use contractual version; Udry, 2003), a community-based longitudinal study of adolescents in the United States. This data analysis project was approved by the Rutgers University Institutional Review Board. First, the AddHealth team identified a stratified, random sample of seventh- through twelfth-grade students from high schools in the United States (Wave 1, 1994–1995; age range = 11–21; $n = 20,728$). In-home interviews with the participants and their mothers were then completed with a subsample of these participants, including over-samples of some special populations. Approximately 1 year later (1996), in-home follow-up assessments were conducted with 71% ($n = 14,738$) of these adolescents (age range = 11–23; Wave 2); participants who were no longer in high school (i.e., those who were in 12th grade at Wave 1) were not recruited to participate at this time. Approximately 6 years after the initial assessment (2001–2002), participants were invited to participate in in-home interviews again; 73% of the Wave 1 sample ($n = 15,197$) did so (age range 18–28; Wave 3). All participants who contributed data at any of the 3 assessment points were included in this study. Details regarding the design of the AddHealth study can be found in Harris et al. (2003).

Participants averaged 15.66 (SD = 1.75), 16.22 (SD = 1.65), and 21.96 (SD = 1.77) years old at Waves 1, 2, and 3, respectively. At Wave 1, sixty-one percent were Caucasian, 23% were African-American, 8% were Asian-American or Pacific Islander, and 4% were Native American. In addition, 17% were Hispanic or Latino. Mothers reported that 9.7% of families were receiving welfare or another form of public assistance.

Because participants were initially assessed at different ages, we checked for cohort differences in mean symptom levels at each age to ensure that those who were, for example, assessed at age 18 at Wave 1 did not differ from those who were assessed at age 18 at Wave 3 (and were therefore 12 at Wave 1). There was no evidence that symptom levels differed substantially based on the age at which the participants were first assessed—that is, mean levels of symptoms were similar at each age regardless of whether it was the participants' Wave 1, Wave 2, or Wave 3 assessment. Specifically, the *largest* differences in mean symptom levels across cohorts were less than one-quarter and one-sixth of a standard deviation for depressive symptoms and alcohol problems, respectively, and the vast majority of mean differences were less than one-tenth of a standard deviation. Because of this lack of cohort differences, it was reasonable to combine participants who were initially assessed at different ages into one study.

At Wave 1, 78.9% of selected adolescents participated in the in-home interview. Response rates were 88.2% at Wave 2 and 77.4% at Wave 3. To assess for the possibility of differential attrition, participants who were assessed at both Wave 1 and Wave 3 were compared to participants who only completed the Wave 1 assessment on levels of depressive symptoms,

alcohol problems, and delinquent behavior (Wave 2 was not included in this attrition analysis because participants who had graduated from high school between Wave 1 and Wave 2 were intentionally not assessed at Wave 2). Mean levels of Wave 1 depressive symptoms were similar in these groups (t = −.98, *p* > .05). Wave 3 non-participants had slightly higher mean levels of alcohol problems at Wave 1 (t = −3.52, *p* < .001), but this effect seemed to be related to the higher levels of Wave 3 non-response among older participants (who were more likely to have had alcohol problems at Wave 1, due to being in late, as opposed to early, adolescence). Specifically, mean levels of Wave 1 alcohol problems among participants who did and did not participate at Wave 3 were similar when participants of similar ages were examined (e.g., when Wave 3 participants and non-participants who were 12–13 and 17–18 at Wave 1 were compared separately, there were no differences in alcohol problems between the groups [t = −1.44, *p* > .05 and t = −1.17, *p* > .05, respectively]). Wave 3 non-participants had higher levels of delinquent behavior at Wave 1 than Wave 3 participants (t = 3.26, *p* < .01); this effect seemed to be driven by younger participants (among participants who were 12–13 at Wave 1, higher levels of delinquent behavior were associated with lower levels of T3 assessment [t = 3.08, *p* < .01], but among participants who were 17–18 at Wave 1, there were no differences in delinquent behavior between Wave 3 participants and non-participants [t = 0.56, *p* > .05]).

2.2 Measures

2.2.1 Depressive symptoms—Participants responded to nine depression-related questions, drawn from the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), at all three assessments. Each item asked about a symptom that the participant may have had during the past week and was rated on a 4-point scale (never/rarely, sometimes, a lot of the time, most of the time/all of the time). This resulted in a scale ranging from 0 to 27 (actual maximum score = 27). The mean total score (across all waves and ages) was 5.55 (standard deviation [SD] = 4.26). Standardized Cronbach's alpha coefficients ranged from .80 at the first assessment to .81 at the third assessment. This scale correlated highly with the longer scale that was administered at Waves 1 and 2 (*r* = .95 at Wave 1, *r* = .96 at Wave 2) and has previously been shown to have a high degree of validity (e.g., Rende, Slomkowski, Lloyd-Richardson, Stroud, & Niaura, 2006; Steuber & Banner, 2006). Studies of community-based samples of adolescents have reported that the CES-D is strongly associated with diagnoses of major depression (e.g., Prescott, Aggen, & Kendler, 1998).

2.2.2 Alcohol problems—Participants responded to seven questions regarding alcohol problems at all three assessments. Each asked about the participant's frequency of experiencing various types of problems that may occur as a result of alcohol use during the past twelve months (e.g., "…you've had problems at school or with school work because you had been drinking"). Each item was rated on a 5-point scale ("never" to "5 or more times"), resulting in a scale ranging from 0 to 35 (actual maximum score = 28). The mean score (across all waves and ages) was 1.47 (SD = 2.95; median = 0.00); among people who had used alcohol at least 2–3 times, the mean score was 2.82 (SD = 3.57; median = 2.00). Scores were log-transformed due to skew. Standardized Cronbach's alpha coefficients ranged from .74 at the first assessment to .76 at the third assessment.

2.2.3 Delinquent behavior—Participants responded to seven delinquent behavior-related questions at all three assessments. Each asked about a behavior that the participant may have had engaged in during the past year (e.g., "…deliberately damage property that didn't belong to you," "…use or threaten to use a weapon to get something from someone," "…steal something worth more than $50"). Each item was rated on a 4-point scale (0 = never engaged in this behavior during the past 12 months; 1 = 1–2 times; 2 = 3–4 times; 3 = 5 or more times). This resulted in a scale ranging from 0 to 21 (actual maximum score = 21). The mean total score (across all waves and ages) was 0.94 (SD = 2.05). Scores were log-transformed due to

skew. Standardized Cronbach's alpha coefficients ranged from .71 at the third assessment to .77 at the first assessment. Although some researchers use a narrow definition of delinquent behavior, typically referring to law-breaking behavior among youth under age 18, because the AddHealth study refers to the interview module from which these items are drawn as "delinquency" regardless of the age at which it was administered, we use that word to refer to these behaviors in this study.

2.2.4 Gender—Based on information obtained at the first assessment, males were coded zero and females were coded one.

2.2.5 Age—Each participant's age was recorded at each assessment.

2.3 Statistical Analyses

First, each participant's score on each measure at each assessment *wave* was converted to a score at each *age* he or she was assessed. Each participant contributed data at his or her set of three ages (e.g., ages 12, 13, and 18 for one participant; ages 17, 18, and 23 for another). All participants who contributed data on the relevant variables at any point in the study were included in these analyses. Scores for delinquent behavior and alcohol problems were log-transformed to correct for skew.

Next, Pearson correlations between depressive symptoms and alcohol problems at each age were computed. Partial correlations between these problems, adjusting for delinquent behavior, were then computed.

Multilevel models (sometimes referred to as growth curve models or mixed effects models; Singer, 1998) were used to investigate the effect of depressive symptoms on alcohol problem trajectories over time and the effect of alcohol problems on depressive symptom trajectories over time, while adjusting for delinquent behavior and examining its interactions with each independent variable. Models were estimated using PROC MIXED in the Statistical Analysis System (SAS) version 9.1. Full information maximum likelihood estimation (ML) was used in order to compare the fit of nested models and in order to use all available data (missing data were treated as missing at random; Singer & Willett, 2003). Both the likelihood ratio test (LRT; comparing the −2 log likelihood of nested models) and the Bayesian Information Criterion (BIC) were used to assess model fit (Singer & Willett, 2003).

Based on previous research with this sample (Marmorstein, 2009), models including quadratic slope terms were estimated, and separate models were built for males and females due to evidence that these associations may differ by gender. For each gender, first, depressive symptoms at each time point (a time-varying predictor) were entered as predictors of alcohol problems. Next, delinquent behavior was added to the model, both as a main effect and in interaction with depressive symptoms in order to examine whether accounting for delinquent behavior impacted the associations between depressive symptoms and the trajectory of alcohol problems (full model). The final model was determined by examining both the pattern of significance of the predictors and the fit statistics of the models.

Next, analogous models were estimated using depressive symptoms as the dependent variable and alcohol problems and delinquent behavior as predictor variables. Briefly, models including (1) slope terms and alcohol problems only and (2) slope terms, delinquent behavior, and alcohol problems were examined.

These analyses result in models in which the main effects of each predictor variable reflect the influence of the predictor on the initial level of the dependent variable. Interaction effects of the predictors with the slope terms indicate how the predictor variable was associated with a

deflection in the individual's score on the dependent variable off of the typical developmental trajectory. A non-significant interaction between the independent variable (alcohol problems or depressive symptoms) and the slope term(s) (linear and/or quadratic) indicates that the association between these problems remains similar at different ages. A significant interaction between the independent variable and slope term(s) indicates that the effect of the predictor varied at different points in development. The intercepts and slopes are estimated independently; therefore, the estimate of initial values is separated from the estimate of change over time.

3. Results

3.1 Correlations

Partial correlations (adjusted for delinquent behavior) revealed a steadily decreasing strength of association between depressive symptoms and alcohol problems for females from early adolescence through early adulthood (significant at ages 12–18, $r = .21$ at 12 and $r = .06$ at 18, and non-significant after that). In contrast, for males, there were significant positive correlations near the end of high school (ages 16 and 17, $r = .05$ and $.06$, respectively) and around the time participants who attended college would have been graduating (ages 22 and 23, $r = .06$ at both ages). In contrast, at age 19, there was a significant negative correlation for males ($r = -.07$). These correlations that were adjusted for the effect of delinquent behavior were smaller in magnitude but mirrored the overall (non-adjusted) Pearson correlations, which showed a decreasing strength of association between depressive symptoms and alcohol problems with increasing age among females and relatively stronger associations in mid-to-late adolescence and again in the early 20s for males.

3.2 Trajectories of Alcohol Problems

3.2.1 Males—Parameter estimates (and standard errors), the significance levels of t-values associated with each parameter estimate, and fit statistics for all models predicting alcohol problems for males are presented in Table 1. In the model with depressive symptoms only, depressive symptoms predicted initial levels of alcohol problems. Next, delinquent behavior and its interaction with depressive symptoms were added to the model (full model) and then non-significant terms were removed from the model and fit statistics were used to determine the best-fitting final model. This final model that included significant, positive main effects of both delinquent behavior and depressive symptoms on initial alcohol problems, indicating that both problems were associated with higher initial levels of alcohol problems. There was also an interaction effect such that males with higher levels of both depressive symptoms and delinquent behavior were at especially high risk for relatively high initial levels of alcohol problems. In addition, the effect of delinquent behavior on linear growth was significant, indicating that more delinquent behavior was associated with a faster rate of growth in alcohol problems. A prototypical plot of this model is depicted in Figure 1.

3.2.2 Females—Parameter estimates (and standard errors), the significance levels of t-values associated with each parameter estimate, and fit statistics for all models predicting alcohol problems for females are presented in Table 2. In the model with depressive symptoms only, depressive symptoms predicted initial levels of alcohol problems. Next, delinquent behavior and its interaction with depressive symptoms were added to the model (full model), and then non-significant terms were removed from the model and fit statistics were used to determine the best-fitting final model. This final model included a positive main effect of depressive symptoms on initial alcohol problems, indicating that higher levels of depressive symptoms were associated with higher initial levels of alcohol problems. In addition, there was an interaction effect such that females with higher levels of both depressive symptoms and delinquent behavior were at especially high risk for relatively high levels of alcohol problems.

However, this combination of high depressive symptoms and high delinquent behavior related to a slightly slower rate of growth in alcohol problems. Delinquent behavior predicted a faster rate of growth, though slightly less curvature in the trajectory of growth, of alcohol problems. Depressive symptoms did not significantly predict growth in alcohol problems over time. A prototypical plot of this model is depicted in Figure 2.

3.3 Trajectories of Depressive Symptoms

3.3.1 Males—Parameter estimates (and standard errors), the significance levels of *t*-values associated with each parameter estimate, and fit statistics for all models predicting depressive symptoms for males are presented in Table 3. In the model with alcohol problems symptoms only, alcohol problems predicted higher initial levels of depressive symptoms. Alcohol problems also predicted slightly slower growth in, but less curvature in the slope of, depressive symptoms over time. Next, delinquent behavior and its interaction with alcohol problems were added to the model (full model), and then non-significant terms were removed from the model and fit statistics were used to determine the best-fitting final model. This final model included positive main effects of both delinquent behavior and alcohol problems on depressive symptoms, indicating that both problems were associated with higher initial levels of depressive symptoms. Alcohol problems were associated with a somewhat slower rate of overall (linear) change over time, but less curvature in the slope of the change. A prototypical plot of this model is depicted in Figure 3.

3.3.2 Females—Parameter estimates (and standard errors), the significance levels of *t*-values associated with each parameter estimate, and fit statistics for all models predicting depressive symptoms for females are presented in Table 4. In the model with alcohol problems only, alcohol problems predicted higher initial levels of depressive symptoms. Alcohol problems also predicted slightly slower growth in, but less curvature in the slope of, depressive symptoms over time. Next, delinquent behavior and its interaction with alcohol problems were added to the model (full model), and then non-significant terms were removed from the model and fit statistics were used to determine the best-fitting final model. This final model included positive main effects of both delinquent behavior and alcohol problems on initial depressive symptoms, indicating that both problems were associated with higher initial levels of depressive symptoms. In addition, there was an interaction effect such that females with higher levels of both depressive symptoms and delinquent behavior were at somewhat lower risk for relatively high levels of alcohol problems than would be expected based on the additive positive effects of delinquent behavior and alcohol problems. In addition, higher levels of alcohol problems predicted slower growth in (though less curvature in the trajectory of) of depressive symptoms over time, though the combination of higher levels of alcohol problems and delinquent behavior predicted faster growth in depressive symptoms over time. A prototypical plot of this model is depicted in Figure 4.

4. Discussion

The results of this study indicated that once the effects of delinquent behavior were taken into account, alcohol problems and depressive symptoms reciprocally predicted each other, though the strength and direction of effects depended somewhat on gender and whether initial level or rate of change was examined (indicating that these effects differed at different ages). Speaking generally about all analyses, it appeared that: (1) once the effects of delinquent behavior were taken into account, there were stronger links between depressive symptoms and alcohol problems at younger, compared to older, ages; and (2) there were more interaction effects between delinquent behavior and the other problems (depressive symptoms and alcohol problems) among females compared with males, indicating that the presence of comorbid delinquent behavior may have affected these associations more strongly in females than males.

Turning to the specific results, when predicting initial levels of alcohol problems, main effects of delinquent behavior, depressive symptoms, and their interaction were all important for both males and females, indicating that both delinquent behavior and depressive symptoms were associated with high levels of alcohol problems in early adolescence and that their combination was particularly toxic. In both sexes, delinquent behavior was associated with growth in alcohol problems over time; however, among females the combination of relatively high levels of delinquent behavior and depressive symptoms was associated with a different trajectory of growth (slower increase but more curvature) such that by early adulthood, the model-predicted levels of alcohol problems were similar among those with high delinquent behavior and high depressive symptoms and those with high delinquent behavior but low depressive symptoms.

Turning to the prediction of initial levels of depressive symptoms, both delinquent behavior and alcohol problems were associated with increased levels; among females, though, the combination of high levels of delinquent behavior and alcohol problems together related to lower initial levels of depressive symptoms than would be predicted based on additive effects alone. Among males, alcohol problems were associated with slower growth in (and a flatter trajectory of) depressive symptoms, so that by early adulthood alcohol problems related to less of an increase in depressive symptoms than they did in early adolescence. Among females, this same growth effect was found, but in addition, the combination of delinquent behavior and alcohol problems was related to more positive growth in depressive symptoms over time than would otherwise have been predicted.

Overall, the results of this study indicate that co-occurring delinquent behavior does not fully account for the link between depressive symptoms and alcohol problems. This is important because previous studies that have not examined this potential moderating factor may have overestimated the link between depression and alcohol problems by, for example, using samples of conduct-disordered youth (e.g., Riggs, Baker, Bilulich, Young, & Crowley, 1995) or samples of youth who were in treatment for substance-related problems (e.g., Deykin et al., 1992; Bukstein et al., 1992). This study demonstrated that, although part of the association between these disorders may be accounted for by the fact that both disorders are associated with delinquent behavior, delinquent behavior did not *fully* account for their apparent association. This is consistent with previous research that has shown significant links between depression and substance use disorders even once the effects of disruptive behavior disorders or conduct problems are adjusted for (Roberts et al., 2007), but not consistent with research that has found that these associations become non-significant once the effects of conduct problems are adjusted for (Pardini et al., 2007). The study by Pardini and colleagues examined boys' depressive symptoms and conduct problems at a single time point in early adolescence (approximately age 14) and assessed alcohol use disorders in early adulthood (ages 20 and/or 25); perhaps multiple assessments at different time points in development are needed, or perhaps these links are weak enough by early adulthood as to render non-significant effects that may have been present in early adolescence.

The results of this study also highlighted the interactive effects of delinquent behavior with alcohol problems and depressive symptoms. Specifically, high levels of delinquent behavior and depressive symptoms were particularly predictive of high initial levels of alcohol problems among both females and males (though this interaction was also associated with slightly slower growth among females); this is consistent with previous research (Marmorstein & Iacono, 2001, 2003). There was also a positive interaction effect of delinquent behavior and alcohol problems on the rate of change in depressive symptoms among females, though this same combination was related to lower initial levels of depressive symptoms than would be expected based on the additive effects of delinquent behavior and alcohol problems. It is interesting to note that most interaction effects with delinquent behavior occurred in females and the one significant interaction effect for males was significant only at the $p < .05$ level; this may indicate

that the presence of delinquent behavior along with other symptoms of psychopathology affects the functioning or meaning of psychopathology in females more than males.

Inspection of the model-predicted values for people with high and low levels of predictor variables (the figures) reveals patterns of associations that differed at different stages of development. When predicting alcohol problems in males, the effects were consistent over time, with delinquent behavior exerting a small effect and depressive symptoms exerting a smaller effect. In contrast, developmental differences were present for the three other sets of analyses. When predicting alcohol problems in females, early-adolescent girls with high levels of both depressive symptoms and delinquent behavior were at the highest risk for alcohol problems, but by early adulthood, in the presence of high levels of delinquent behavior, depressive symptoms did not make a substantial difference. Turning to the prediction of depressive symptoms, among early-adolescent males, high levels of delinquent behavior and alcohol problems combined predicted particularly high levels of depressive symptoms. However, by early adulthood, this interaction effect became less prominent—young men with both high levels of alcohol problems and delinquent behavior only had slightly higher levels of depressive symptoms than those with only one of these problems. Similarly, among early-adolescent females, high levels of delinquent behavior and alcohol problems combined predicted particularly high levels of depressive symptoms. Although this interaction effect diminished from late adolescence into the transition to adulthood (during which time delinquent behavior carries the most weight in the prediction of depressive symptoms), it began to increase again in early adulthood, such that those young women with delinquent behavior and alcohol problems again had more depressive symptoms, as they did in early adolescence. Thus, although there was no simple and consistent effect of age, it is clear that these associations differ at different points in development.

Because it provides information about which youth are especially at risk for depressive symptoms and alcohol problems, this study has several implications for treatment and prevention. Based on the model-predicted values depicted in the figures, youth with delinquent behavior, and especially early adolescent girls with both delinquent behavior and depressive symptoms, are at high risk for alcohol problems and should therefore be carefully assessed for their substance use patterns and related problems. Young-adult females with delinquent behavior are also at especially high risk for alcohol problems. Early adolescents with both delinquent behavior and alcohol problems are at especially high risk for depressive symptoms; although it could be easy to overlook internalizing symptoms in the presence of significant externalizing behavior and substance problems, it is important to assess these youth for depressive symptoms and treat them if necessary. Also, clinicians should be aware that alcohol problems appear to be less of a risk factor for depressive symptoms (once the effect of delinquent behavior is accounted for) during the transition to adulthood than prior to that (during adolescence) or after that (in early adulthood); this may be because heavy alcohol use is common during the transition to adulthood (White, Xie, Thompson, Loeber, & Stouthamer-Loeber, 2006).

This study has several strengths, including its use of a large national sample of both males and females who were followed for six years. The fact that it included participants from early adolescence through early adulthood, an important developmental period for the development of depressive symptoms, alcohol problems, and delinquent behavior, also represents a strength. In addition, we were able to examine how depressive symptoms and alcohol problems predicted both initial levels and rate of change in the other problem, providing some indication about how these problems are related over time rather than limiting the analysis to a particular set of two assessment points. However, this study had limitations as well. Clinical diagnoses of depression and alcohol use disorders were not used; instead, dimensional measures of each problem were examined. Overall mean levels of these problems were fairly low, as would be

expected in a community-based sample. Therefore, it is not clear how these results would apply to people with diagnosable disorders, or to clinical populations. The assessment periods for each problem differed as well. Specifically, alcohol problems and delinquent behavior that may have occurred in the past year were assessed, while depressive symptoms that may have occurred in the past week were assessed. Therefore, it is possible that problems that appeared concurrent actually were not. However, these differing assessment windows may correspond to people's ability to report problems accurately: for example, people may remember getting suspended from school for drinking in the past year, but may not remember that they had a somewhat elevated depressed mood several months ago. Finally, because we did not apply sample weights to the data, these results cannot be generalized to the entire population of adolescents living in the United States.

The results of this study lead to several broad conclusions. First, co-occurring delinquent behavior does not appear to fully account for the apparent link between alcohol problems and depressive symptoms. Second, the links between delinquent behavior, depressive symptoms, and alcohol problems vary by gender and age. Specifically, in general terms, alcohol problems and depressive symptoms appeared to have stronger reciprocal effects in early adolescence than in early adulthood. In addition, it is possible that interactive effects of delinquent behavior and the other problems are more prominent among females than males. Future studies examining potential mediators and moderators of these associations and/or different subgroups would be particularly useful.

Acknowledgments

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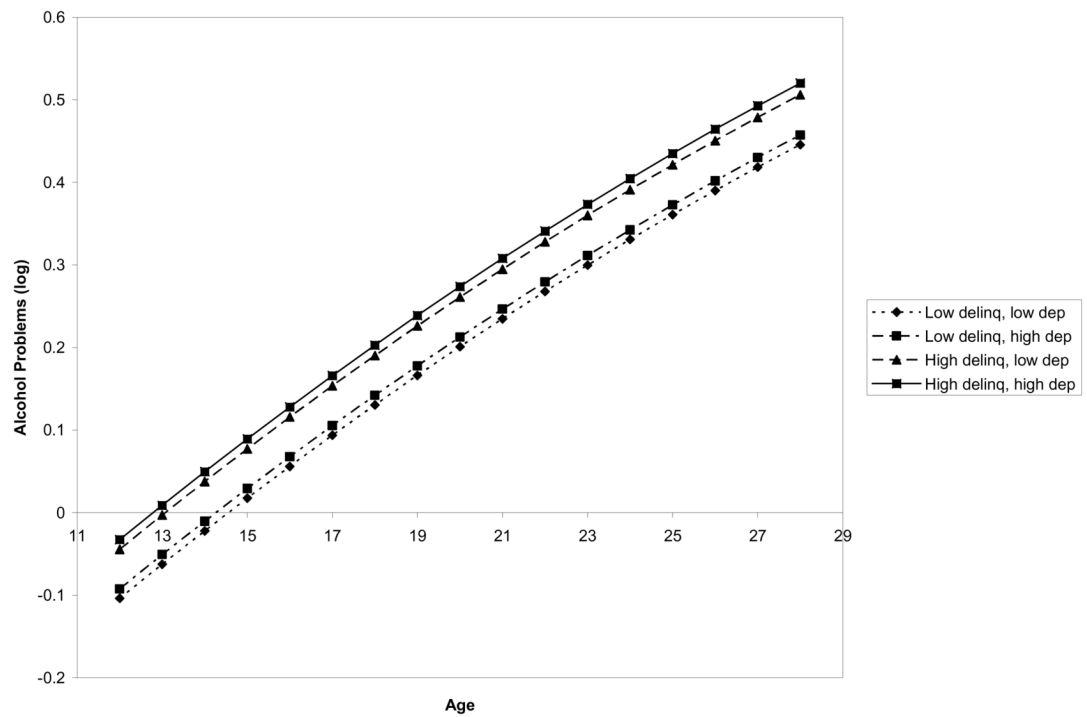
Figure 1.
Trajectories of alcohol problems among males, by level of depressive symptoms and delinquent behavior (*n*=20,728). "Low"=25th percentile, "high"=75th percentile.
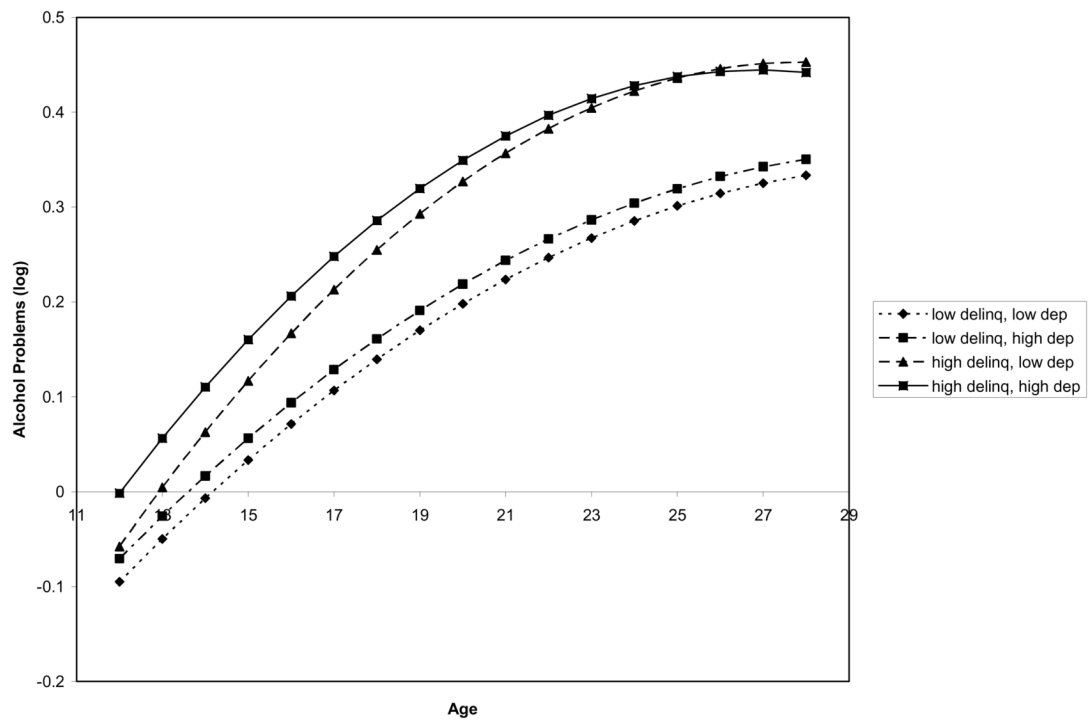
Figure 2.
Trajectories of alcohol problems among females, by level of depressive symptoms and delinquent behavior (*n*=20,728). "Low"=25th percentile, "high"=75th percentile.

Figure 3.
Trajectories of depressive symptoms among males, by level of alcohol problems and delinquent behavior (*n*=20,728). "Low"=25th percentile, "high"=75th percentile.
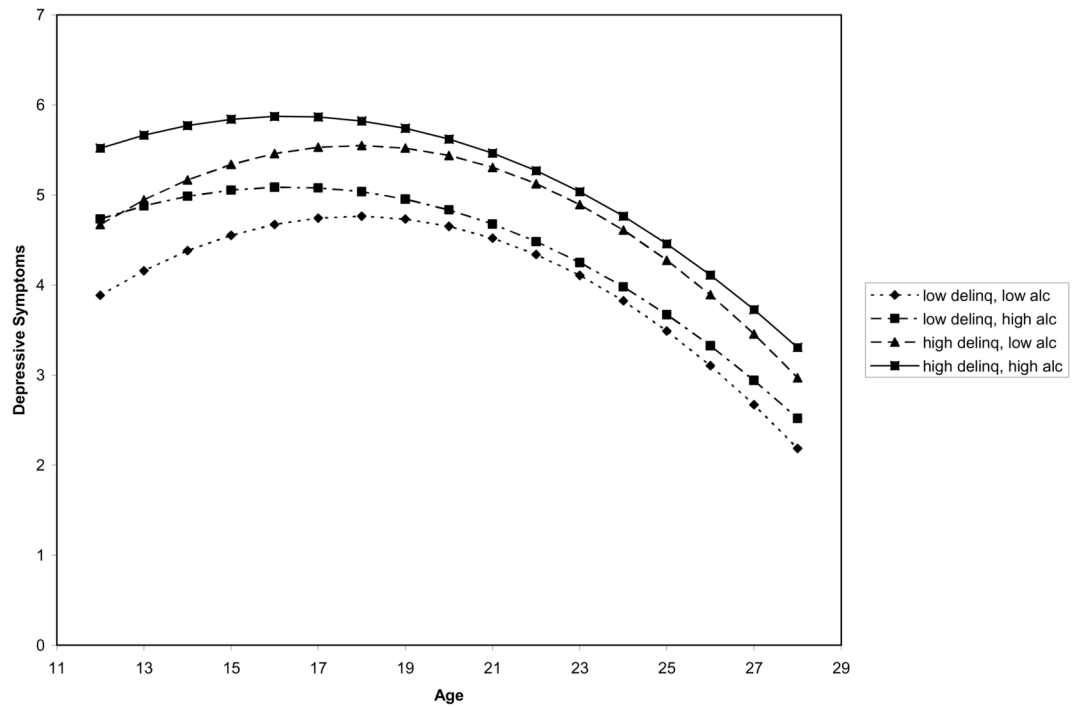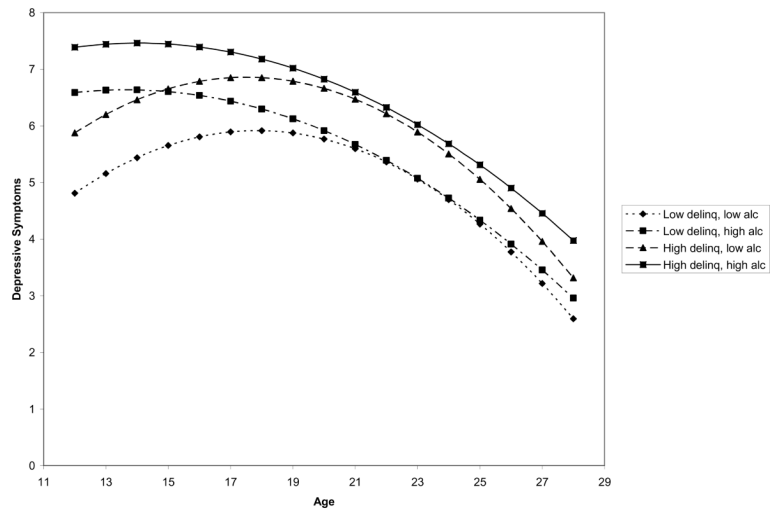
Figure 4.
Trajectories of depressive symptoms among females, by level of alcohol problems and delinquent behavior (*n*=20,728). "Low"=25th percentile, "high"=75th percentile.

Table 1

Predicting Alcohol Problems Among Males

	Model with Depressive Symptoms	Full Model (Delinquent Behavior and Depressive Symptoms)	Final Model
Initial Status:			
Intercept	$-.1059^{***}$ (.0129)	$-.0848^{***}$ (.0146)	$-.1086^{***}$ (.0085)
Delinquent behavior		.0817 (.0452)	$.1247^{***}$ (.01595)
Depressive symptoms	$.0052^{*}$ (.0022)	$-.0023$ (.0027)	$.0023^{***}$ (.00067)
Delinquent Behavior × Depressive symptoms		.0089 (.0069)	$.0037^{*}$ (.0015)
Rate of Change:			
Time (linear)	$.0566^{***}$ (.0043)	$.0358^{***}$ (.0048)	$.0419^{***}$ (.0026)
Time (quadratic)	$-.0013^{***}$ (.0003)	$-.0002$ (.0003)	$-.0005^{**}$ (.0002)
Delinquent behavior × linear time		$.0447^{**}$ (.0148)	$.0359^{***}$ (.0022)
Depressive symptoms × linear time	.0080 (.0007)	.0010 (.0008)	
Delinquent behavior × Depressive symptoms × linear time		$-.0004$ (.0022)	
Delinquent behavior × quadratic time		$-.0001$ (.0010)	
Depressive symptoms × quadratic time	$-.00004$ (.00005)	$-.00003$ (.00006)	
Delinquent behavior × Depressive symptoms × quadratic time		$-.00008$ (.00015)	
Fit Statistics:			
$-2LL$	12063.3	9213.0	9224.6
BIC	12174.1	9379.3	9344.7

* $p<.05$;

** $p<.01$;

*** $p<.001$

Table 2

Predicting Alcohol Problems Among Females

	Model with Depressive Symptoms	Full Model (Delinquent behavior and Depressive Symptoms)	Final Model
Initial Status:			
Intercept	−.1149*** (.0122)	−.0908*** (.0129)	−.1071*** (.0094)
Delinquent behavior		.0252 (.0534)	.0711 (.0383)
Depressive symptoms	.0140*** (.0017)	.0010 (.0020)	.0041*** (.0010)
Delinquent behavior × Depressive symptoms		.0249*** (.0060)	.0175*** (.0031)
Rate of Change:			
Time (linear)	.0542*** (.0040)	.0408*** (.0042)	.0467*** (.0027)
Time (quadratic)	−.0017*** (.0003)	−.0008** (.0003)	−.0012*** (.0002)
Delinquent behavior × linear time		.0830*** (.0191)	.0652*** (.0117)
Depressive symptoms × linear time	−.0009 (.0005)	.0010 (.0006)	−.0001 (.0001)
Delinquent behavior × Depressive symptoms × linear time		−.0048* (.0021)	−.0021*** (.0006)
Delinquent behavior × quadratic time		−.0040** (.0015)	−.0026** (.0008)
Depressive symptoms × quadratic time	−.000001 (.000037)	−.0001 (.00004)	
Delinquent behavior × Depressive symptoms × quadratic time		.0002 (.0002)	
Fit Statistics:			
−2LL	9563.4	7400.8	7404.5
BIC	9674.4	7567.4	7552.6

*
$p<.05$;

**
$p<.01$;

***
$p<.001$

Table 3

Predicting Depressive Symptoms Among Males

	Model with Alcohol Problems	Full Model (Delinquent behavior and Alcohol Problems)	Final Model
Initial Status:			
Intercept	4.2863*** (.1190)	3.8470*** (.1386)	3.8851*** (.1185)
Delinquent behavior		1.8253*** (.4303)	1.6475*** (.0836)
Alcohol Problems	2.8163*** (.4161)	3.2133*** (.6639)	1.7783*** (.4162)
Delinquent behavior × Alcohol Problems		−2.8039* (1.1038)	
Rate of Change:			
Time (linear)	.2886*** (.0366)	.3059*** (.0422)	.2979*** (.0361)
Time (quadratic)	−.0264*** (.0024)	−.0257*** (.0028)	−.0253*** (.0002)
Delinquent behavior × linear time		−.0464 (.1392)	
Alcohol Problems × linear time	−.3969*** (.1092)	−.6072*** (.1652)	−.2818** (.1085)
Delinquent behavior × Alcohol Problems × linear time		.6636* (.3032)	
Delinquent behavior × quadratic time		.0036 (.0100)	
Alcohol Problems × quadratic time	.0178** (.0066)	.0304** (.0095)	.0134* (.0065)
Delinquent behavior × Alcohol Problems × quadratic time		−.0364 (.0192)	
Fit Statistics:			
−2LL	126082.8	125550.3	125558.2
BIC	126202.7	125725.7	125687.4

*
 $p<.05$;

**
 $p<.01$;

***
 $p<.001$

Table 4

Predicting Depressive Symptoms Among Females

	Model with Alcohol Problems	Full Model (Delinquent behavior and Alcohol Problems)	Final Model
Initial Status:			
Intercept	5.5572***(.1349)	4.8553***(.1484)	4.8122***(.1424)
Delinquent behavior		2.7680***(.6116)	3.5367***(.3336)
Alcohol Problems	6.3108***(.4760)	6.6227***(.6883)	5.9055***(.6008)
Delinquent behavior × Alcohol Problems		−4.6141**(1.4125)	−2.9316***(.6963)
Rate of Change:			
Time (linear)	6.3108***(.4760)	.3619***(.0442)	.3775***(.0418)
Time (quadratic)	−.0290***(.0027)	−.0312***(.0029)	−.0323***(.0027)
Delinquent behavior × linear time		.2325 (.2113)	−.0710 (.0596)
Alcohol Problems × linear time	−1.0352***(.1303)	−1.2564***(.1761)	−1.0597***(.1483)
Delinquent behavior × Alcohol Problems × linear time		.8587*(.4313)	.3856***(.1063)
Delinquent behavior × quadratic time		−.0237 (.0159)	
Alcohol Problems × quadratic time	.0454***(.0080)	.0597***(.0104)	.0479***(.0086)
Delinquent behavior × Alcohol Problems × quadratic time		−.0282 (.0297)	
Fit Statistics:			
−2LL	141780.4	141114.3	141122.3
BIC	141891.3	141280.7	141270.3

*
$p<.05$;

**
$p<.01$;

***
$p<.001$