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Associations between alcohol-use and depression symptoms in adolescence: Examining gender differences and pathways over time

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Abstract

Several studies examining alcohol use and depression in youth have focused on documenting prevalence of overlap, or temporal ordering in longitudinal samples. Fewer studies have examined pathways connecting alcohol use and depression over time. This study examined gender differences between depression and alcohol use across adolescence while examining peer and family pathways as possible mediators of effects. Data was collected longitudinally from 593 families from three urban public middle schools in the United States. Participants were recruited in 6th grade and followed through 9th grade. We examined gender differences using a nested model comparison approach. Results indicated the association between depression and alcohol use differs by gender. For males, depression and alcohol use were independent across adolescence, and no significant indirect pathways were observed. For females, bidirectional effects were found between alcohol use and depression, as well as an indirect effect from depression to alcohol use via peer deviance.

Keywords

Depression; Alcohol use; Adolescence; Trajectory

Adolescence is a time of heightened risk for the development and escalation of both alcohol use and depression (Measelle, Stice, & Hogansen, 2006; Willoughby & Fortner, 2015). Indeed, developmental pathways for both depression and alcohol use are intertwined, and co-occurring depression and alcohol use problems represent one of the most prevalent and debilitating comorbidities in adolescence and adulthood. For instance, co-occurring depression and alcohol use problems are associated with greater severity of impairment, heightened risk for suicide, and prolonged symptom course (Archie, Kazemi, & Akhtar-Danesh, 2012; Brière, Rohde, Seeley, Klein, & Lewinsohn, 2014; Haynes et al., 2008). While much research has examined the interplay between alcohol use and depression, most studies have either focused on documenting prevalence of overlap, cross-sectionally (Birchwood, Mason, MacMillan, & Healy, 1993; Brown, Lewinsohn, Seeley, & Wagner,

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1996), or examining temporal ordering in longitudinal samples (Brook, Brook, Zhang, Cohen, & Whiteman, 2002; King, Iacono, & McGue, 2004; Rohde, Lewinsohn, Kahler, Seeley, & Brown, 2001). Fewer studies have examined pathways connecting problems with alcohol use and depression over time, or potential gender differences within those pathways. Such work may have substantial prevention implications, highlighting targets and time-points for prevention efforts.

1. Models of co-occurrence

Several models describe the pathways through which depression may predict alcohol use, and vice versa. These models share an emphasis on the importance of risk processes common to both depression and alcohol use. Notable shared risk factors include peer relational difficulties, such as peer rejection and association with deviant peer groups (e.g. Connell & Dishion, 2006; Fergusson, Wanner, Vitaro, Horwood, & Swain-Campbell, 2003; Van Ryzin, Fosco, & Dishion, 2012), and conflictual parent-child interactions (e.g. Bond, Toumbourou, Thomas, Catalano, & Patton, 2005; Sigfusdottir, Farkas, & Silver, 2004). Directional models propose that family conflict and peer deviance are among the main pathways through which depression may predict later substance use (and vice versa). For example, these models suggest that as youth enter adolescence, they both spend more time with peers, and are at a heightened risk for susceptibility to peer influence (Fergusson, Swain-Campbell, & Horwood, 2002). The importance of family risk has also been well characterized, and parent-focused prevention and intervention efforts for alcohol use are well supported, with emerging evidence highlighting the importance of family-interventions for depression, as well (Bond, Toumbourou, Catalano, & Patton, 2005). Thus, examining the role of these risk factors represents an important step in delineating pathways connecting substance use and depression over adolescence.

In addition to these shared risk factors, there are also several, more specific, proposed directional models for co-occurrence. First, some evidence supports the influence of earlier substance use on subsequent depression (e.g. Brook et al., 2002; Fergusson, Boden, & Horwood, 2011; Rohde et al., 2001). For instance, the cumulative failure model (Patterson & Stoolmiller, 1991) suggests substance use may predict escalating difficulties in important life domains (e.g. social and academic problems), which may undermine self-confidence and lead to depression. Similarly, adolescent alcohol abuse may interfere with brain development (Hermens et al., 2013), producing neurocognitive impairments ultimately leading to depression (see Peeters, Vollebergh, Wiers, & Field, 2014).

Conversely, Hussong, Jones, Stein, Baucom, and Boeding (2011) reviewed evidence for an internalizing pathway to alcohol use disorders, in which early internalizing problems (including depression) predicted subsequent alcohol use through interpersonal (interpersonal difficulties and peer deviance) and cognitive (alcohol use as a coping mechanism) pathways. Several studies have supported the association between earlier depression and later alcohol use (see O'Neil, Conner, & Kendall, 2011). For instance, McCarty et al. (2012; 2013) found that depressive symptoms predicted later alcohol use across grades 6 through 12. Relatively few studies, however, have examined mediators of either directional model in detail.

2. Gender differences

Evidence regarding directional effects has been mixed, with some studies supporting bidirectional associations (e.g. Needham, 2007; Pacek, Martins, & Crum, 2013). While several methodological factors might contribute to this variability (e.g. use of clinical vs. community samples, retrospective vs. prospective reports), there may also be gender differences in relations between substance use and depression over time. Gender differences in prevalence rates of depression have been well-documented (e.g. Hanna & Grant, 1997; Kumpulainen, 2000; Marmorstein, 2009). Similarly, studies have demonstrated differences in alcohol use patterns across males and females. For example, Hussong, Curran, and Chassin (1998) found greater variability in heavy alcohol use across time points for males and found that males' heavy alcohol use escalated at a faster rate than did females.

However, gender differences in the relation between alcohol use and depression across development have been less studied, and results have been inconsistent. Several studies have observed the association between alcohol use and depression in girls, but not boys (e.g. Edwards et al., 2014; Fleming, Mason, Mazza, Abbott, & Catalano, 2008; Miettunen et al., 2014; Nolen-Hoeksema, 2004). Others, have either found earlier depression predicted subsequent alcohol use in boys, but not girls (e.g. Kumpulainen, 2000; Tapert et al., 2003), or have failed to find gender differences (McCarty et al., 2012). For instance, Fergusson, Boden, and Horwood (2009) found no evidence for gender differences in their 25-year longitudinal study examining the association between alcohol use and depression. Finally, Marmorstein (2009) found baseline depression was more strongly related to baseline alcohol use for girls in early adolescence, but was related to stronger growth in alcohol use through late adolescence for boys. Given the variability of findings, and the lack of studies testing whether intervening processes connecting depression and alcohol use may vary by gender, additional work examining the association between depression and alcohol use across genders over adolescence is needed (Marmorstein et al., 2010).

The current study examines data from a large school-based intervention trial, but focuses on developmental processes (rather than treatment outcomes). In line with the randomized encouragement trial design of the current study, significant treatment effects have not been observed for depression or substance use in Intent to Treat analyses (Connell, Dishion, & Stormshak, 2013; Connell, Stormshak, & Dishion, 2009, 2014). As a result, significant developmental differences across intervention and control groups are unlikely. Thus, consistent with similar studies that have examined developmental questions using treatment samples (Dishion, Veronneau, & Myers, 2010; Murray-Close et al., 2010), the current study combined data from the control and intervention groups.

The broad goal of the current study was to examine pathways connecting alcohol use and depression symptoms longitudinally from 6th to 9th grade. We sought to characterize the direction of influences across early adolescence, and to examine possible family and peer pathways of effects. Given the substantial literature identifying peer deviance and family conflict as risk factors for both alcohol use (Baer, Garmezy, McLaughlin, Pokorny, & Wernick, 1987; Donovan, 2004; Fergusson et al., 2002; Newcomb, Maddahian, & Bentler, 1986) and depression (Brendgen, Vitaro, & Bukowski, 2000; Fergusson et al., 2003;

Sheeber, Hops, Alpert, Davis, & Andrews, 1997; Sigfusdottir et al., 2004), we predicted family conflict and peer deviance may be significant mediating factors in the relationship between alcohol use and depression. Further, we examined whether such pathways differed by gender. In line with Nolen-Hoeksema (2004), and Scholes-Balog, Hemphill, Patton, and Toumbourou (2015), we predicted for females, earlier depressive symptoms would be a stronger predictor of later alcohol use, while for males, depression and alcohol use would be more independent pathways. Additionally, we predicted peer deviance would play a larger mediating role for females than males based on the findings of Ehrensaft (2005), and that family conflict would lead to larger increases in depressive symptomology for females than males (Sigfusdottir et al., 2004), while demonstrating similar increases in alcohol use across genders (Baer et al., 1987).

3. Method

3.1. Participants

Participants were recruited from three urban public middle schools. Families with a child in the sixth grade (782 families) were invited to participate. Of those, 593 families (76%) agreed to participate in the study (183 families refrained from participating). The sample was ethnically diverse including individuals who reported being European American (36%), Hispanic or Latino (18%), African American (15%), Asian (7%), biracial or mixed identity (19%), Pacific Islander (2%), and Native American (2%), and contained roughly equal numbers of males and females (51% and 49% respectively). The average age of participants was: 11 years 10 months (wave 1), 13 years 1 month (wave 2), 14 years 1 month (wave 3), and 15 years (wave 4). 80% of participants' fathers and 79% of mothers had a high school degree or higher. 65% of children reported feeling their family had enough money. 87% of children reported feeling that their neighborhood was safe or very safe, and 64% of children reported often or always feeling safe at school. Families were randomly assigned to "school as usual" ($N = 207$; 35%) or to receive the intervention ($N = 386$; 65%). Randomization was done using an unbalanced approach to increase the power to detect different patterns of intervention effects.

3.2. Assessment procedures

The University of Oregon Review Board approved all procedures and the study received funding in 2005. After informed consent was obtained, every spring from 6th through 9th grade, participating students completed a questionnaire adapted from Metzler, Biglan, Rusby, and Sprague (2001) assessing a wide range of domains. Assessments were completed in school unless a child was absent or their family had moved away, in which case assessments were mailed to the home. Students received \$20 for each completed assessment. Measures used in this study are described below. For further information regarding these measures see Dishion and Kavanagh (2003), Dishion and Stormshak (2007).

3.3. Measures

3.3.1. Adolescent alcohol use—Youth completed a self-report survey about their substance use at each year of the study (6th through 9th grades), including the frequency they used alcohol and tobacco during the previous month (e.g., "How many alcoholic drinks

did you have last month?”). For analyses, alcohol use was examined in isolation. Previous research on adolescent substance use has used such individual items asking about alcohol use (Fosco, Frank, Stormshak, & Dishion, 2013; Stormshak et al., 2011; Van Ryzin, Stormshak, & Dishion, 2012), and single-item measures of alcohol use have demonstrated validity for assessing longitudinal stability and subsequent alcohol use (Fosco et al., 2013; Van Ryzin, Fosco, & Dishion, 2012). Further, past research has found that diagnoses as part of the study scores on this measure predict adult alcohol use diagnoses (Connell, Dishion, Yasui, & Kavanagh, 2007).

3.3.2. Adolescent depressive symptoms—Youth completed a 14-item self-report measure assessing depressive symptoms at each year of the study (6th through 9th grades). Youth were asked to report on the frequency of experienced depressive symptoms including feeling sad, moody, or hopeless and having trouble sleeping. All diagnostic criteria for depression were addressed by at least one item. Participants rated the frequency of each symptom in the past month on a 5-point scale ranging from “never or almost never” to “always or almost always”. For analyses, the average across items was used. This measure demonstrates high internal reliability and convergent validity (Connell, Stormshak, Dishion, Fosco, & Van Ryzin, 2015; Klostermann, Connell, & Stormshak, 2016; Stormshak, Fosco, & Dishion, 2010). In the current study, Cronbach’s alpha was between 0.92 and 0.95 for this measure across the four waves of data. Additionally, youth in the intervention completed the Child Depression Inventory (CDI) as part of the Family Check-Up (FCU) assessment (N = 120), and scores on the two scales were significantly correlated within assessment waves (r between 0.49 and 0.53).

3.3.3. Peer deviance—Each year youth completed a self-report measure assessing time spent with deviant peers who engaged in problematic behavior such as lying, stealing, or fighting. Items were rated on a 5-point scale from “never” to “more than 7 times,” and the average score was used in analyses. These items have been used in previous research on adolescent peer deviance and are a reliable estimate of the construct (Cronbach’s alpha was between 0.73 and 0.86 for this measure across the four waves of data). Prior research has provided robust evidence of the construct validity as scores on this scale are correlated in the predicted direction to other scales (Connell et al., 2007; Dishion & Kavanagh, 2003; Fosco et al., 2013; Stormshak et al., 2011).

3.3.4. Family conflict—Youth report of family conflict was measured at each year of the study (6th through 9th grades) averaging across 5 items, reflecting the frequency that family members engaged in a variety of conflict behaviors (e.g., “got angry with each other,” “argued at the dinner table”) within the past month. Responses ranged from 0 (“never”) to 7 (“more than seven times”). Good internal reliability was found for this scale (alpha reliability = 0.81). This measure has been used in previous research on family conflict in adolescence and demonstrates good construct validity as scores on these scales are correlated in the predicted direction to other scales (Connell et al., 2007; Dishion & Kavanagh, 2003; Van Ryzin, Fosco, & Dishion, 2012).

3.3.5. Gender—Gender of youth was coded as 0 = male and 1 = female.

3.3.6. Ethnicity—For the purposes of these analyses, a dichotomous score reflecting youth reports of ethnicity was created, with 0 ethnic minority and 1 = Caucasian.

3.4. Intervention protocol

Data from a randomized, school-based prevention trial was used for the current study. The prevention program was a brief multilevel, school-based intervention (see Dishion & Kavanagh, 2003). The first level was the family resource center (FRC), which was available to all families assigned to the intervention condition and was made available in all schools participating in the study. The second level of the intervention was the FCU, which uses the Drinker's Check-Up (Miller & Rollnick, 2002) as a model and is based on motivational interviewing. This was also offered to all families in the intervention condition, and included three sessions: an initial home visit and interview, an ecological assessment, and a feedback session. For a more comprehensive explanation of the intervention, see Dishion and Kavanagh (2003) or Stormshak et al. (2010). Within the intervention condition, 42% ($n = 163$) of families received the FCU between grades 7–9 (average FCU duration = 37.24 min, $SD = 50.34$ min), with an average post-FCU treatment time of 65.54 min ($SD = 184.92$ min). Four-hundred-and-eighty families did not receive the active prevention services, and for those who did, treatment contact was relatively brief (by design).

3.5. Analytic approach

The analyses for this study were conducted using Mplus 7.1 (Muthen & Muthen, 2013). A series of cross-lagged path models examining direct and indirect effects were used to test hypotheses. Ethnicity and intervention condition were included as covariates in all analyses. Preliminary correlation analyses indicated that intervention condition was not significantly correlated with any of the variables (depression, alcohol use, peer deviance, or family conflict) included in the models at any time point (grades 6, 7, 8, and 9). Ethnic minority status was modestly associated with peer deviance at grades 6 ($r = 0.11$, $p < 0.05$) and 7 ($r = 0.12$, $p < 0.05$), and family conflict at grade 6 ($r = 0.13$, $p < 0.05$), 7 ($r = 0.12$, $p < 0.05$), and 9 ($r = 0.10$, $p < 0.05$), but was otherwise unrelated to any variables included in the models.

We examined possible gender differences using a nested model comparison approach, comparing a model in which paths were allowed to vary across genders with a model in which paths were constrained to be equal for males and females. This test allows the investigation of gender as a moderator between depression and alcohol use. Next, we used model constraints in Mplus to conduct follow-up analyses to examine gender differences in specific paths. Last, we examined indirect paths from depression to alcohol use, and vice versa. Standard errors for indirect effects were calculated using the delta method (MacKinnon, Lockwood, & Williams, 2004; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). We restricted our investigation of indirect paths to those focused on the relations between depression and alcohol use over time.

4. Results

4.1. Descriptive statistics

Measures assessing depression, alcohol use, peer deviance, and family conflict were collected longitudinally at yearly intervals from students each spring from 6th through 9th grade. Models examining the direct pathways between alcohol use and depression, as well as models examining the indirect pathways between alcohol use and depression via family conflict and peer deviance were examined. Ethnicity and intervention condition were included as covariates in all analyses. The mean number of symptoms for each variable present at each time point is presented in Table 1 and bivariate correlations are displayed in Table 2. Repeated measures ANOVAs were run to examine the differences between genders in mean symptom expression across time points. There was a significant interaction effect of time and gender on depressive symptoms, Wilks' Lambda = 0.73, $F(3,426) = 8.33$, $p = 0.00$, partial eta squared = 0.06, and females expressed significantly higher symptoms from 7th grade to 9th grade. For alcohol use, there were no significant differences between male and female levels at any time point. For peer deviance, there was a significant interaction effect of time and gender on peer deviance, Wilks' Lambda 0.98, $F(3,431) = 3.60$, $p < 0.05$, partial eta squared = 0.02, where males expressed more symptoms of peer deviance at 6th and 7th grade, and females reported more peer deviance than males at 8th and 9th grade. For family conflict, there was a significant interaction between time and gender, Wilks' Lambda = 0.98, $F(3, 429) 3.07$, $p < 0.05$, partial eta squared = 0.02, with females consistently reporting more family conflict across all grade levels. Table 2 shows significant correlations for most variables across all time points (grades 6, 7, 8, and 9). However, for males, 6th grade alcohol use was not significantly correlated with family conflict across any measured time points, while for females, 6th grade alcohol use was not significantly correlated with depression across any measured time points.

4.2. Cascade models

4.2.1. Direct effects model—We first examined a “direct effects” cross-lagged model including only depression symptoms and self-reported alcohol use. Three nested model comparisons tested whether autoregressive and cross-lagged paths differed across time-points, across genders, and across treatment and control conditions. First, allowing the paths to vary over time fit the data significantly better than restricting paths to be equal across time ($\chi^2_{\text{diff}}(16) = 70.16$, $p < 0.05$), so paths in subsequent models were allowed to vary over time. Second, allowing paths to differ by gender fit the data significantly better than a model restricting paths to be equal by gender ($\chi^2_{\text{diff}}(12) = 115.19$, $p < 0.05$). Finally, we examined possible treatment versus control group differences separately by genders. For both males ($\chi^2_{\text{diff}}(12) = 18.81$, *n.s.*) and females ($\chi^2_{\text{diff}}(12) = 21.29$, *n.s.*), allowing paths to differ across treatment and control groups did not result in significantly better model fit.

The unrestricted model, allowing paths to vary over time and across genders, but not across treatment and control groups, demonstrated reasonable fit to the data ($\chi^2(50) = 163.64$, $p < 0.05$; RMSEA = 0.06; SRMR = 0.06; CFI = 0.86), although the significant chi-square value likely reflects the large sample size. Results of the unrestricted model are shown in Figs. 1 and 2. As shown, there were no cross-domain influences for males from 6th through 9th

grade, although there was a significant residual correlation between depression and alcohol use at 9th grade. For females, past year alcohol use predicted elevated depressive symptoms at 7th and 8th grade, while past year depression also predicted elevated alcohol use at 7th grade.

4.2.2. Indirect effects model—Next, we extended the model allowing paths to vary by gender by including peer deviance and family conflict over time, and examining indirect paths from alcohol use to depression and vice versa. Results of this model are shown in Figs. 3 and 4, for males and females, respectively.

For males and females, 6th grade depression directly predicted depression at 9th grade. Additionally, for females, 6th grade depression predicted 9th grade alcohol use mediated by 7th and 8th grade peer deviance. Furthermore, there was a direct path from 7th grade alcohol use to 8th grade depression. For males, alcohol use and depression pathways were independent. There were, however, connections from 7th grade peer deviance and depression to 9th grade alcohol use via 8th grade family conflict, although the direction of the family-conflict to alcohol use path was unexpected.

Tests of gender differences in specific paths focused only on pathways of potential mediation of depression and alcohol use for males and females. Results indicated two effects differed significantly between males and females. The path from 6th grade depression to 7th grade peer deviance was stronger in females (estimate = 0.25, SE = 0.12, $p < 0.05$), as was the path from 7th grade family conflict to 8th grade peer deviance (estimate = -0.18, SE = 0.09, $p < 0.05$).

4.2.3. Indirect paths—Lastly, the indirect pathways between depression and alcohol use for males and females were examined (one for males and three for females). For males, the potential pathway from 7th grade depression to 8th grade family conflict to 9th grade alcohol use was not significant, but was at trend-level (estimate -0.08, SE = 0.04, $p = 0.10$).

For females, there was a significant indirect effect of alcohol use in 6th grade on 9th grade depression, mediated by 7th grade alcohol use and 8th grade depression (estimate = 0.08, SE = 0.03, $p < 0.05$). Further, there was a significant indirect effect of depression in 6th grade on 9th grade alcohol use, via 7th and 8th grade peer deviance (estimate = 0.01, SE = 0.01, $p < 0.05$). Finally, the path from 6th grade depression to 7th grade family conflict to 8th grade peer deviance to 9th grade alcohol use was not significant.

5. Discussion

Although the association between depression and alcohol use has been well documented throughout development (Boden & Fergusson, 2011), the direction of the relationship, intervening processes, and gender differences in developmental cascades remain important questions. Therefore, the goal of this study was to examine peer and family risk processes as potential mediators of the association between alcohol use and depression across early adolescence. Several gender differences in pathways connecting depression and alcohol use were observed, suggesting future directions for research and clinical practice.

5.1. Males

For males, there were no significant direct paths between depression and alcohol use from 6th through 9th grades. One possible indirect path (7th grade depression predicting 8th grade family conflict and 9th grade alcohol use) was not significant. Of note, the direction of the final step in this potential path (between family conflict and alcohol use) was negative, with greater family conflict in 8th grade predicting reduced alcohol use in 9th grade. This counter-intuitive result was likely due to statistical suppression, as the correlation between 8th grade family conflict and 9th grade alcohol use was non-significantly positive. Although there were no direct or indirect paths over time for males, there was a significant residual correlation between depression and alcohol use at 9th grade, suggesting significant cross-sectional relations between these symptom domains. Otherwise, depression and alcohol use appeared to be relatively independent in males.

5.2. Females

In contrast, several significant pathways between depression and alcohol use were observed for females, with bidirectional associations between depression and alcohol use observed across adolescence, both in the direct- and indirect-effects models. In the direct effects model, depression predicted alcohol use and vice versa (Fig. 2). Such results are consistent with Miettunen et al. (2014), who found bidirectional relations between alcohol use and internalizing disorders from childhood through adulthood in females, but no associations for males.

For the indirect-effects model, a significant indirect path was observed from 6th grade depression to 9th grade alcohol use, via 7th and 8th grade peer deviance. This pathway is consistent with Hussong et al.'s (2011) proposal of an internalizing pathway to alcohol use through interpersonal risks such as peer deviance. In line with this model, several studies have highlighted the association between depression and deviant peers (e.g. Brody, Chen, & Kogan, 2010; Connell & Dishion, 2006). Given the social difficulties often associated with depression in youth, it may be that girls high in depression gravitate into deviant peer networks to alleviate loneliness and feelings of social isolation. The reinforcement of deviant behavior often observed within such peer networks (see Dishion, Kim, & Tein, 2015), however, may ultimately foster the initiation of subsequent alcohol use over time among depressed youth. Although additional work is needed to unpack the role of deviant peer processes in the cascade from depression to subsequent alcohol use, this result highlights the importance of monitoring peer relationships and targeting peer deviance as part of prevention and intervention efforts for depression in females. More broadly, these results suggest that targeting early depressive symptoms may be an important part of alcohol use prevention efforts for girls.

Additionally, there was a significant indirect effect from 7th grade alcohol use to 9th grade depression, mediated by 8th grade depression, suggesting a relatively durable influence of earlier alcohol use leading to later depression. This is consistent with previous research showing that earlier alcohol use increases the risk for subsequent depression (e.g. Brook et al., 2002; Chinet et al., 2006; Fergusson et al., 2011; Rohde et al., 2001). One possible explanation for these results is that early alcohol use may alter brain functioning in early

adolescence, which may ultimately lead to subsequent depression. Emerging literature indicates that early binge drinking may lead to depression via structural and functional alterations to frontal and limbic regions, producing affective impairments (e.g. Thayanukulvat & Harding, 2015). This pathway may also be interpreted in line with the cumulative failure model, suggesting early behavior problems (including early alcohol use) predict subsequent peer relational and academic problems, which in turn predicts increased risk for depression. It is notable, however, that the peer deviance path from alcohol use to depression was not supported in the current study, suggesting future work including a broader array of peer relational factors may be needed.

5.3. Consistent findings across genders

While there were several notable differences in effects for males and females, several findings were consistent across genders, as well. First, for both males and females, depressive symptoms predicted subsequent family conflict across all assessment waves. Similarly, family conflict was also predicted by earlier peer deviance for both boys and girls. While family conflict is often characterized as a risk factor for both depression and peer deviance in youth, these consistent pathways across genders highlight the associations are at least bidirectional. Further, they raise the possibility that successful prevention or intervention efforts for both alcohol use (which often targets peer deviance) and depression may lead to improvements in family relational functioning, as well. Finally, for both males and females, peer deviance in 8th grade predicted subsequent alcohol use in 9th grade. This is consistent with the existing literature on peer deviance, and highlights peer deviance as an important alcohol-use prevention target across genders.

5.4. Summary and future directions

Several possible limitations may influence our interpretation of the results. First, assessments were conducted at yearly intervals, but it is possible that important transactions across risk domains operate at smaller time frames. Second, we examined a limited age range (6th through 9th grades), although earlier and later periods of development are likely to be important with respect to co-occurring alcohol use and depression, as well. For instance, while we found that depressive symptoms predicted family conflict (not vice versa), it is possible that earlier family conflict may have predicted depression by the start of the current study, or that family conflict effects on depression and alcohol use might be observed later in adolescence. Relatedly, the developmental span covered by the current analyses captures the early emergence of alcohol use, however, relations between depression and alcohol use may differ in later development. Future studies with wider age ranges are needed to examine such possibilities. Third, the current developmental analyses were examined within the context of a prevention-trial sample. While other developmentally-focused analyses have made use of prevention-trial samples (e.g. Dishion et al., 2010), it will be important for other studies to examine these processes in non-treatment samples. Fourth, we did not use Bonferroni adjustments in the tests of gender differences. Core indirect paths were theoretically-derived, and a relatively small number of indirect paths were examined with respect to gender differences. Therefore, the risk of type one error is reasonable. Nevertheless, replication of these results is an important future goal. Finally, the developmental span covered by the current analyses captures the early emergence of alcohol

use, and so base rates of alcohol use were relatively low (particularly in 6th grade), which may contribute to the current pattern of results (e.g. no effects of early alcohol use on depression for males). Despite such limitations, results demonstrate the importance of examining gender differences in relations between depression and alcohol use in adolescence, and may have implications for future developmental and prevention research.

For females, enhanced focus on deviant peer processes in depression prevention efforts may decrease the effects of peer contagion, which may ultimately disrupt the development of co-occurring alcohol use among females (Dishion & Tipsord, 2011). Future developmental research should also examine changes in the brain as a result of alcohol use in early adolescence. As noted earlier, recent research has suggested that early binge drinking may lead to later cognitive impairments (Thayanukulvat & Harding, 2015) and that binge drinking at a young age shows evidence of large cerebral changes that may be correlated with depression (Mauragea et al., 2012).

For males, depression and alcohol use were relatively independent in early adolescence. Prevention efforts specifically targeting each domain may be necessary for males, while cross-over benefits from depression or alcohol-focused programs may be less likely for males than females. However, future work examining a broader array of intervening processes may also be necessary to identify relevant pathways connecting depression and alcohol use. Indeed, work integrating a broader range of factors such as academic functioning, as well as cognitive, affective, and neurobiological processes may ultimately enrich our understanding of the connections between alcohol use and depression among both adolescent males and females.

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Fig. 1.
Statistically significant paths of unrestricted model for males.

Fig. 2.
Statistically significant paths of unrestricted model for females.

Fig. 3.
Statistically significant paths of extended model for males.

Fig. 4.
Statistically significant paths of extended model for females.

Table 1

Descriptive statistics [means (standard deviations)] of study variables.

	6th grade		7th grade		8th grade		9th grade	
	Male	Female	Male	Female	Male	Female	Male	Female
Depression	1.83 (0.77)	1.90 (0.79)	1.72 (0.68)	2.04 (0.84)	1.70 (0.69)	2.20 (0.93)	1.71 (0.73)	2.15 (0.87)
Alcohol Use	0.11 (0.58)	0.06 (0.67)	0.29 (1.07)	0.33 (1.18)	0.56(1.89)	0.71 (1.98)	0.74 (2.12)	0.75 (2.14)
Peer Deviance	0.63 (0.99)	0.46(0.71)	1.05 (1.38)	0.87 (1.17)	1.18 (1.55)	1.33 (1.46)	1.34(1.61)	1.58 (1.69)
Family Conflict	2.43 (1.39)	2.66(1.40)	2.75 (1.46)	3.10(1.39)	2.63 (1.35)	3.25 (1.41)	2.59 (1.20)	3.17 (1.35)

Table 2

Bivariate pearson correlations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Ethnic minority	–	–0.01	0.05	0.01	–0.06	–0.10	0.12*	0.04	–0.02	–0.07	–0.13*	–0.12*	–0.10	–0.18*	–0.05	–0.03	0.00	–0.01
2. Intervention	–0.01	–	–0.01	0.00	–0.02	0.00	–0.02	–0.06	–0.11	0.03	0.03	0.00	–0.02	0.04	0.00	–0.03	–0.01	–0.14*
3. 6th grade Depression	–0.02	–0.01	–	0.39*	0.33*	0.22*	0.10	0.02	–0.02	–0.07	0.20*	0.17*	0.04	0.04	0.43*	0.26*	0.30*	0.12
4. 7th grade Depression	–0.07	–0.01	0.49*	–	0.48*	0.32*	0.02	0.12	0.07	0.02	0.08	0.21*	0.13*	0.02	0.22*	0.34*	0.20*	0.13
5. 8th grade Depression	0.02	0.05	0.35*	0.49*	–	0.49*	0.02	0.17*	0.28*	0.02	0.07	0.15*	0.28*	0.09	0.22*	0.21*	0.30*	0.22*
6. 9th grade Depression	–0.04	0.03	0.34*	0.51*	0.68*	–	–0.04	0.00	0.12	0.09	0.16*	0.01	0.05	0.20*	0.10	0.12	0.22*	0.31*
7. 6th grade Alcohol use	0.03	0.06	0.01	0.13*	0.20*	.07	–	.41*	0.06	.06	0.22*	0.20*	0.14*	0.01	0.04	0.01	–0.04	–0.11
8. 7th grade Alcohol use	0.13*	0.10	0.11	0.29*	0.30*	0.19*	0.55*	–	0.43*	0.04	0.26*	0.36*	0.21*	0.02	–0.09	0.04	0.06	–0.01
9. 8th grade Alcohol use	0.10	–0.14	0.08	0.25*	0.38*	0.30*	0.20*	0.50*	–	.17*	0.12	0.20*	0.26*	–0.01	–0.02	0.09	0.24*	0.14*
10. 9th grade Alcohol use	–0.09	–0.03	0.03	0.17*	0.18*	0.18*	0.33*	0.29*	0.36*	–	0.06	0.11	0.15*	0.33*	–0.04	–0.03	0.04	0.19*
11. 6th grade Peer Deviance	–0.17*	0.10	0.16*	0.23*	0.26*	0.18*	0.36*	0.31*	0.15*	0.17*	–	0.52*	0.30*	0.21*	0.32*	0.28*	0.21*	0.14*
12. 7th grade Peer Deviance	–0.13*	0.11	0.23*	0.31*	0.28*	0.26*	0.18*	0.33*	0.22*	0.19*	0.53*	–	0.59*	0.42*	0.36*	0.42*	0.34*	0.19*
13. 8th grade Peer Deviance	–0.03	0.05	0.09	0.22*	0.34*	0.32*	0.21*	0.30*	0.42*	0.31*	0.36*	0.51*	–	0.51*	0.16*	0.22*	0.38*	0.23*
14. 9th grade Peer Deviance	0.07	0.04	0.17*	0.30*	0.35*	0.33*	0.15*	0.24*	0.38*	0.44*	0.32*	0.51*	0.58*	–	0.12	0.17*	0.24*	0.35*
15. 6th grade Family Conflict	–0.09	0.07	0.27*	0.25*	0.22*	0.15*	0.09	0.20*	0.18*	0.03	0.39*	0.32*	0.22*	0.24*	–	0.50*	0.43*	0.26*
16. 7th grade Family Conflict	–0.09	0.04	0.23*	0.46*	0.34*	0.28*	0.17*	0.30*	0.22*	0.12	0.35*	0.48*	0.37*	0.32*	0.51*	–	0.49*	0.42*
17. 8th grade Family Conflict	–0.09	0.04	0.22*	0.27*	0.41*	0.33*	0.18*	0.20*	0.28*	0.14*	0.38*	0.35*	0.43*	0.43*	0.43*	0.58*	–	0.56*
18. 9th grade Family Conflict	–0.10	0.12	0.26*	0.31*	0.29*	0.34*	0.16*	0.21*	0.20*	0.14*	0.31*	0.30*	0.35*	0.52*	0.44*	0.49*	0.65*	–

*
 $p < 0.05$.

Note: Female below diagonal, male above diagonal.