Gender Differences in Friends’ Influences on Adolescent Drinking: A Genetic Epidemiological Study

Danielle M. Dick, Jason L. Pagan, Candice Holliday, Richard Viken, Lea Pulkkinen, Jaakko Kaprio, and Richard J. Rose

**Background:** We use data from a population-based twin study to examine the association between characteristics of the friendship group and adolescents’ own alcohol use at age 14, with focus on gender differences, both with respect to the adolescent’s own gender and the gender composition of his/her friendship group.

**Methods:** (1) We conducted analyses on the full epidemiological sample of individuals to determine the magnitude of association between friendship characteristics and alcohol use, and to test for interaction with gender and gender of friends. (2) We used the twin structure of the dataset to study the extent to which similarity in drinking behaviors between adolescents and their friends was due to shared genetic and/or environmental pathways.

**Results:** Friends’ drinking, smoking, and delinquency were more strongly related to alcohol use in girls, compared to boys, and in adolescents with opposite-sex friends, compared to adolescents with only same-sex friends. Friends’ alcohol use showed modest evidence of genetic influence in girls, suggesting peer selection; however, there was no evidence of genetic influence on friends’ alcohol use in boys. The correlation between adolescent and friend drinking was largely attributable to shared environmental effects across genders.

**Conclusions:** Gender and gender of friends moderate the associations between friends’ behavior and adolescents’ alcohol use, with evidence that girls, and those with opposite-sex friends, may be more susceptible to friends’ influence. Genetically informative analyses suggest that similarity in alcohol use between adolescents and their friends is mediated, at least partially, through environmental pathways.

**Key Words:** Adolescent Drinking, Friends, Peers, Genetic Influence, Peer Selection.

Peer substance use has been consistently related to adolescents’ own substance use, with numerous studies demonstrating that it is one of the strongest predictors of adolescent substance use, even more so than other factors such as parental alcohol use (Cardenal and Adell, 2000; Duncan et al., 1985; Marshall and Chassin, 2000; Windle, 2000). The extent to which this relationship is due to peer selection, whereby adolescents actively choose friends with substance use patterns and values consistent with their own, versus peer influence, whereby the substance use of the friends actively impacts the substance use choices of the adolescent, has been examined, also. Although some studies have found greater support for one process [e.g., peer influence, (Sieving et al., 2000)] or the other [peer selection (Ennett and Bauman, 1994)], it is largely believed that both selection and socialization processes contribute to the similarity in friendship pairs (Kandel, 1985).

Some of the inconsistency regarding the influence of peers may be attributed to the fact that not all adolescents are equally susceptible to peer influence; conversely, not all peers may be equally influential. Several new studies have attempted to more carefully delineate these processes. For example, a recent study demonstrated the moderating role of friendship characteristics: whether the friendship was mutual, and the status of each friend, moderated the likelihood that the friend would adopt the other’s drinking behavior (Bot et al., 2005). The gender structure of the friendship also has been found to moderate peer influence. In data from the National Longitudinal Study of Adolescent Health adolescents in same-sex best friendships influenced one another mutually, but boys in mixed sex best friendships had a greater influence over their female friends’ drinking patterns than vice versa (Gaughan, 2006). Gender-specific effects in peer influences were also noted in the Teenage Attitudes and Practices Survey (TAPS). For adolescent males, the odds of smoking associated with having male best friends who smoked was 45.0, compared to an odds ratio (OR) of 16.1 for female best friends. Conversely, the OR for females associated with having female best friends who smoked was 40.2, compared to...
These studies suggest that gender may be a particularly relevant variable for study in relation to adolescent substance use. While a number of studies have documented differences in the prevalence of alcohol use in adolescent girls and boys (Cardenal and Adell, 2000; Kokkevi et al., 2007; Rose et al., 2001b), surprisingly little research has been focused on examining gender differences in risk factors associated with alcohol use. Pubertal development is one risk factor that has received particular attention with respect to its association with substance use in girls. Girls who mature earlier than their peers are more likely to engage in substance use in adolescence (Dick et al., 2000; Stattin and Magnusson, 1990), and it is believed that the association is mediated in part through affiliation with older peers and boyfriends.

Previously analyses of the FinnTwin data have also suggested that low-parental monitoring may make girls particularly vulnerable to early-onset drinking (Rose et al., 2001b). Finally, a number of recent studies provide preliminary evidence that peer substance use may be another factor that differentially affects females and males, with suggestion that females may be more susceptible to peer influence than males. In a school population survey of six European countries, the ORs associated with various forms of friends’ substance use tended to be slightly higher in girls, although this difference was not formally tested (Kokkevi et al., 2007). In a study of Taiwanese adolescents, peer relationships had stronger associations with drinking behavior in females compared to males (Yeh et al., 2006). In the TAPS study, believing that one’s best friends would approve of their smoking was associated with a much higher rate of smoking in females (OR = 14.3), as compared to males (OR = 2.0) (Wang et al., 1995). In yet another study, peer pressure was associated with drinking in girls, but not in boys; similarly, associating with problem-behaving friends was more strongly associated with drinking in girls compared to boys (Simons-Morton et al., 2001). These findings suggest that girls may be more susceptible to peer influences than boys.

In summary, there is suggestion from several studies that risk factors for adolescent alcohol use may differ between girls and boys, and that this may be particularly relevant in the area of peer influence. However, few studies have explicitly focused on exploring these differences. In this study, we use data from a population-based twin study to examine the association between characteristics of the friendship group and adolescents’ own alcohol use, as measured at age 14, with particular focus on gender differences, both with respect to the adolescent’s own gender and the gender composition of their friendship group. We examine friends’ drinking, smoking, and getting into trouble, three variables thought to be particularly relevant to adolescent substance use. First, we conduct analyses on the full epidemiological sample of twin individuals to determine the magnitude of association between friendship characteristics and alcohol use, and to test for interaction with gender and gender of the friendship group. Secondly, we exploit the twin structure of the dataset as a unique method by which to address the issue of peer selection-peer influence. To the extent that selective processes are involved in friendship similarity, we expect to find evidence of genetic influence on friends’ substance use, as adolescents’ own temperaments, and predispositions impact their choice of friends. In addition, by simultaneously evaluating the adolescents own alcohol use and that of their friends, we can test the extent to which the association between adolescent’s alcohol use and the substance use of their friends is genetically and/or environmentally mediated. Is the similarity in alcohol use between adolescents and their friends purely due to a predisposition that influences the adolescent’s own alcohol use and also influences their selection of drinking peers, or is there evidence that friendship similarity is also influenced by environmental processes?

METHODS

Sample

FinnTwin12 is a population-based, longitudinal twin-family study of behavioral development and health risk factors (Kaprio, Pulkkinen, & Rose, 2002). FinnTwin12 consists of five consecutive birth cohorts of Finnish twins identified through Finland’s Central Population Registry, which permits exhaustive and unbiased ascertainment of all twins living and residing in the country. Of the 2724 families with twins born 1983 through 1987, 87% consented to participate. Immediately on receipt of the completed family questionnaire, individual questionnaires were mailed to both co-twins and both their parents (including parents not residing with either twin child). Self-report questionnaires were mailed to co-twins and their parents in the autumn of the year in which their birth cohort reached age 11, with a small minority (~10%) returning the questionnaires very early in the year in which the cohorts turned 12. Twins were sent a follow-up questionnaire in the month that they reached age 14, and ~90% of twins completed and returned it. Mean age at response was 14.05 years, with 95% responding by age 14.2 years. All analyses reported here utilize data from the age 14 assessment, when questions on substance use were first asked of the epidemiological sample. Assessments of nonresponders at each stage uncovered no evidence of biased selection for family structure, parental age, area of residence, or twins’ zygosity or sex.

Zygosity was determined using a well-validated questionnaire completed by both co-twins at the baseline, containing items regarding similarity and confusability (Kaprio et al., 1995). Because these twins were younger than in previous Finnish studies, classification was supplemented by parental response to items developed for zygosity classification of twin children (Goldsmith, 1991). Assignment of same-sex co-twins, whose zygosity could not be determined definitively from information in twin and parental questionnaires, was supplemented by comparisons of school photographs and additional information obtained from twins’ mothers. Definitive zygosity diagnosis of a small group (~5%) of same-sex twins awaits genotyping, and these twins were excluded from analyses reported here. The sample used in the age 14 epidemiological analyses reported here consisted of 4,709 individuals with data on alcohol use. Twin analyses utilized 1,488 same-sex twin pairs of confirmed zygosity: 353 monozygotic (MZ) and 400 dizygotic (DZ) male twin pairs, and 376 MZ and 359 DZ female twin pairs.
Measures

Alcohol Initiation. Alcohol use was measured in the age 14 questionnaire with an item that asked “How often do you drink alcohol at all?” This question was adapted from a nine-alternative response item in Finland’s biennial Adolescent Health Habits Survey [AHHS; (Rimpela et al., 1988)], an item used also in an earlier study of 16-year-old Finnish twins (Rose et al., 1999). The wording of the question remained unchanged, but the responses were truncated to four alternatives more appropriate for this younger age group. These alternatives ranged from abstinence (“Never; I don’t drink alcohol”) to drinking weekly or more often.

Friend Characteristics. Friends’ smoking was assessed by asking the adolescents “Do any of your friends smoke?” Responses were made on a four point scale: ‘no one smokes’, ‘one of them smokes’, ‘2–5 of them smoke’, ‘more than 5 of them smoke’. Friends’ drinking was assessed by asking the adolescents “Do any of your friend drink alcohol?” with four response options parallel to those for smoking. Friend delinquency was measured with an item that asked adolescents “Have any of your friends gotten into trouble at school because of bad behavior or dishonesty?” Gender of friends was measured with an item that asked “Are your friends (or friend) with whom you most usually spend your leisure time (other than your twin and members of your family): of the same sex as you; of both sexes; of the opposite sex. Because so few adolescents of either gender (<1%) responded that they mostly associated with friends of the opposite sex, we collapsed the response options to create a variable indicating (0) only same-sex friends or (1) some friends of the opposite sex.

Statistical Analyses

Epidemiological Analyses. Logistic regression was performed to assess predictors of alcohol initiation by age 14 using Stata statistical software (StataCorp, 2003). The “Cluster” option was used to provide robust variance estimation to take into account the clustered nature of the twin data within families (Williams, 2000). The outcome variable in all analyses was alcohol use by age 14. Predictor variables included friends’ use of alcohol, friends’ smoking, friends’ delinquency, having opposite-sex friends, and gender of the adolescent. In addition, because we were particularly interested in potential gender interactions with respect to friend influences, we tested for interaction between the friend variables and gender of the adolescent, and gender of friends. In addition, we tested for three way interactions between friend variables, gender, and gender of friends. To facilitate the interpretation and presentation of the regression results, all variables were dichotomized to indicate absence (0) or presence (1) of the putative risk factor, e.g., substance using peers. To create the binary variable of alcohol initiation for logistic regression, responses were dichotomized to indicate (0) no initiation of alcohol use and (1) alcohol use, as in previous analyses in the dataset (Rose et al., 2001b).

Twin Analyses. Genetically informative twin models partition variance in a phenotype into additive genetic influences (A), dominant genetic influences (D), common environmental influences (C), and unique environmental influence (E). Genetic influences correlate 1.0 between monozygotic (MZ) twins, because they share all their genes identical-by-descent, and 0.5 between dizygotic (DZ) twins, who like ordinary siblings, share, on average, half their segregating genes. Dominance effects are suggested when the correlation between DZ twins is less than half the correlation observed in MZ twins. Common environmental effects, as defined in biometrical twin modeling, refer to all environmental influences (in the family, as well as in the school and community) that make siblings more similar to one another. Common environmental effects are suggested by DZ twin correlations that exceed half the MZ twin correlation; if only additive genetic influences are present, correlations among DZ twins should be half that of correlations between MZ twins, as that is the degree of similarity expected based solely on shared genes. Under the usual, testable, and usually tenable, assumptions made in such modeling, these common environmental influences correlate 1.0 between pairs of both MZ and DZ co-twins. Common environmental effects and dominance effects cannot be tested simultaneously in twin models, when additional family members are not included in the modeling. Accordingly, because same-sex DZ twin correlations exceeded half the MZ twin correlations for the variables analyzed here, we tested ACE models rather than ADE models. Unique environmental influences are uncorrelated between co-twins and have the effect of decreasing the covariance between siblings. Examples of unique environmental correlations include peers or activities that are not shared between the twins. Measurement error is included in the E term, as well.

In the bivariate extension of the basic twin model, ACE influences on each variable can be tested; in addition, bivariate models allow one to estimate the extent to which the covariation between two traits is due to genetic and/or environmental influences, by utilizing the additional information contained in the cross-twin cross-trait correlations. Bivariate Cholesky models were fit to adolescent alcohol use and friends’ alcohol to test hypotheses about similarity in substance use between adolescents and their friends. A bivariate Cholesky model is shown for one twin in Fig. 1. We have previously reported analyses of adolescent alcohol use in this dataset (Pagan et al., 2006; Rose et al., 2001b), finding significant evidence of genetic (albeit modest) and environmental effects, predominantly of the shared variance (C). In this paper, the bivariate extension of the model including friends’ alcohol use allowed us to test the following questions of interest: (1) Is there evidence of genetic effects (paths a21, a22) on friends’ alcohol use? Significant evidence of genetic effects would suggest a degree of peer selection, whereby an adolescent’s own genetic predisposition impacts the friends they choose to assort with. (2) Is the relationship between adolescents’ own alcohol use and alcohol use in their friends mediated via shared genetic and/or environmental pathways? As drawn in the Fig. 1, the path a21 represents genetic influences that are shared between the adolescent’s alcohol use and their friends’ alcohol use. Similarly, c21 represents shared common environmental influences that impact an adolescent’s own use and having substance using friends, and c21 (not shown) represents shared
unique environmental influences impacting both variables. The significance of each of these pathways provides an indication of what factors contribute to the correlation between alcohol use among friends.

All modeling was conducted using the raw ordinal data option in Mx (Neale et al., 1999). Mx is a structural equation modeling program developed specifically for the use of twin data. When the outcome is ordinal, the model involves the use of thresholds, rather than means. The significance of each of the parameters in the model can be tested by dropping a parameter and evaluating the change in \(-2\) log likelihood between the initial model and the nested submodel. This difference is evaluated using a chi square distribution. A significant change in fit between the models \((p < 0.05)\) for the difference in degrees of freedom indicates that dropping the parameter caused a significant decrease in fit of the model, indicating that pathway significantly contributes to the outcome trait and should be retained in the model. We first fit a full model, where thresholds and ACE estimates were allowed to vary between boys and girls. We next tested whether the thresholds for the variables could be constrained equal across the genders, and then, whether the ACE estimates could be constrained equal without causing a significant decrease in fit. The best-fitting model from these initial tests was subsequently used to fit submodels addressing the questions of interest listed above.

**RESULTS**

**Descriptives**

Boys and girls reported similar levels of drinking at age 14. Overall, 65% of the sample (63% of girls, 66% of boys) reported never drinking; 21% (both girls and boys) reported drinking less than once a month; 12% (14% girls, 11% boys) reported drinking about 1–2 times a month; and 3% (both girls and boys) reported drinking weekly or more often. These differences were not statistically significant \((\chi^2 = 1.99, 3 \text{ df}, p = 0.11)\), after accounting for the clustered nature of the data. Similarly, friends’ smoking was very similar across boys and girls: 39% (40% of girls, 39% of boys) reported no smoking friends; 11% (11% girls, 12% boys) reported one smoking friend; 27% (25% girls, 28% boys) reported 2–5 smoking friends, and 22% (24% girls, 21% boys) reported more than 5 smoking friends. These small differences again were not statistically significant \((\chi^2 = 1.09, 3 \text{ df}, p = 0.35)\). Friends’ drinking showed larger differences between girls and boys: 43% of the sample (39% girls, 47% boys) reported none of their friends drank alcohol; 10% (9% girls, 10% boys) reported one drinking friend; 26% (27% girls, 25% boys) reported 2–5 drinking friends, and 22% (25% girls, 18% boys) reported more than 5 drinking friends \((\chi^2 = 5.24, 3 \text{ df}, p = <0.001)\). Accordingly, it appears that girls are somewhat more likely to have friends who drink alcohol at age 14 than are boys, who are more likely to report that none of their friends drink. In contrast, boys were more likely to report friends who had gotten into trouble at school due to bad behavior or dishonesty: 3% of the overall sample (3% of girls, 4% of boys) reported more than 5 friends who had gotten into trouble; 17% (15% of girls, 19% of boys) reported 2–5 friends who had; 18% (15% girls, 10% of boys) reported one of their friends had; and 62% (68% of girls, 56% of boys) reported that none of them had \((\chi^2 = 71.07, 3 \text{ df}, p = <0.001)\). Finally, there was no significant difference in the gender composition of peer groups with 31% of girls and 30% of boys reporting some friends of the opposite sex, and the majority of girls and boys reporting spending most of their time with friends of the same sex \((\chi^2 = 1.11, 1 \text{ df}, p = 0.29)\).

Alcohol use at age 14 was moderately correlated (although highly significant at \(p < 0.001\)) with all of the peer characteristic variables. The polychoric correlations between alcohol use and friends’ alcohol use was 0.48, friends’ smoking, 0.41, having opposite-sex friends, 0.29, and having delinquent friends, 0.29.

**Epidemiological Analyses**

Table 1 shows results from individual logistic regression analyses with each of the risk variables and alcohol use at age 14. Odds ratios are presented for the full sample and for males and females separately, along with the \(p\)-value associated with the significance of the interaction term. Gender showed a marginally significant association with alcohol use, with girls slightly more likely to have initiated alcohol use by age 14. Gender of friends was also related to alcohol use, with adolescents who reported some opposite-sex friends at \(>3\) times the risk of alcohol use by 14. Having opposite-sex friends appeared to be somewhat more strongly related to alcohol use in girls \((\text{OR} = 3.6)\) as compared to boys \((\text{OR} = 2.8)\), although this difference did not reach statistical significance \((p = 0.08)\). There were significant interactions with each of the other three friend characteristic variables and gender: in all cases, the risk associated with having friends who used alcohol, smoked, or had been in trouble was more strongly associated with alcohol use in girls as compared to boys.

**Table 1. Odds Ratios (with 95% Confidence Intervals in Parentheses) and Associated \(p\)-Values for Alcohol Use at Age 14, Split by Gender**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
<th></th>
<th>Males</th>
<th></th>
<th>Females</th>
<th></th>
<th>Interaction*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>(p)-value</td>
<td>Odds ratio</td>
<td>(p)-value</td>
<td>Odds ratio</td>
<td>(p)-value</td>
<td>(p)-value</td>
</tr>
<tr>
<td>Gender</td>
<td>1.14 (1.00, 1.30)</td>
<td>0.059</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Friends drink</td>
<td>6.76 (5.75, 7.96)</td>
<td>&lt;0.001</td>
<td>5.65 (4.57, 6.98)</td>
<td>&lt;0.001</td>
<td>8.31 (6.44, 10.72)</td>
<td>&lt;0.001</td>
<td>0.021</td>
</tr>
<tr>
<td>Friends smoke</td>
<td>4.88 (4.15, 5.74)</td>
<td>&lt;0.001</td>
<td>4.14 (3.32, 5.15)</td>
<td>&lt;0.001</td>
<td>5.76 (4.55, 7.28)</td>
<td>&lt;0.001</td>
<td>0.040</td>
</tr>
<tr>
<td>Delinquent friends</td>
<td>2.87 (2.50, 3.29)</td>
<td>&lt;0.001</td>
<td>2.43 (2.01, 2.93)</td>
<td>&lt;0.001</td>
<td>3.72 (3.04, 4.55)</td>
<td>&lt;0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Gender of friends</td>
<td>3.18 (2.75, 3.67)</td>
<td>&lt;0.001</td>
<td>2.79 (2.29, 3.40)</td>
<td>&lt;0.001</td>
<td>3.59 (2.93, 4.41)</td>
<td>&lt;0.001</td>
<td>0.078</td>
</tr>
</tbody>
</table>

*Between the variable listed on each row and gender of the adolescent.
Having drinking friends was most strongly associated with the adolescent’s own alcohol use at age 14 in both girls (OR = 8.3) and boys (OR = 5.6). Having smoking friends was also significantly related to alcohol use in girls (OR = 5.8) and boys (OR = 4.1), as was reporting friends who had been in trouble (girls OR = 3.7, boys OR = 2.4).

Table 2 presents the odds ratios separately for adolescents with same-sex and opposite-sex friends, along with the significance of the interaction term associated with each friend variable and gender of the friends. ORs for the full sample are also repeated in the Table for ease of comparison. Having friends who drink was more strongly associated with adolescent alcohol use when the adolescent reported having some opposite-sex friends (OR = 10.3) as compared to reporting only same-sex friends (OR = 4.7). Similar patterns were observed for having smoking friends (OR = 8.7 for opposite-sex friends, OR = 3.2 for same-sex friends), and for reporting friends who had been in trouble (OR = 3.0 for opposite-sex friends, OR = 2.1 for same-sex friends), whereby the risk was greater when the friends included the opposite sex.

There were no significant three-way interactions between the friend variables, gender, and friendship group composition (for friends’ alcohol use: $p = 0.72$; for friends’ smoking: $p = 0.74$; for friends’ delinquency: OR, $p = 0.90$).

**Twin Analyses**

The correlation between female MZ twins for friends alcohol use was 0.78, for female DZs, 0.66. For males, the correlation between friends alcohol use for MZs was 0.58, and for DZs, 0.52. DZ correlations exceeded half the MZ correlations for both genders, indicating considerable common environmental influences. MZ correlations were larger than DZ correlations, suggesting genetic effects, with greater differences in girls as compared to boys. MZ correlations were lower in boys, indicating greater influence of unique environmental effects.

Table 3 shows the fit statistics for the bivariate models for self-reported alcohol use and friends’ alcohol use. Constraining the thresholds to be equal for the variables across girls and boys caused a significant decrease in fit of the model, again suggesting slight differences in frequencies between girls and boys. Similarly, constraining A, C, and E to be equal across girls and boys caused a significant decrease in fit; accordingly, submodels testing each component of the model (A on self-reported alcohol use, A on friends’ alcohol use, etc) were fit separately for girls and boys. Similarly, estimates for the components of variance (A, C, E) are presented separately for girls and boys in Table 4. Point estimates for each of the variance components, and the correlations between the influences (A, C, E) on each variable, are presented from the full model in Table 4, rather than from submodels in which non-significant parameters are dropped. This was done because CIs from submodels can underestimate the variance

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**Table 2. Odds Ratios (with 95% Confidence Intervals in Parentheses) and P-Values for Alcohol Use at Age 14, Split by Gender of Friends**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample Odds ratio</th>
<th>p-value</th>
<th>Same-sex friends Odds ratio</th>
<th>p-value</th>
<th>Opposite-sex friends Odds ratio</th>
<th>p-value</th>
<th>Interaction* Odds ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.14 (1.00, 1.30)</td>
<td>0.059</td>
<td>1.03 (0.87, 1.23)</td>
<td>0.700</td>
<td>1.33 (1.06, 1.67)</td>
<td>0.014</td>
<td>0.078</td>
<td></td>
</tr>
<tr>
<td>Friends drink</td>
<td>6.76 (5.75, 7.96)</td>
<td>&lt;0.001</td>
<td>4.69 (3.89, 5.66)</td>
<td>&lt;0.001</td>
<td>10.31 (7.35, 14.48)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Friends smoke</td>
<td>4.88 (4.15, 5.74)</td>
<td>&lt;0.001</td>
<td>3.21 (2.66, 3.86)</td>
<td>&lt;0.001</td>
<td>8.74 (6.16, 12.40)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Delinquent friends</td>
<td>2.87 (2.50, 3.29)</td>
<td>&lt;0.001</td>
<td>2.15 (1.80, 2.57)</td>
<td>&lt;0.001</td>
<td>2.98 (2.36, 3.75)</td>
<td>&lt;0.001</td>
<td>0.029</td>
<td></td>
</tr>
</tbody>
</table>

*Between the variable listed on each row and gender of the friends.

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**Table 3. Results From Bivariate Cholesky Model of Self-Reported Alcohol Use and Friends’ Alcohol Use at Age 14**

<table>
<thead>
<tr>
<th>Fit statistics</th>
<th>$-2\text{LL}$</th>
<th>df</th>
<th>$\chi^2\Delta$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bivariate model with males/females different</td>
<td>11041.461</td>
<td>5926</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Bivariate model constraining thresholds across gender</td>
<td>11063.388</td>
<td>5932</td>
<td>21.927</td>
<td>0.0012</td>
</tr>
<tr>
<td>3. Bivariate model constraining A, C, E only across gender</td>
<td>11088.2</td>
<td>5935</td>
<td>46.739</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Submodels (as compared to model 1)**

- **Girls:**
  - a. Drop A on alcohol use (a11)
  - b. Drop A on friends’ alcohol use (a12, a22)
  - c. Drop C on alcohol use (c11)
  - d. Drop C on friends’ alcohol use (c12, c22)
  - e. Drop shared A (c12)
  - f. Drop shared C (c12)
  - g. Drop shared E (e12)

- **Boys:**
  - a. Drop A on Alcohol Use (a11)
  - b. Drop A on friends’ alcohol use (a12, a22)
  - c. Drop C on Alcohol Use (c11)
  - d. Drop C on friends’ alcohol use (c12, c22)
  - e. Drop shared A (a12)
  - f. Drop shared C (c12)
  - g. Drop shared E (e12)

Dropped pathways for each submodel corresponding to the paths as labeled on Fig. 1 indicated in parentheses. E effects for each variable cannot be dropped since the E term contains the error. LL, log likelihood.
surrounding point estimates. In addition, we note that components of variance do not exactly match quick calculations that one could make based on the twin correlations [e.g., heritability = 2(rMZ - rDZ)] because the estimates yielded by Mx incorporate the additional information gained from cross-twin cross-trait correlations.

There was evidence of significant additive genetic (A) and environmental (C and E) influences on alcohol use and friends’ alcohol use in girls. Common environmental influences predominated on friend’s alcohol use, although there was significant evidence for genetic influence, estimated to account for 27% of the variance (95% CI = 0.16–0.40). The correlation between adolescents’ alcohol use and their friends’ alcohol use was attributed to shared genetic and common and unique environmental influences in girls, with the correlations between genetic (0.68) and common environmental (0.75) influences being largest (though note the broader CI around the genetic correlation). For boys, although self-reported alcohol use showed evidence of genetic influence, genetic influences on friends’ alcohol use were not statistically significant. Friends’ alcohol use was largely environmentally influenced in boys. Accordingly, the covariance between self-alcohol use and friends’ alcohol use was largely environmentally influenced. Note that although the genetic correlation is large, as reported from the full model in Table 4, the CI is very broad, ranging from nearly 0 to 1.0, rendering it largely meaningless, particularly since genetic influences on friends’ alcohol use were not significant.

**DISCUSSION**

In this paper, we conducted a series of analyses exploring the association between friendship characteristics (friends’ drinking, smoking, getting into trouble) and adolescent alcohol use, with focus on how these associations may be moderated by gender of the adolescent and the composition of the friendship group. We find consistent evidence that having friends who drink, smoke, or get into trouble is more strongly associated with alcohol use in girls. This suggests that girls may be more susceptible to peer influence, consistent with previous studies (Simons-Morton et al., 2001; Wang et al., 1995; Yeh et al., 2006). These findings extend previous work in the FinnTwin studies, in which we reported that girls were more susceptible to low-parental monitoring (Rose et al., 2001b). Furthermore, taken together, our analyses suggest that girls may be more susceptible to many kinds of risk factors in early adolescence. Our epidemiological analyses also suggest that having friends who drink, smoke, or get into trouble is more strongly associated with alcohol use when those friends consist of some members of the opposite sex. This was true for both girls and boys. These findings are in line with previous studies suggesting that gender of friends is an important moderator of friends’ influence on substance use (Gaughan, 2006; Wang et al., 1995). However, these studies have all used different measures of assessing friendship characteristics, with the Gaughan et al. study (Gaughan, 2006) assessing same-sex versus opposite-sex best friendships, the Wang et al. study (Wang et al., 1995) separately asking about ones best male friends and best female friends, and our study asking about the gender of the friends with whom the adolescent usually spends their time. It is likely that the manner in which the question is asked will impact the reference group that the adolescent reports on. We limited our analyses to questions that asked specifically about the adolescents’ “friends”, rather than about their “peers”, as it is unclear whether adolescents’ reports of peer behavior refer to the adolescents with whom they have reciprocal friendships or, more generally, to their classmates and other children of similar age. Future research is necessary to address these inconsistencies in order to better understand the role of friends and peers.

Nonetheless, it is interesting that having opposite-sex friends appeared to increase the risk of alcohol use in both girls and boys. What might contribute to this effect? It is possible that adolescents who begin spending time with members of the opposite sex at a young age are more disinhibited and sensation-seeking. Thus, having opposite-sex friends may be a reflection of these temperamental characteristics, as would be the use of alcohol at a younger age. Alternatively, it may be that opposite-sex friends are particularly influential at this transitional, developmental phase. Adolescents who spend time with opposite-sex friends are already engaging in non-normative, more precocious behavior for this age, and, as a result, these friendships may contribute to added pressure to engage in other more “adult-like” behavior, such as alcohol use. These alternative possibilities merit further study.

The twin nature of the dataset also allowed us a unique opportunity to address mechanisms related to friends’
similarity in alcohol use. Our finding of genetic influence on friend’s alcohol use in girls suggests that selective processes are involved, whereby the adolescent’s own genetic predispositions influence the selection of friends who are similarly engaged in alcohol use. Despite this, we also find strong evidence that the correlation between the adolescent’s own alcohol use and their friends’ drinking is also attributable to shared common environmental processes. In other words, although we find evidence of genetic influences on the girls’ drinking and their friends’ drinking, the association between these variables is not mediated solely through a genetic correlation. There is also evidence for common environmental processes that impact whether an adolescent is drinking and whether they have friends who are drinking. Similar results have recently been reported in an independent twin sample (Hill et al., 2007).

For boys, a somewhat different picture emerges. We find no significant genetic effects on friends’ drinking. Instead, substance use among boys’ friends is largely environmentally influenced. These findings are in line with previous analyses in the FinnTwin12 dataset that suggest that girls show earlier evidence of genetic influences on alcohol use and may be more advanced developmentally than boys in this respect (Rose et al., 2001b). Girls have slightly elevated rates of alcohol use at this young age, providing earlier opportunity to express genetic predispositions, and, these analyses would suggest, to have these predispositions influence the selection of drinking friends. The correlation between boys’ alcohol use and that of their friends is still entirely environmental at this age. Our analyses of a slightly older adolescent Finnish sample, studied at ages 16, 17, and 18.5, suggest that a “catch-up effect” exists, eliminating significant gender differences in rates of alcohol use, and in the degree of genetic and environmental influences on alcohol use, later in adolescence (Rose et al., 2001a). However, the analyses reported here suggest that particular importance should be paid to alcohol use in girls at this young age, as they appear to be engaging in earlier experimentation, to show earlier manifestation of genetic influences, and to be particularly susceptible to peer (and perhaps other sources of environmental) influence.

The results of this study should be interpreted within the context of several limitations. The analyses reported here are all cross-sectional in nature, with adolescents’ alcohol use and friendship characteristics reported concurrently at age 14. Thus, we are unable to draw conclusions about directions of causality. The genetically informative twin models do provide some insight into the processes that are involved in the correlations between adolescents’ drinking patterns and that of their friends. Although we do have longitudinal data on the twins, with assessment of the adolescents’ alcohol use again at age 17, the correlations with friends’ substance use three years earlier (~0.3 for girls, 0.2 for boys) were too small to be able to meaningfully partition variance into genetic and environmental components. The results from those models were inconclusive: either genetic or common environmental cross-paths could be dropped, but not both.

Another limitation of the study is that fairly simple measures were used to assess friends’ behavior, a necessary trade-off to obtain population-based information. The measure of friends’ delinquency should be interpreted with caution, as it consisted of a single item asking whether any of the adolescents’ friends have “gotten into trouble at school because of bad behavior or dishonesty”. What constitutes bad behavior may vary according to the perception of different adolescents, as it could encompass behaviors ranging from failure to complete homework to more severe conduct problems, such as physical fighting. Similar concerns exist with the adolescent report of substance use in their friends. We did not have independent, corroborating reports of substance use in the friends. It is known that adolescent’s beliefs about their friends’ behavior can be inaccurate and may be influenced by the adolescent’s own behavior. Nonetheless, we believe that the adolescents’ perceptions of their friends’ substance use is an important variable for study, as it is these perceptions that potentially impact the adolescent’s own decisions about substance use. A more extensive discussion about genetic influences on adolescent friendships in the FinnTwin dataset is available in (Rose, 2001).

In conclusion, our analyses suggest that drinking, smoking, and delinquent behavior in friends may be particularly influential on alcohol use in girls, and when the friends consist of some members of the opposite sex. These findings provide information about moderating influences on the widely reported association between adolescents’ substance use and that of their peers, and suggest areas of focus for prevention and intervention efforts.

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