



HHS Public Access

Author manuscript

Prev Sci. Author manuscript; available in PMC 2017 February 23.

Published in final edited form as:

Prev Sci. 2009 June ; 10(2): 141–150. doi:10.1007/s11121-008-0120-y.

Pubertal Timing, Friend Smoking, and Substance Use in Adolescent Girls

Elizabeth Marklein,

Northwestern University, Evanston, IL, USA

Sonya Negriff, and

Division of Adolescent Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA

Lorah D. Dorn

Division of Adolescent Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA; University of Cincinnati College of Medicine, Cincinnati, OH, USA

Abstract

The influence of friend substance use on the association between pubertal timing and substance use has received little consideration in the literature. With a sample of 264 female adolescents (11–17 years), this study examined (a) the relationship between pubertal timing and substance use, (b) the impact of number of friends that smoke cigarettes on adolescents' use of three substances (cigarettes, alcohol, and marijuana), and (c) the interactions between pubertal timing and friends' smoking in predicting individual substance use. Results showed a significant relationship between pubertal timing and alcohol use; later timing was related to more alcohol use. This association between late timing and alcohol use is contrary to previous literature and may be due to the broad age range of this sample. Pubertal timing may have less of an effect in late adolescence when drinking becomes more normative and less deviant; the rationale for this association is discussed. Second, this study found females who reported that more of their friends smoke regularly (at least once a week) used significantly more cigarettes, alcohol, and marijuana than those who reported no friends who smoke. Finally, the interaction between pubertal timing and number of friends who were regular smokers was not significantly related to adolescent substance use. However, friend smoking explained more of the variation in substance use than pubertal timing. This indicates that having friends who smoke is more influential in predicting substance use than pubertal timing. These findings are important when considering the development of interventions to target adolescent substance use.

Keywords

Pubertal timing; Friend smoking; Cigarettes; Alcohol; Marijuana

Adolescence is a critical period of growth and development when many individuals begin experimenting with substances, including cigarettes, alcohol, and illicit drugs (Johnston et

Correspondence to: Lorah D. Dorn.

al. 2008). The teenage brain is still maturing, thus it is especially important to examine the effects of substance use during this developmental period. Regions of the brain involving executive function, attention, and memory have been found to develop extensively during adolescence and into young adulthood (Dahl 2004; Giedd 2008; Gogtay et al. 2004). Studies have found that individuals who use alcohol and other drugs during adolescence exhibit lasting deficits in cognitive abilities such as learning and memory (Brown et al. 2000; Monti et al. 2005; Tapert and Brown 1999; Tapert et al. 2002).

The association between substance use and mental health problems is well established. High rates of comorbid mental health problems have been reported in adolescents who use substances. For example, in a sample of over 1,500 adolescents, Rohde and colleagues (1996) found that more than 80% of adolescents with an alcohol use disorder also reported some type of co-occurring lifetime psychopathology. In particular, disruptive behavioral disorders (conduct disorder or oppositional defiant disorder) have been found to be highly comorbid with substance use disorders (Lansford et al. 2008). Additionally, higher levels of externalizing problems and depressive symptoms are associated with more substance use (Costello 2007; Fleming et al. 2008). Not only is the comorbidity of mental health problems and substance use problematic during adolescence, but adolescent alcohol and drug use have also been associated with increased internalizing symptoms in young adults, after controlling for concurrent substance use in adulthood (Trim et al. 2007). Additionally, conduct problems as early as ages 7–9 years are related to substance use in early adulthood (Fergusson et al. 2007).

Moreover, substance use is often related to the leading causes of death among United States adolescents, including unintentional injuries, homicides, and suicides (Eaton et al. 2006). Childhood and adolescent substance use can also disrupt normative processes important to positive development in this age group including physical health, school performance, and family and peer relationships. Therefore, adolescent substance use is among the leading public health problems in the United States. Its significance as a public health problem stimulates the need to improve understanding of the risk factors for early initiation and abuse of substances in order to inhibit the development of mental disorders, ensure optimal brain development, and prevent untimely death.

While some experimentation with substances may indicate healthy adolescent development (Baumrind 1991), individuals with an early onset of substance use are at higher risk for later dependence and abuse (Grant and Dawson 1997; Hingson et al. 2006). One risk factor for early substance initiation is the timing of puberty. Pubertal timing is a significant influence on depression, externalizing behavior, and self-esteem for both males and females (Ge et al. 2006a; Siegel et al. 1999). Females may be especially vulnerable because they mature at earlier ages than males (Brooks-Gunn et al. 1985). In particular, early pubertal timing in females has been associated with psychopathology and risk taking behaviors such as substance use in adolescence and young adulthood (Graber et al. 2004; Stice et al. 2001).

Numerous studies have examined the relationship between early pubertal timing and substance use in females and found that girls who become physically mature earlier than their peers are at particular risk for substance use (Harrell et al. 1998; Lanza and Collins

2002; Wilson et al. 1994). Notably, females with an earlier onset of menarche are at an increased risk of engaging in substance use earlier, more often, and in greater quantities than their later maturing peers (Dick et al. 2000; Stattin and Magnusson 1990; Tschann et al. 1994). For example, in a sample of 966 seventh grade females, Lanza and Collins (2002) found that earlier maturing females were 3.3 times more likely than their on-time or later maturing peers to have tried cigarettes, alcohol, and marijuana, and been drunk.

The early timing hypothesis posits that early maturing girls face social pressures before their later developing peers because others view them as older and more mature. There is compelling evidence that females developing early may be more likely to socialize with older peers, thus placing them in more mature situations at a younger age (Caspi and Moffitt 1991; Petersen and Taylor 1980; Stattin and Magnusson 1990). The association between early pubertal timing and higher rates of substance use in adolescent females may be due to their earlier introduction to substance using peers, therefore increasing the adolescent's opportunity to use substances. A second interpretation states that early maturing girls present with earlier substance use because they do not simultaneously mature cognitively or emotionally. Thus, they may be less capable to deal appropriately with the opportunities and pressures to engage in risk taking behaviors, such as the experimentation with substances.

In addition to timing of puberty, peer substance use is a factor contributing to the initiation of substance use in early adolescence. In a study by Dick et al. (2000), earlier maturing girls were more likely to report that more of their peers drink, while later maturing girls reported that fewer of their peers drink. Having friends who engage in risky behavior is a prevailing and consistent predictor of individual risk behavior with peers and young adults similar across time in their cigarette use, alcohol use, binge drinking, and marijuana use (Andrews et al. 2002). However, the perception of peer substance use may actually be more significant than actual peers' use. Among adolescents in the sixth, seventh, and eighth grades, perceived peer alcohol use was associated with initiation of alcohol, increased alcohol use, and increased marijuana use (D'Amico and McCarthy 2006). Perception of peer use is thus an important factor in the initiation of substance use. Not only does peer use influence adolescent substance use, but having peers with positive attitudes towards cigarettes, alcohol, and cannabis use is associated with initiation of cannabis use in females (Agrawal et al. 2007).

Perhaps even more significant than peers' substance use, friends' use has been shown to influence individual substance use. Close friends, more than friendship groups, have been found to influence the initiation of cigarette and alcohol use in adolescents (Urberg et al. 1997). A study by Lloyd-Richardson et al. (2002) identified that middle and high school students were 24 times more likely to become regular smokers if they reported that three of their friends smoked when compared to adolescents that reported no friends who smoked.

Cigarette and alcohol use tends to be concomitant in adolescence (Hoffman et al. 2001). Thus, adolescents with more peers that smoke cigarettes may not only be more likely to smoke cigarettes, but may also be more likely to use other substances as well. D'Amico et al. (2006) found that perceived peer alcohol use predicted both increased alcohol and marijuana use, while perceived peer marijuana use predicted increased alcohol use in a group of middle

school students. To our knowledge, previous studies have not examined whether perception of peer cigarette use may impact the use of other substances. Iannotti and Bush (1992) found that among early adolescents, perception of friends' substance use was a better predictor of adolescent use than peers' own report. In order to develop effective prevention programs for adolescent substance use, it is imperative that we understand the relationship between perception of peer substance use and adolescent substance use in this population.

In reviewing the literature, few studies have investigated the interaction between pubertal timing and peers' substance use on adolescent substance use. Ge et al. (2006) identified in a sample of 9–12 year olds that earlier maturing African American girls and boys were at a higher risk of using substances if they associated with substance-using peers. Similarly, Costello et al. (2007) found that, in a longitudinal study of males and females (69% Caucasian) who were 9–13 years old at enrollment, there was an interaction between early maturation and deviant peers' which increased alcohol use in both males and females. A third study examining a sample of 360 fourth and fifth grade boys and girls (92% Caucasian) found that the effect of pubertal timing on trying cigarettes was partially mediated by affiliation with deviant peers (e.g., kids who get into fights or lie) in girls only (Westling et al. 2008). Thus, although association with deviant peers has been found to moderate the relationship between pubertal timing and substance use, these studies do not speak specifically to the influence of close friends or the smoking behavior of close friends.

The present study aimed to build on previous literature by examining the relationship between pubertal timing, number of friends who smoke, and substance use in adolescent females. On the basis of previous theory and empirical findings, we hypothesized that: (1) adolescents with earlier pubertal timing would use substances (cigarettes, alcohol, and marijuana) more than their later maturing peers, (2) adolescents who reported a greater number of friends who smoke regularly would use cigarettes, alcohol, and marijuana more than those who reported no friends who smoke, and (3) there would be an interaction effect between pubertal timing and number of friends that smoke on adolescent substance use.

Method

Participants and Recruitment

The data for this study were collected from the initial visit of a longitudinal study investigating moods, smoking, and bone health in adolescent girls (Dorn et al. 2008). Participants were 264 female adolescents enrolled in age cohorts of 11, 13, 15, and 17 years (mean age = 14.9 + 2.2). Ethnicity was primarily Caucasian (62.1%) and African American (32.6%). The remainder (5.3%) reported other ethnicities or mixed race.

Potential participants were recruited from an urban teen health center and the surrounding Midwestern community. Participants completed a screening survey to determine the initial level of eligibility. Exclusionary criteria included 1) pregnancy or breast feeding within 6 months, 2) primary amenorrhea (> 16 years), 3) secondary amenorrhea (< 6 cycles/year), 4) body mass index less than the 1st percentile or body weight greater than 300 pounds, 5) medication or medical disorder influencing bone health, and 6) psychological disabilities impairing comprehension or compliance. Females were enrolled into the longitudinal study

based on five previously defined levels of smoking behavior ranging from “never smoked” to “established, dependent smoker.”

Procedure

The study was approved by the Institutional Review Board. Consent from the parent/guardian and assent from the adolescent were obtained. A Certificate of Confidentiality was obtained to assure confidentiality of the adolescent. The girl and her parent/guardian completed their portions of the study visit separately in the General Clinical Research Center at a Midwestern children's hospital. A trained clinician assessed pubertal stages by physical examination and recorded girls' self-reported age at menarche. Girls completed a smoking history questionnaire during study procedures as well as a diagnostic interview including substance use questions. The participating parent/guardian completed questionnaires about demographic information.

Measures

Pubertal Timing

Age at menarche was obtained through a clinician interview. Girls reported the age in years and months of their first menstrual cycle using prior methodologies to enhance accuracy (Dorn et al. 1999, 2006). Age at menarche was used to construct a pubertal timing variable. Early, on-time, and late maturing groups were created based on the sample distribution of age at menarche within Caucasian and African American girls in this study. Girls who were 1 SD or more below the mean (within their race) were coded as early-timing, and those that were 1 SD or more above the mean were coded as late-timing. All other girls were coded as on-time.

At Time 1, 2,110 (80%) of the sample had reached menarche, and thus had reported the age of their first menstrual cycle. For the remaining 54 premenarcheal girls, age at menarche was obtained from a subsequent data collection time point. Thus, Year 2, 3, or 4 age at menarche data was used for the majority of the remaining premenarcheal girls. There were six girls who had not reached menarche at Year 1 but withdrew before the Year 2 visit, and thus could not be assigned to a timing group. At Year 4, there were three girls that had not reached menarche. However, based on their chronological age and using our stated criterion, they were placed in the late-timing group.

Substance Use

Adolescent substance use was measured using the questions from the alcohol, marijuana, and tobacco modules in the Diagnostic Interview Schedule for Children (DISC), Version IV (Shaffer et al. 2000). Research coordinators with prior training in the administration of the DISC completed the standardized interview via computer to the adolescents. The DISC is a structured interview to assess DSM-IV psychiatric disorders and symptoms in children and adolescents. It has demonstrated reliability and validity (Shaffer et al. 2000). Three categories of use (never tried, experimentation, and use) were defined based on items from the tobacco, alcohol and marijuana modules. These categories have been used by previous studies to examine substance use in adolescents (Pajer et al. 2007).

Adolescent cigarette use—Participants were coded into three categories: 0 = those who had never smoked cigarettes in their lifetime, 1 = those who had experimented with cigarettes in the past year (at least a puff, but not more than once a week for a month or longer), and 2 = those who were regular smokers in the past year (smoked at least once a week for a month or longer).

Adolescent alcohol use—Participants were coded into three categories: 0 = those who had never tried alcohol in their lifetime *excluding* a sip, 1 = those who had experimented with alcohol in the past year (more than one but less than six drinks), and 2 = those who consumed alcohol in the past year (6 or more drinks).

Adolescent marijuana use—Participants were coded into three categories: 0 = those who had never used marijuana in their lifetime, 1 = those who had experimented with marijuana in the past year (more than one but less than six times), and 2 = those who had smoked marijuana in the past year (6 or more times).

Friend Smoking

Friend smoking behavior was assessed by a self-report question, “How many of your three closest or best friends are regular smokers (at least once a week)?” Response options ranged from 0 (none) to 3 (all three). This question was developed for the present study and is similar to one used by Lloyd-Richardson et al. (2002) to assess peer daily smoking.

Control Variables

Sociodemographics—The covariates included in the data analyses were age, race (Caucasian, non-Caucasian), and socioeconomic status (SES) (Hollingshead 1975). These have been shown to be related to pubertal timing and/or substance use (Biro et al. 2006; Harrell et al. 1998; Jackson et al. 2002; Johnson and Hoffmann 2000).

Rule breaking behavior—A proportion of this sample was recruited by smoking behavior, and therefore may be more deviant than other samples. To account for this we controlled for rule breaking behavior using a subscale from the Youth Self-Report (Achenbach and Rescorla 2001). The rule breaking behavior subscale consists of 15 items which are summed and converted to a T score with higher score indicating more rule breaking behavior. Items include behaviors such as “I lie or cheat” or “I steal things from home.” There was an internal consistency reliability of .81 in this sample.

Data Analysis

To examine the relationship between pubertal timing and substance use, a series of hierarchical linear regression analyses were completed. In the first step, the covariates (age, race, SES, and rule breaking behavior) were entered. In the second step, the independent variable, pubertal timing, was entered. This was done in three separate analyses with cigarette use, alcohol use, or marijuana use as the dependent variables. The acceptable significance level was set to $p < .05$ for all analyses. Similarly, hierarchical linear regression was used to examine the relationship between number of close friends who smoke and

substance use. The model included entry of the covariates first (age, race, SES, rule breaking behavior) followed by the number of close friends who smoke entered as the independent variable. The analyses were completed separately with cigarette use, alcohol use, and marijuana use. Lastly, the interaction between pubertal timing and friends' smoking was examined by hierarchical linear regression. In the first step, the covariates (age, race, SES, and rule breaking behavior) were entered followed by pubertal timing and friends' smoking in the second step, and then the entry of the interaction term between friends' smoking and pubertal timing in the third step. An interaction effect was determined by the significance of the R square change between the second and third step.

Results

Descriptive Statistics

The means, standard deviation, and ranges of age, SES, age at menarche, and rule breaking behavior variables as well as the number of participants in each category of substance use can be found in Table 1. For the pubertal timing groups there were 39 in the early group (15%), 175 in the on-time group (68%), and 44 in the late group (17%). Regarding number of close friends that smoke, 146 participants answered none (61%), 41 answered one (17%), 31 answered two (13%), and 23 answered three (9%). Correlations were computed between the primary variables of interest (Table 2).

Substantive Analyses

Pubertal Timing and Substance Use—The main effect of pubertal timing was significant for alcohol use ($\beta = .14, p < .05$), after controlling for age, race, SES, and rule breaking behavior. The direction of the regression coefficient indicates later timing was associated with more alcohol use. However this association was not significant for cigarette ($\beta = -.01, p = .88$) or marijuana use ($\beta = .04, p = .39$).

Number of Friends that Smoke and Substance Use—Regarding the relationship between number of friends who are regular smokers and substance use by the adolescent, significant effects were noted for all three types: cigarettes ($\beta = .45, p < .01$), alcohol ($\beta = .18, p < .01$), and marijuana ($\beta = .20, p < .01$). The direction of the coefficients indicates that having more close friends that smoke is associated with more individual cigarette, alcohol, and marijuana use.

Interaction Effect between Pubertal Timing and Friends Smoking—Lastly the interaction between pubertal timing and number of friends who are regular smokers was not significant for any of the substance use variables (cigarette, alcohol, marijuana). However when pubertal timing was entered in the second step of the regression model for alcohol use, and friends' smoking in the third there was a significant R square change indicating that friend smoking accounted for a significant proportion of variance above that accounted for by pubertal timing (R square change = .02, significant F change = .002). Therefore although there was a significant main effect of pubertal timing ($\beta = .14, p < .05$), there was additional variance explained by friends' smoking.

Discussion

The purpose of this study was to examine the influence of pubertal timing and friends' smoking on female adolescents' substance use. We analyzed the relationship between pubertal timing and adolescent substance use, number of friends who smoke regularly and adolescent substance use, and whether the effects of pubertal timing on substance use were moderated by peer smoking behavior. The sample included primarily Caucasian and African American females. The results of the analyses showed that pubertal timing was significantly correlated with alcohol use, but not with marijuana or cigarette use. However, the effect of pubertal timing on alcohol use was in the reverse direction of our hypothesis. Girls with later maturational timing used alcohol significantly more than girls with earlier maturational timing. This is inconsistent with previous findings that support the early timing hypothesis (Caspi and Moffitt 1991; Stattin and Magnusson 1990).

While this study did not find any early timing effects, the relationship between later maturational timing and increased alcohol use is consistent with an alternative theory, the maturational-deviance hypothesis (Petersen and Taylor 1980; Brooks-Gunn et al. 1985). The maturational-deviance hypothesis suggests that adolescents who are off-time in the development—early or late—experience more distress than their on-time developing peers. The hypothesis postulates that girls who mature off-time may attempt to relieve their stress through deviant behavior, including initiation and use of substances (Brooks-Gunn et al. 1985). Specifically in this sample, there was a significant relationship between only later maturing girls and alcohol use. Later maturing girls experience maturation at a time when most of their peers are in advanced stages of development. Thus, they may be more distressed and at an increased risk for substance use due to their off-time maturation. In this sample, the adolescents with later pubertal timing may try to behave in more mature ways, including smoking, drinking, and using marijuana, to compensate for their delayed pubertal development and added stress.

The finding that later pubertal timing was associated only with increased alcohol use but not with cigarette or marijuana use may be due to the more prevalent and normative use of alcohol; in our society, recreational alcohol use in a limited fashion is often viewed as acceptable when safety issues are kept in mind. Conversely, anti-tobacco advertising focuses on the harmful health consequences of smoking cigarettes, and messages about marijuana spotlight the negative health risks as well as its illegality. In comparison to tobacco in particular, fewer media and health promotional messages are evident for the negative effects of alcohol. More public disapproval associated with cigarette and marijuana use may explain the insignificant associations between pubertal timing and cigarette and marijuana use. In addition to the more sociable aspect of alcohol use, alcohol may be easier for adolescents to access and conceal. Many parents may keep alcohol in the home more so than cigarettes or marijuana. Adolescents may have easier access from peers because alcohol is used in more of a social setting. Additionally, adolescents may choose to use alcohol instead of cigarettes or marijuana because it is easier to mask the smell and hide from authority figures.

The broad age range of this sample may have had an impact on the relationship between alcohol use and late pubertal timing. Older adolescents tend to use more substances than

younger adolescents (Johnston et al. 2008). Consistent with past research, in this sample older girls (15–17 years olds) were drinking alcohol significantly more than younger girls (11–13 year olds) (data not shown). Consequently, there was more variance in the older adolescents' use, increasing the likelihood of detecting a significant effect. This is the first time point in a longitudinal study; therefore it will be important to assess the substance use of this sample at a later time point when the younger participants may be experimenting with substances at higher rates and in larger amounts.

Additionally, the broad range in age of 11 to 17 years may explain the association between late timing and increased alcohol use. Pubertal timing may have less of an effect in late adolescence when drinking becomes more normative; early, on-time, and late maturing girls become more similar as alcohol use becomes less deviant. While only a small number of studies have examined the influence of pubertal timing in late adolescence, two influential studies found “a catch up” effect at later time points which weakened the relationship between pubertal timing and alcohol use. Dick et al. (2000) found that late maturing females between ages 16–18.5 “caught up” to their early and on-time maturing peers in their alcohol use. Similarly, Stattin and Magnusson (1990) no longer found an effect of pubertal timing on substance use in 25 year old participants at the final time point in their longitudinal study. As this study's sample encompasses early, middle, and late adolescence, we may be seeing an overcompensated “catch-up” effect by the late maturing girls. Additional research is necessary to examine the effects of pubertal timing on substance use in young adulthood and later in life.

The majority of studies examining pubertal timing and substance use used the measure of age at menarche to construct early, on-time, and late timing groups. There is evidence that constructing pubertal timing in different ways (i.e., national norms vs. sample distribution) can result in significant differences with the outcomes (Negri et al. 2008). However, multiple studies have used the sample distribution to construct timing groups and found early timing effects (Caspi et al. 1993; Ge et al. 2002, 2006a). Therefore, it is unlikely that the differences in our findings linking pubertal timing to increased alcohol use are due to different measures of pubertal timing than used in previous studies

Finally, while unlikely, this sample may represent a different generation of study participants than previously studied samples. Much of the data from previous studies on pubertal timing and substance use are from 10–30 years ago. Thus, the current study cohort may indicate a secular trend in change of perception or impact of early maturation on outcomes in more recently studied younger generations. Both the changing perceptions of societal expectations for physically mature adolescents, as well as the effects of an individual's own perceptions of their changing maturity may be different in contemporary cohorts than in past generations.

Consistent with our second hypothesis, females who reported that more of their friends smoke regularly used significantly more cigarettes, alcohol, and marijuana. This study is the first to our knowledge that links the number of close friends perceived to smoke cigarettes to individual use of not only cigarettes but alcohol and marijuana as well. These results build upon previous research indicating that adolescents are more likely to become regular smokers if they report more of their friends smoke when compared to adolescents who

report no friends smoke (Lloyd-Richardson et al. 2002). With respect to alcohol, D'Amico and McCarthy (2006) found that perceived peer alcohol use predicted individual alcohol and marijuana use in adolescents; similarly, perceived peer marijuana use predicted increased individual alcohol use. In contrast to our findings, D'Amico and McCarthy (2006) determined that only personal use of alcohol and marijuana, not peer substance use, predicted onset of adolescent cigarette use. The findings of the current study indicate that having more friends that smoke cigarettes regularly significantly increases adolescents' use of not only cigarettes, but also alcohol and marijuana. Thus, perceived use of one substance by friends may increase the use of that substance as well as other substances in adolescents.

Finally, the interaction between pubertal timing and number of close friends who were regular smokers was not significantly related to adolescent substance use. However, an important finding was that friend smoking explained more of the variation in alcohol use than pubertal timing. Therefore, although there was a significant effect of later pubertal timing on alcohol use, more variance was explained by friend smoking. We expected there would be an interaction effect because friend influence has been shown to be a major indicator of individual substance use in adolescence (Andrews et al. 2002) and other studies have found an interaction between pubertal timing and peer substance use/deviance (Costello et al. 2007; Ge et al. 2006b; Westling et al. 2008). However, our study is different in several ways from these previous studies. As mentioned, our cross-sectional age range is much broader than in previous studies. Second, a substantial proportion of our sample is African American. This differs from much of the literature on pubertal timing as they have primarily assessed samples of Caucasian adolescents. Third, our sample is drawn from an economically diverse area including urban, suburban, and rural areas. Thus, although we cannot generalize our results to the larger population of adolescents, we do have a more diverse sample than in many previous studies. Lastly, our measure of peer influence was that of close friends, which may be more salient than peer groups.

There are several limitations of the study that should be noted. First, friends' smoking was assessed through the participants' reports rather than through friends' reports. Previous research has found that participants tend to overestimate how similar they are to their peers in their substance use (Urberg et al. 1990). Due to this "false consensus effect" (Ross et al. 1977) peer reports of their own substance use may be a better measure of actual peer substance use than adolescent observation of their peers' use. However, previous research by Iannotti and Bush (1992) found that among early adolescents, perception of friends' substance use was a better predictor of adolescent use than peers' own report. The measure used in the present study was the adolescent's perception of their friends' smoking behavior which has been shown to be more influential than peers' actual use. Thus, perception of peer substance use is still a risk factor contributing to individual substance use.

This study was cross-sectional; thus we cannot ascertain whether it was friends' smoking behavior that was causing adolescents to use substances, or if there was a selection effect. There are similarities between adolescent friends that may have existed before they became friends, which may be what drew them together (Aboud and Mendelson 1998). However, there are also social pressures operating within friendship groups; individuals feel compelled to adhere to the norms (or perceived norms) of the group to which they belong (Berndt

1996). Thus, if an adolescent does not smoke before they become friends with individuals who smoke, this behavior may be central to the identity of the group and as a result the adolescent will feel more pressure to engage in this behavior in order to be homogenous with the group. Consequently, peer influence may not necessarily be overt; in one study of 16–17 year old girls 40% said they started smoking because their friends smoked, but said they did not experience peer pressure to smoke (Nichter et al. 1997). In this study we were unable to tease apart these potential mechanisms, but we can say that friends' smoking is associated with adolescents' cigarette, alcohol, and marijuana use which is a novel result in the literature.

The accuracy of self-report of age at menarche may also be a limitation. Age at menarche is used in many studies as a measure of pubertal timing. However, some studies have found variability across time (1 year) of reporting the date of menarche as large as 18 months (Dorn et al. 1999). Additionally, menarche is a late event in the process of puberty and thus cannot be equated to pubertal onset.

Recruitment by smoking behavior is another limitation of this study. The study sample may be participating in more delinquent behavior and substance use than the general population because they were recruited by smoking behavior; girls were recruited into five groups: never-smokers, initiators, experimenters, regular smokers, and established-dependent smokers. Specifically, towards the end of recruitment we targeted girls who smoked. However, it should be emphasized that never smokers were recruited as well. Thus, this sample cannot be generalized to other adolescent populations who were recruited in other ways.

Additionally, the impact of pubertal timing on substance use may be more proximal to the time when puberty occurs. If that were the case, the age range of the study sample may be too broad to examine pubertal timing because it encompasses three developmental periods of adolescence (early, middle, and late). Late adolescence is associated with more risk taking behaviors including experimentation with substances.

Finally, other variables beyond close friends' smoking could influence the individuals' substance use or the role that pubertal timing may play. For example, substance use of parents or siblings, parental monitoring, and neighborhood factors may influence the substance use of the adolescent. Our study was limited to examining close friends' smoking.

Nonetheless, these findings are important because the results can help us understand the potential individual contributions of biology versus social context in the development of substance use in female adolescents. This study found that later pubertal timing was significantly associated with more alcohol use. In order to target those most at risk for alcohol use, it will be important to examine subgroups of the population that consume greater amounts of alcohol as later maturing rather than earlier maturing females. Additionally, the current study extends our knowledge of the influence of friends on individual use of cigarettes, alcohol, and marijuana. While additional research is needed to understand the influences of pubertal timing and friend substance use on individual use, these findings extend research on the development of substance use and can aid in the

prevention and treatment of adolescent substance use. Acknowledging the contribution of close friends' smoking substance use would be important for teachers and parents to be aware of so that such issues could be addressed.

Future research on the effects of pubertal timing should take into account using other measures of pubertal timing, like Tanner staging, to examine the impact of peer substance use on individual substance use. Other mediating and moderating variables, like parental influence, that may impact the relationship between peer substance use, pubertal timing, and individual substance use could also be examined. It will be especially important to study pubertal timing in females as they transition from adolescence to young adulthood to examine the effects on their lifetime substance use. Finally, the relationships between peer influence and pubertal timing could also be studied in a male population.

Acknowledgments

Financial support was from a grant received by the third author (R01DA16402). The study was also supported by USPHS GCRC Grant #M01 RR 08084 from the National Center for Research Resources, National Institutes of Health.

References

- About, FE., Mendelson, MJ. Determinants of friendship selection and quality: Developmental perspectives. In: Bukowski, WM, Newcomb, AF., Hartup, WW., editors. *The company they keep: Friendship in childhood and adolescence*. New York: Cambridge University Press; 1998. p. 87-112.
- Achenbach, TM., Rescorla, LA. *Manual for the ASEBA school-age forms & profiles*. Burlington, VT: University of Vermont, Research Center for Children Youth and Families; 2001.
- Agrawal A, Lynskey M, Bucholz K, Madden P, Heath A. Correlates of cannabis initiation in a longitudinal sample of young women: the importance of peer influences. *Preventive Medicine*. 2007; 45:31–34. DOI: 10.1016/j.ypmed.2007.04.012 [PubMed: 17561248]
- Andrews J, Tildesley E, Hops H, Li F. The influence of peers on young adult substance use. *Health Psychology*. 2002; 21:349–357. DOI: 10.1037/0278-6133.21.4.349 [PubMed: 12090677]
- Baumrind D. The influence of parenting style on adolescent competence and substance use. *The Journal of Early Adolescence*. 1991; 11:56–95. DOI: 10.1177/0272431691111004
- Berndt, TJ. Transitions in friendship and friends' influence. In: Graber, JA, Brooks-Gunn, J., Petersen, AC., editors. *Transitions through adolescence: Interpersonal domains and context*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1996. p. 57-84.
- Biro FM, Huang B, Crawford PB, Lucky AW, Striegel-Moore R, Barton BA, et al. Pubertal correlates in black and white girls. *The Journal of Pediatrics*. 2006; 148:234–240. DOI: 10.1016/j.jpeds.2005.10.020 [PubMed: 16492435]
- Brooks-Gunn J, Petersen A, Eichorn D. The study of maturational timing effect in adolescence. *Journal of Youth and Adolescence*. 1985; 14:149–161. DOI: 10.1007/BF02090316 [PubMed: 24301174]
- Brown SA, Tapert SF, Granholm E, Delis DC. Neurocognitive functioning of adolescents: effects of protracted alcohol use. *Alcoholism, Clinical and Experimental Research*. 2000; 24:164–171. DOI: 10.1111/j.1530-0277.2000.tb04586.x
- Caspi A, Lynam D, Moffitt TE, Silva PA. Unraveling girls' delinquency: biological, dispositional, and contextual contributions to adolescent misbehavior. *Developmental Psychology*. 1993; 29:19–30. DOI: 10.1037/0012-1649.29.1.19
- Caspi A, Moffitt TE. Individual differences are accentuated during periods of social change: the sample case of girls at puberty. *Journal of Personality and Social Psychology*. 1991; 61:157–168. DOI: 10.1037/0022-3514.61.1.157 [PubMed: 1890586]

- Costello EJ. Psychiatric predictors of adolescent and young adult drug use and abuse: what have we learned? *Drug and Alcohol Dependence*. 2007; 88:S97–S99. DOI: 10.1016/j.drugalcdep.2006.12.027 [PubMed: 17276625]
- Costello EJ, Sung M, Worthman C, Angold A. Pubertal maturation and the development of alcohol use and abuse. *Drug and Alcohol Dependence*. 2007; 88S:S50–S59. DOI: 10.1016/j.drugalcdep.2006.12.009
- D'Amico E, McCarthy D. Escalation and initiation of younger adolescents' substance use: the impact of perceived peer use. *The Journal of Adolescent Health*. 2006; 39:481–487. DOI: 10.1016/j.jadohealth.2006.02.010 [PubMed: 16982381]
- Dahl, RE. Adolescent brain development: A period of vulnerabilities and opportunities. In: Dahl, RE., Spear, LP., editors. *Adolescent brain development: Vulnerabilities and opportunities*. New York: New York Academy of Sciences; 2004. p. 1–22.
- Dick DM, Rose RJ, Viken RJ, Kaprio J. Pubertal timing and substance use: associations between and within families across late adolescence. *Developmental Psychology*. 2000; 36:180–189. [PubMed: 10749075]
- Dorn LD, Dahl RE, Woodward HR, Biro F. Defining the boundaries of early adolescence: a user's guide to assessing pubertal status and pubertal timing in research with adolescents. *Applied Developmental Science*. 2006; 10:30–56. DOI: 10.1207/s1532480xads1001_3
- Dorn LD, Nottelmann E, Susman EJ, Inoff-Germain G, Cutler G, Chrousos G. Variability in hormone concentrations and self-reported menstrual histories in young adolescents: menarche as an integral part of a developmental process. *Journal of Youth and Adolescence*. 1999; 28:283–304. DOI: 10.1023/A:1021680726753
- Dorn LD, Susman EJ, Pabst SR, Huang B, Kalkwarf HJ, Grimes S. The association of depressive symptoms and anxiety with bone mass and density in ever smoking and never smoking adolescent girls. *Archives of Pediatrics & Adolescent Medicine*. 2008; 162:1181–1188. [PubMed: 19047547]
- Eaton DK, Kann L, Kinchen S, Ross J, Hawkins J, Harris W, et al. Youth risk behavior surveillance—United States, 2005. *The Journal of School Health*. 2006; 76:353–372. DOI: 10.1111/j.1746-1561.2006.00127.x [PubMed: 16918870]
- Fergusson DM, Horwood LJ, Ridder EM. Conduct and attentional problems in childhood and adolescence and later substance use, abuse and dependence: results of a 25-year longitudinal study. *Drug and Alcohol Dependence*. 2007; 88:S14–S26. DOI: 10.1016/j.drugalcdep.2006.12.011
- Fleming CB, Mason WA, Mazza JJ, Abbott RD, Catalano RF. Latent growth modeling of the relationship between depressive symptoms and substance use during adolescence. *Psychology of Addictive Behaviors*. 2008; 22:186–197. DOI: 10.1037/0893-164X.22.2.186 [PubMed: 18540716]
- Ge X, Brody GH, Conger RD, Simons RL, McBride-Murray V. Contextual amplification of pubertal transition effects on deviant peer affiliation and externalizing behavior among African American children. *Developmental Psychology*. 2002; 38:42–54. DOI: 10.1037/0012-1649.38.1.42 [PubMed: 11806701]
- Ge X, Brody GH, Conger RD, Simons RL, McBride-Murray V. Pubertal maturation and African American children's internalizing and externalizing symptoms. *Journal of Youth and Adolescence*. 2006a; 35:531–540. DOI: 10.1007/s10964-006-9046-5
- Ge X, Jin R, Natsuaki M, Gibbons FX, Brody GH, Cutrona CE, et al. Pubertal maturation and early substance use risks among African American children. *Psychology of Addictive Behaviors*. 2006b; 20:404–414. DOI: 10.1037/0893-164X.20.4.404 [PubMed: 17176175]
- Giedd J. The teen brain: insights from neuroimaging. *The Journal of Adolescent Health*. 2008; 42:335–343. DOI: 10.1016/j.jadohealth.2008.01.007 [PubMed: 18346658]
- Gogtay N, Giedd J, Lusk L, Hayashi K, Greenstein D, Vaituzis A, et al. Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America*. 2004; 101:8174–8179. DOI: 10.1073/pnas.0402680101 [PubMed: 15148381]
- Graber JA, Seeley J, Brooks-Gunn J, Lewinsohn P. Is pubertal timing associated with psychopathology in young adulthood? *Journal of the American Academy of Child and Adolescent Psychiatry*. 2004; 43:718–726. DOI: 10.1097/01.chi.0000120022.14101.11 [PubMed: 15167088]

- Grant B, Dawson D. Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse*. 1997; 9:103–110. DOI: 10.1016/S0899-3289(97)90009-2 [PubMed: 9494942]
- Harrell J, Bangdiwala S, Deng S, Webb J, Bradley C. Smoking initiation in youth: the roles of gender, race, socioeconomics, and developmental status. *The Journal of Adolescent Health*. 1998; 23:271–279. DOI: 10.1016/S1054-139X(98)00078-0 [PubMed: 9814387]
- Hingson RW, Heeren T, Winter MR. Age at drinking onset and alcohol dependence: age at onset, duration, and severity. *Archives of Pediatrics & Adolescent Medicine*. 2006; 160:739–746. DOI: 10.1001/archpedi.160.7.739 [PubMed: 16818840]
- Hoffman J, Welte J, Barnes G. Co-occurrence of alcohol and cigarette use among adolescents. *Addictive Behaviors*. 2001; 26:63–78. DOI: 10.1016/S0306-4603(00)00089-7 [PubMed: 11196293]
- Hollingshead, AB. Four factor index of social status. New Haven, CT: Yale University Press; 1975.
- Iannotti RJ, Bush PJ. Perceived vs. actual friends' use of alcohol, cigarettes, marijuana, and cocaine: which has the most influence? *Journal of Youth and Adolescence*. 1992; 21:275–389. DOI: 10.1007/BF01537024
- Jackson KM, Sher KJ, Cooper ML, Wood PK. Adolescent alcohol and tobacco use: onset, persistence and trajectories of use across two samples. *Addiction (Abingdon, England)*. 2002; 97:517–531. DOI: 10.1046/j.1360-0443.2002.00082.x
- Johnson RA, Hoffmann JP. Adolescent cigarette smoking in U.S. racial/ethnic subgroups: findings from the National Education Longitudinal Study. *Journal of Health and Social Behavior*. 2000; 41:392–407. DOI: 10.2307/2676293 [PubMed: 11198564]
- Johnston, LD., O'Malley, PM., Bachman, JG., Schulenberg, JE. Monitoring the future national results on adolescent drug use: Overview of key findings, 2007 (NIH Publ No 08-6418). National Institute on Drug Abuse; Bethesda, MD: 2008.
- Lansford JE, Erath S, Yu T, Pettit GS, Dodge KA, Bates JE. The developmental course of illicit substance use from age 12 to 22: links with depressive, anxiety, and behavior disorders at age 18. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*. 2008; 49:877–885. DOI: 10.1111/j.1469-7610.2008.01915.x
- Lanza ST, Collins LM. Pubertal timing and the onset of substance use in females during early adolescence. *Prevention Science*. 2002; 3:69–82. DOI: 10.1023/A:1014675410947 [PubMed: 12002560]
- Lloyd-Richardson E, Papandonatos G, Kazura A, Stanton C, Niaura R. Differentiating stages of smoking intensity among adolescents: stage-specific psychological and social influences. *Journal of Consulting and Clinical Psychology*. 2002; 70:998–1009. DOI: 10.1037/0022-006X.70.4.998 [PubMed: 12182283]
- Monti PM, Miranda R, Nixon K, Swartzwelder HS, Sher KJ, Tapert SF, et al. Adolescence: booze, brains, and behavior. *Alcoholism, Clinical and Experimental Research*. 2005; 29:207–220. DOI: 10.1097/01.ALC.0000153551.11000.F3
- Negriff S, Fung M, Trickett P. Self-rated pubertal development, depressive symptoms and delinquency: measurement issues and moderation by gender and maltreatment. *Journal of Youth and Adolescence*. 2008; 37:736–746. DOI: 10.1007/s10964-008-9274-y [PubMed: 25152546]
- Nichter M, Nichter M, Vuckovic N, Quintero G, Ritenbaugh C. Smoking experimentation and initiation among adolescent girls: qualitative and quantitative findings. *Tobacco Control*. 1997; 6:285–295. [PubMed: 9583626]
- Pajer K, Kazmi A, Gardner W, Wang Y. Female conduct disorder: health status in young adulthood. *Journal of Adolescent Health*. 2007; 40(1):84.e1–84.e7.
- Petersen, AC., Taylor, B. The biological approach to adolescence. In: Adelson, J., editor. *Handbook of adolescent psychology*. New York City: Wiley; 1980. p. 115-155.
- Rohde P, Lewinsohn P, Seeley J. Psychiatric comorbidity with problematic alcohol use in high school students. *Journal of the American Academy of Child and Adolescent Psychiatry*. 1996; 35:101–109. DOI: 10.1097/00004583-199601000-00018 [PubMed: 8567601]

- Ross L, Grene D, House P. The false consensus phenomenon: an attributional bias in self-perception and social psychological processes. *Journal of Experimental Social Psychology*. 1977; 13:279–301. DOI: 10.1016/0022-1031(77)90049-X
- Shaffer D, Fisher P, Lucas CP, Dulcan MK, Schwab-Stone ME. NIMH Diagnostic Interview Schedule for Children, Version IV (NIMH DISC-IV): description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2000; 39:28–38. DOI: 10.1097/00004583-200001000-00014 [PubMed: 10638065]
- Siegel JM, Yancey AK, Aneshensel CS, Schuler R. Body image, perceived pubertal timing, and adolescent mental health. *The Journal of Adolescent Health*. 1999; 25:155–165. DOI: 10.1016/S1054-139X(98)00160-8 [PubMed: 10447043]
- Stattin, H., Magnusson, D. Pubertal maturation in female development. Hillsdale, NJ: Lawrence Erlbaum Associates; 1990.
- Stice E, Presnell K, Bearman SK. Relation of early menarche to depression, eating disorders, substance abuse, and comorbid psychopathology. *Developmental Psychology*. 2001; 37:608–619. DOI: 10.1037/0012-1649.37.5.608 [PubMed: 11552757]
- Tapert SF, Brown SA. Neuropsychological correlates of adolescent substance abuse: four-year outcomes. *Journal of the International Neuropsychological Society*. 1999; 5:481–493. DOI: 10.1017/S1355617799566010 [PubMed: 10561928]
- Tapert SF, Granhold D, Leedy NG, Brown SA. Substance use and withdrawal: neuropsychological functioning over eight years in youth. *Journal of the International Neuropsychological Society*. 2002; 8:873–883. DOI: 10.1017/S1355617702870011 [PubMed: 12405538]
- Trim R, Meehan B, King K, Chassin L. The relation between adolescent substance use and young adult internalizing symptoms: findings from a high-risk longitudinal sample. *Psychology of Addictive Behaviors*. 2007; 21:97–107. DOI: 10.1037/0893-164X.21.1.97 [PubMed: 17385959]
- Tschann J, Adler N, Irwin C, Millstein S, Turner R, Kegeles S. Initiation of substance use in early adolescence: the roles of pubertal timing and emotional distress. *Health Psychology*. 1994; 13:326–333. DOI: 10.1037/0278-6133.13.4.326 [PubMed: 7957011]
- Urberg K, Degirmencioglu S, Pilgrim C. Close friend and group influence on adolescent cigarette smoking and alcohol use. *Developmental Psychology*. 1997; 33:834–844. DOI: 10.1037/0012-1649.33.5.834 [PubMed: 9300216]
- Urberg K, Shyu S, Liang J. Peer influence in adolescent cigarette smoking. *Addictive Behaviors*. 1990; 15:247–255. DOI: 10.1016/0306-4603(90)90067-8 [PubMed: 2378284]
- Westling E, Andrews J, Hampson S, Peterson M. Pubertal timing and substance use: the effects of gender, parental monitoring and deviant peers. *The Journal of Adolescent Health*. 2008; 42:555–563. DOI: 10.1016/j.jadohealth.2007.11.002 [PubMed: 18486864]
- Wilson D, Killen J, Hayward C, Robinson T, Hammer L, Kraemer H, et al. Timing and rate of sexual maturation and the onset of cigarette and alcohol use among teenage girls. *Archives of Pediatrics & Adolescent Medicine*. 1994; 148:789–795. [PubMed: 8044254]

Table 1
Descriptive statistics for study variables

	N	Mean	SD	Range
Age (years)	264	14.93	2.18	11.07–17.99
SES	263	37.38	13.63	14–66
Age at menarche (years)	254	12.39	1.24	7.42–16.08
Rule breaking behavior	264	57.58	7.17	50–83
	<i>a</i>	0	1	2
Alcohol use: <i>n</i>		136 (51.7%)	60 (22.8%)	67 (25.5%)
Marijuana use: <i>n</i>		183 (69.6%)	31 (11.8%)	49 (18.6%)
Cigarette use: <i>n</i>		148 (56.3%)	38 (14.4%)	77 (29.3%)

^aFor alcohol and marijuana 0 = no use, 1 = used 1-5 times, 2 = used 6 times; for cigarettes 0 = no use, 1 = smoked less than once a week, 2 = smoked at least once a week for a month or longer; alcohol, marijuana, and cigarette use from the Diagnostic Interview Schedule for Children; SES = socioeconomic status; rule breaking behavior taken from the Youth Self-Report (T score)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2

Correlations between study variables

	Pubertal timing	Alcohol use (past year)	Marijuana use (past year)	Cigarette use (past year)	Friend smoking
Pubertal timing	1.00				
Alcohol use (past year)	.12*	1.00			
Marijuana use (past year)	.06	.57**	1.00		
Cigarette use (past year)	.01	.64**	.58**	1.00	
Friend smoking	.04	.55**	.49**	.73**	1.00

Note: a lower score of pubertal timing reflects "early timing"

* $P < .05$;

** $P < .01$