THE ROLE OF GENES AND ENVIRONMENT IN ADOLESCENTS' AND YOUNG ADULTS' ALCOHOL USE

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CHAPTER

1

GENERAL INTRODUCTION

INTRODUCTION

In the current thesis we will examine the etiology of individual differences in alcohol use in adolescents and young adults. In this chapter we first provide background information on the development of alcohol consumption in adolescents and young adults. Next, relevant studies on the etiology of individual differences in alcohol use in young people are reviewed. In addition, we introduce the studies from the current thesis.

DEVELOPMENT OF ALCOHOL CONSUMPTION IN ADOLESCENTS AND YOUNG ADULTS

Alcohol use below the age of 16 years is common in the Netherlands, although it is illegal under Dutch law to sell light alcoholic beverages, such as beer and wine, to people under the age of 16. For strong alcoholic beverages (liquor) this age limit is even 18 years. Alcohol use in adolescents and young adults develops across multiple stages, starting with the initiation of alcohol use. Similar to the behavior of adolescents in many other countries, experimentation with alcohol in the Netherlands starts during adolescence. Most Dutch adolescents initiate alcohol use between the age of 11-14 years (Monshouwer et al., 2004), which is somewhat younger than in other European countries (Currie et al., 2004). After initiation has taken place, the drinking pattern generally becomes more regular. Drinking in that period is usually moderate in amount and does not cause problems (World Health Organization, 1994). Most Dutch adolescents enter the initiation stage and continue into the regular drinking stage; 85% of the adolescents between the age of 12-18 have experimented with alcohol and 58% of the adolescents between the age of 12-18 drink alcohol regularly (Monshouwer et al., 2004).

Prevalence of alcohol use increases with age, in particular between the age of 12 and 15 years (De Zwart et al., 2000; Sutherland & Sheperd, 2001; Ter Bogt et al., 2002; Young et al., 2002). Data collected in the Netherlands show that 2.8% of the 11-year-old girls and 9.1% of the 11-year-old boys report weekly drinking, these percentages increase to 47.3% in 15-year-old girls and 55.6% in 15-year-old boys (Currie et al., 2004). Alcohol use generally continues to increase until at least the age of 18 years. However, there is a lack of information regarding alcohol use during the transition from late adolescence into young adulthood as prevalence studies of alcohol use usually take all persons after the age of 18 until for example 65 together, therefore it is hard to disentangle drinking patterns of young people from these studies.

In a small percentage of the population regular drinking evolves into problem drinking. Problem drinkers drink above a certain threshold and as a consequence they experience problems related to their alcohol consumption. Problem drinking generally develops when individuals are older and have a longer history of alcohol use. Among 16-24-year olds in the Netherlands 22% are identified as problem drinkers (34% of the males and 9% of the females) (Van Dijck & Knibbe, 2005). This percentage is rather high compared to for example young people in the United States, where it is approximately 15% (no sex differences) (Young et al., 2002).

Heavy alcohol use and problem drinking in young people is associated with short-term consequences such as alcohol related violence, drunk driving, injuries and risky sexual behavior (Gruber et al., 1996; Hingson et al., 2003; Wechsler et al., 1994). In addition, it is associated with brain damage and neuro-cognitive deficits with implications for learning and intellectual development (Brown et al., 2000; Zeigler et al., 2005). In the long-term, heavy alcohol use and problem use is predictive of, among other things, problematic alcohol use in adulthood (McCarty et al., 2004, O'Neill et al., 2001), liver damage (Norstrom & Ramstedt, 2005) and diverse types of cancer (i.e., head and neck cancer, gastrointestinal cancer and breast cancer) (Thomas, 1995). Obviously, problem drinking and heavy alcohol use should be prevented. As adolescents in the Netherlands start drinking regularly at a relatively young age and because the percentage of young problem drinkers is rather high, the transition through the stages of alcohol consumption should be examined in young people. Studies on the determinants of stages of alcohol consumption point to the relevance of both social factors and genes in the alcohol use of young people. Therefore, in the current thesis we focus on the etiology of individual differences across several stages of alcohol use in young people. In particular, we will explore the role of alcohol use of family and friends in this respect and we will apply a genetic informative research design to disentangle social factors from genetic factors.

THE ROLE OF FAMILY AND FRIENDS

One of the explanatory theories of the role of family and friends in young people's drinking behavior could be the Social Learning Theory (Bandura, 1977). The main idea of this theory is that people learn by observing and imitating role models. If this theory is applied to alcohol use it is assumed that alcohol use in young people stems from alcohol-specific attitudes and behaviors of people who serve as role models, especially parents, siblings and friends. Continuation of drinking will occur if social reinforcement through encouragement and support by role models takes place and this is likely to result in positive expectations of future alcohol use and actual alcohol use (e.g., Petraitis et al., 1995).

In addition, the role of family members and friends in young people's drinking behavior can also be explained by genetic factors, with family members being more similar in alcohol use as they share more of the genes that influence alcohol use. In contrast to family members, friends are not biologically related, although genetics may play a role in the relation between friends' alcohol use and young people's alcohol use, as friendship selection processes may take place on basis of genetic make-up of individuals (Cleveland et al., 2005; Fowler et al., 2007b; Rose & Dick, 2005).

PARENTAL ALCOHOL USE

Parents are the family members most often studied as potential sources of influence on adolescent alcohol consumption. Nevertheless, the direct association between parental drinking and drinking in their offspring seems far from clear. A number of studies found that parental alcohol use predicted moderate drinking of adolescents and young adults (Cleveland & Wiebe, 2003; Duncan et al., 1996; Engels et al., 1999; Green et al., 1991; Hops et al., 1996; Koopmans & Boomsma, 1996; Li et al., 2002; Van Der Vorst et al., 2005; Windle, 2000; Wood et al., 2004), while others did not find such an association (Beal et al., 2001; Boyle et al., 2001; Power et al., 2005; Reifman et al., 1998). These studies did have a longitudinal design, but the intervals between the waves were relatively short (1 to 2-year intervals were most common). As studies on long-term effects are lacking, it is not clear whether parental drinking affects young people's alcohol use over a longer period of time, or whether the impact of parental alcohol use decreases because other factors, such as genetics or drinking of friends, become relatively more important.

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Results are also mixed with regard to the parental role in problem drinking; while some studies found a relation between parental drinking and problem drinking in their children (Ellickson et al., 2001), others did not find evidence for this relation (Ouellette et al., 1999; Windle, 2000). By using an adoption study design McGue et al., (1996a) showed that parental problem drinking was related to alcohol misuse in biological offspring, but not in adoptive offspring, indicating that genetic factors underlie the association. Whether genetic or environmental factors or a combination of both were involved in the relation between parental drinking and alcohol use in their offspring can not be concluded from the other studies we described.

Studies on more advanced stages of alcohol consumption such as heavy drinking and alcohol abuse and dependence also revealed empirical evidence for the importance of parental drinking in predicting their offspring's more problematic alcohol use. Walden et al. (2007) found parental drinking to be related to heavy drinking and Reifman et al. (1998) found higher levels of mothers' drinking but not fathers' drinking to be related to adolescent heavy drinking. Alati et al. (2005) only examined mothers' drinking and found higher levels of mothers' drinking to be related to alcohol abuse and dependence in young adult children.

ALCOHOL USE OF SIBLINGS

Compared to parents' drinking, the role of siblings' alcohol use in the drinking behavior of young people is less often examined. Siblings are genetically related and therefore they might be similar in alcohol use, as the chance is larger than for unrelated individuals that they share genes that directly or indirectly influence alcohol use. When the siblings are also close in age, these shared genes are even more likely to be expressed in these individuals. Siblings might also exert an influence on adolescents' drinking, because most adolescents have daily contact with their siblings. Especially if siblings are close in age and spend time together at home or outside home without parental supervision, siblings can be of influence on alcohol use. Siblings might serve as role models for young people and therefore young people might imitate their siblings' drinking behavior. Studies in which the role of siblings in adolescents' drinking was examined showed drinking of siblings to be associated with alcohol use of adolescents and young adults (Ary et al., 1993; Boyle et al., 2001; D'Amico & Fromme, 1997; Duncan et al., 1996; McGue et al., 1996a; Needle et al., 1986; Van Der Vorst et al., 2007; Windle, 2000).

Even less research focused on the role of siblings' drinking in problem drinking. We found two studies in this respect, showing contradictory findings. Windle (2000) did not find a longitudinal relation between siblings' frequency of drinking and adolescent problem drinking. In contrast, McGue et al. (1996a) indicated that siblings' drinking is substantially related to adolescent alcohol misuse. McGue and colleagues used data of adoptive siblings, the fact that they found an association in alcohol use of non-biological adoptive siblings suggests that the effect of siblings' drinking on a person's alcohol use is due to social factors, not genetic factors.

FRIENDS' ALCOHOL USE

In addition to the influence of family members, factors outside the family also require consideration. During adolescence young people tend to form an identity independent from their families and this period is characterized by an increase in time spent with peers. Adolescents have a strong need for social approval, group membership and close friends (Hartup, 1996), making them susceptible to the pressure to conform to norms among peers, which in turn may lead to initiation or increase of alcohol use. In research on adolescents' substance use much attention has been paid to the role of friends. In general, friends' drinking is now considered to be one of the strongest predictors of adolescents' and young adults' alcohol use (see review study by Petraitis et al., 1995), both cross-sectionally and over a short period of time (within a year) (Andrews et al., 2002; Ary et al., 1993; Beal et al., 2001; Bot et al., 2005a; Engels et al., 1999; Graham et al., 1991; Reifman et al., 1998; Urberg et al., 1997; Webster et al., 1994; Windle, 2000; Wood et al., 2001). However, two longitudinal studies have shown that the influence of friends on drinking is important in early adolescence, but decreases over a longer period of time (two years and three years or more) (Andrews et al., 2002; Engels et al., 1999). In addition to alcohol use, longitudinal research also shows the importance of drinking of friends for adolescent heavy alcohol use (Griffin et al., 2000; Guilamo-Ramos et al., 2004; Ouellette et al., 1999; Reifman et al., 1998; Tucker et al., 2003) and problem drinking (Ellickson et al., 2001; Windle, 2000).

LIMITATIONS IN RESEARCH ON THE ROLE OF FAMILY AND FRIENDS' DRINKING

Research on the role of family and friends' drinking in young people's alcohol use suffers from a number of limitations. Previous studies have indicated that alcohol use of family members and friends is a relevant contributor to the different stages of alcohol use which

adolescent and young adults pass through. However, the impact of parents, siblings and friends on separate stages of alcohol consumption has seldom been examined simultaneously in a long-term longitudinal study. It is relevant to examine whether parents, siblings and friends have a different impact in separate stages of alcohol use. Little is known about the relative contribution of all persons relevant to young people's environments. Therefore longitudinal research examining the drinking of parents, siblings and friends simultaneously is needed. Moreover, the influence of parental alcohol use on their offspring's drinking is often examined with a combined measure of paternal and maternal alcohol use and not by examining the effect of alcohol use of mothers and fathers separately. As fathers and mothers may have a unique effect on their offspring's alcohol use, this approach of one overall measure of parental drinking might not reflect the entire impact of parental alcohol use. Furthermore, research on the role of family and friends in young people's drinking generally focuses on moderate drinking. Few studies examined the etiology of heavy drinking, but even less focused on factors related to problem drinking in young people.

THE TWIN DESIGN AND STAGES OF ALCOHOL USE

     To examine to what extent variation in phenotypes or behaviors such as initiation of alcohol use and frequency of drinking are explained by genetic or environmental factors, we should make use of genetically informative designs. Of these the twin design is the most commonly used. The twin method is often referred to as a natural experiment that is based on the difference in genetic relatedness between monozygotic (MZ, or identical) twin pairs on the one hand and dizygotic (DZ, or fraternal) twins on the other hand. MZ twins develop from one zygote (fertilized egg-cell) and therefore they are genetically identical, DZ twins develop from two separately fertilized egg-cells and therefore they are on average 50% genetically similar, just like first-degree relatives such as ordinary siblings and parents and their children. In twin research, within twin-pair correlations of a trait are compared between MZ and DZ twin pairs; a higher similarity in a trait among MZ twins than among DZ twins indicates that genetic factors are important for this specific trait. By using structural equation modeling based on the twin data, the variance of a trait is partitioned into three components: (1) additive genetic influences (A), (2) common environmental influences (C) which are environmental influences that family members have in common and make them similar to each other (such as the availability of alcohol within the household), and (3) unique environmental influences (E) which are environmental influences that family members experience uniquely and make them different from each other (such as unique experiences with friends). The standardized estimate of the genetic influences is also referred to as heritability.

     One of the principles in the comparison of MZ twins and DZ twins is that these twin pairs only differ in their genetic relatedness. It is assumed that environmental factors are independent of zygosity. This assumption is referred to as the equal environments assumption which supposes that environmentally caused similarity is roughly the same for both MZ and DZ twins pairs (Plomin et al., 2001; Rutter, 2006). The equal environments assumption has sometimes been criticized, because, for example, parents may treat MZ twins more similarly than DZ twins. Violation of the equal environments assumption could lead to overestimation of genetic effects, because in that case the difference in correlation between MZ and DZ is not only caused by the genetic difference between MZ and DZ twins but also by differences in the environment. Empirical

studies provided support for the equal environment assumption in case of emotional and behavioral problems (Cronk et al., 2002), psychiatric disorders including alcoholism (Hettema et al., 1995; Kendler et al., 1994) and substance dependence disorders (Kendler & Gardner, 1998).

TWIN STUDIES ON INITIATION OF ALCOHOL USE

Twin studies on alcohol use in adolescents show that variation in initiation of alcohol use among 11-19-year-old adolescents (Fowler et al., 2007a; Koopmans & Boomsma, 1996; Maes et al., 1999; Pagan et al., 2006; Rhee et al., 2003; Rose et al., 2001; Viken et al., 1999) and age of initiation of alcohol use (Heath & Martin, 1988; Stallings et al., 1999) is moderately heritable, with heritabilities ranging from 0% to 43% (in general approximately 30%). Only Han, McGue and Iacono (1999) reported a relatively high heritability estimate (84%) for 17-18-year-old males. Results of these twin studies show that common environmental influences explain a large part of the individual variation in initiation of alcohol use, with c^2 ranging from 32% to 88%, although Han et al. (1999) did not find significant influences of common environment among 17-18-year-old males. These twin studies provide insight in the etiology of initiation of alcohol use. However, most studies examined mainly older adolescents (16 or older) or examined adolescent samples with a relatively wide age range (thus also including older adolescents), while the initiation of alcohol use typically occurs in early adolescence. Therefore, initiation of alcohol use should be assessed in this age period.

TWIN STUDIES ON REGULAR DRINKING

Whereas the largest part in the variance of initiation of alcohol use is explained by environmental factors, genetic factors seem to become more important as adolescents continue their alcohol consumption (see review study by Hopfer et al., 2003). However, there are some inconsistencies in findings between studies. Some twin studies on continuation of alcohol use show that genetics account for the largest part in the variation of frequency of drinking (Pagan et al., 2006; Viken et al., 1999) and quantity of drinking (Fowler et al., 2007a), with heritabilities ranging from 37% to 64% in 11-19-year-old adolescents. In contrast, other studies of alcohol use in 12-19-year-old adolescents found that all of the variance was explained by environmental factors (Rhee et al., 2003; Young et al., 2006). Inconsistencies in findings between studies may be caused by differences in assessment of alcohol use: Rhee et al. (2003) and Young et al. (2006) defined alcohol use as having six or more drinks during one's lifetime, while the other studies on continuation of alcohol use employed measures with several categories such as frequency and quantity of drinking. In addition,

inconsistencies in findings might also be explained by cultural differences between samples. The studies who found evidence for genetic effects in the variance of alcohol use were based on European samples. Both Pagan (2006) and Viken (1999) used Finnish twins and Fowler et al. (2007a) used twin pairs from the United Kingdom. The studies who did not found evidence for genetics used twin pairs from the United States (Rhee et al., 2003; Young et al., 2006).

The estimates of genetic and environmental influences on stages of alcohol use have been found to be age dependent. For example, Viken et al. (1999) showed a relative increase in genetic factors and a decrease of common environmental factors in the variance of alcohol in 17-year-old adolescents compared to 16-year-old adolescents. In general, genetic and social factors influencing behavior did not appear to be static, and it is assumed that the impact of heritable factors increases during development (Dick & Rose, 2002; Rende & Plomin, 1995). This implies that age effects should be incorporated in behavioral genetic research or that groups with a homogeneous age constellation should be examined.

OVERLAP IN ETIOLOGY OF STAGES OF ALCOHOL USE

Most twin studies on variation in young people's alcohol use have examined initiation of alcohol use, continuation to more regular drinking or heavy drinking as separate traits using a univariate approach. Relatively little is known about the overlap in etiology of initiation of alcohol use and the uptake of more regular drinking patterns. For example, most Dutch adolescents drink their first glass of alcohol in company of their parents (Van Der Vorst et al., 2008a), while continuation of alcohol use might be under influence of friends. In order to have an accurate insight in individual differences of stages of alcohol consumption it is necessary to examine whether and to what degree the same factors are related to initiation and continuation of alcohol use. This insight provides relevant information with regard to prevention of alcohol use in young people. If the same factors are related to variation in initiation and continuation of alcohol use, strategies to prevent adolescents from starting to use alcohol may also be effective to prevent adolescents from uptake of regular drinking patterns or problematic alcohol use. However, separate prevention strategies need to be designed in case different factors are related to initiation and continuation of alcohol use.

Pagan and colleagues (2006) showed that in 17-year-old adolescents largely the same factors influence both variation in initiation of alcohol use and frequency of drinking. Genetic factors influencing initiation also explained 26% of the variance in frequency of drink-

ing and common environmental factors influencing initiation also explained 66% of the variance in frequency of drinking. In the study by Fowler and colleagues (2007a) in 11-19-year-old adolescents, the variance in quantity of drinking was partly (23%) due to factors also affecting the initiation of alcohol use. Though Fowler et al. also included early adolescents, both studies assessed older adolescents, while initiation of alcohol use and development of drinking habits is typical for early adolescents and should therefore be assessed in a homogeneous group of early adolescents.

MODERATION OF HERITABILITY AND COMMON ENVIRONMENT

Twin studies show that both genes and environment are important in the explanation of individual differences in alcohol use of adolescents who have developed regular drinking patterns (e.g., Hopfer et al., 2003; Pagan et al., 2006; Viken et al., 1999). According to several non-twin studies, friends' drinking is one of the strongest predictors of young people's alcohol use (e.g., Andrews et al., 2002; Ary et al., 1993; Graham et al., 1991; Petraitis et al., 1995; Urberg et al., 1997; Wood et al., 2001). Furthermore, Dick et al. (2007) showed that drinking behavior of friends interacts with genetic influences on variation in alcohol use in adolescents. Dick and colleagues (2007) showed that genetic influences on adolescent drinking were higher and common environmental influences were lower among adolescents with a larger number of drinking friends compared to adolescents with a small number of drinking friends. If the drinking behavior of friends interacts with genetic influences, twin studies taking the drinking behavior of the friends of twins into account, would provide a more complete picture of the factors influencing alcohol use in adolescence. When doing so, the extent to which twins share their friends becomes highly relevant. Several twin studies have indicated that in adolescence in particular MZ twins are likely to share all or nearly all of their friends (Horwitz et al., 2003; Rende et al., 2005; Rose, 2002; Walden et al., 2004). In addition to sharing the same friends, twins can also have different friends who behave similarly. In this respect, research showed that MZ twins were more likely to have similarly behaving friends than DZ twins (Horwitz et al., 2003; Rose et al., 2002). Both the sharing of friends and the similarities in alcohol use of friends might affect estimates of heritability and common environment. No study so far has tested whether heritability is moderated by the extent to which the friends of twins are similar in behavior, which could well have the same effect on heritability as having the same friends.

THIS THESIS

      The present thesis focuses on the etiology of individual differences in alcohol use in adolescents and young adults. Table 1 provides an overview of the papers presented in this thesis with regard to the research topic and the data used. We examine the role of parents, siblings and friends in alcohol consumption and the relative contribution of genes and environment to the variation in alcohol use. To do so we have used data from the "Twin-Family Study on Health, Lifestyle and Personality" by the Netherlands Twin Register of the VU University Amsterdam and from the "Family and Health Study" of the Radboud University.

THE NETHERLANDS TWIN REGISTER

      The study of health, lifestyle and personality is a large scale longitudinal questionnaire study in Dutch twins-families by the Netherlands Twin Register (NTR). The NTR was started in 1990 by asking all city councils in the Netherlands for addresses of families with twins in the age of 13-22-years old. Families were asked to participate in this study and if families were willing to participate they received a mailed questionnaire in 1991. In later years additional addresses were obtained and new families were included in the register. Data were collected by mailed surveys in 1991, 1993, 1995, 1997, 2000, 2002 and 2004. Twins were asked to participate at all measurement waves, parents in 1991, 1993, 1995, 2000 and 2004 and siblings (other than the twin-sibling) from 1995 onwards. Some persons participated once, while others participated several times. Questionnaires included items on lifestyle (smoking, alcohol use, exercise), physical and mental health (e.g., general health, depression) and personality (e.g., sensation seeking, neuroticism, extraversion) (Boomsma et al., 2002; Boomsam et al., 2006; Koopmans, 1997; Vink, 2004).

      In this thesis we used data of the 1993, 1995, 1997 and 2000 measurement waves, because alcohol use was measured by identical instruments in these waves and most twins pairs were of adolescent or young adult age. Data of 1991 were not included, as at this wave alcohol use was assessed differently from the following waves. Several instruments to assess alcohol use were available in these data: lifetime alcohol use, age of initiation of alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking. As can be seen from Table 1 not all measurement waves and instruments were used in each study described in the chapters of this thesis. Moreover, participants included in studies of this thesis were between 12 and 30 years old. Depending on the subject and research questions of the separate studies we used a subset of participants and data (Table 1).

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Table 1
OVERVIEW OF THE PAPERS PRESENTED IN THIS THESIS

Chapter	Subject	Participants	Design	Data waves
2	Description of prevalence and trends in adolescent and young adult alcohol consumption	Twins and non-twin siblings aged 12-30; Netherlands Twin Register	Cross-sectional	1993, 1995, 1997, 2000
3	Associations in regular drinking with regular drinking of parents, siblings and friends	Twins aged 12-25, non-twin siblings and parents; Netherlands Twin Register	Cross-sectional	1993
4	Parents, siblings and friends as predictors of regular drinking	Twins aged 12-25, non-twin siblings and parents; Netherlands Twin Register	Longitudinal	1993, 1995, 2000
5	Relative contribution of genes and environment to initiation of alcohol use and frequency of drinking	Twins aged 12-15; Netherlands Twin Register	Cross-sectional	1993, 1995, 1997, 2000
6	Longitudinal associations between best friend, sibling and adolescent drinking	Non-twin siblings aged 13-17; Family and Health	Longitudinal	2002-2003, 2003-2004
7	The role of similar friends in alcohol use in twins	Twins aged 16-25; Netherlands Twin Register	Cross-sectional	1993, 1995
8	Parents, siblings and friends as predictors of problem drinking	Twins aged 12-25, non-twin siblings and parents; Netherlands Twin Register	Longitudinal	1993, 1995, 2000

FAMILY AND HEALTH

In addition to the data of the Netherlands Twin Register we used data of a longitudinal project called "Family and Health Study", which was designed to examine socialization processes underlying several health behaviors in adolescents. In this project families with at least two adolescent siblings (who were not twins) aged between 13 and 16 years were invited to take part. The addresses of these families were derived from registers of 22 municipalities in the Netherlands. Families were included if adolescents and their parents were biologically related, and parents had to be married or living together. Families with twins or with offspring with mental or physical disabilities were excluded from the study. Fathers, mothers, and two adolescent children filled out questionnaires. Data were

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collected at two time points with an one-year interval between the waves. At the first measurement wave, adolescents were between 13 and 16 years. The data of the adolescent siblings participating in both waves were used in the present thesis. For further details of the sample and data collection see Harakeh et al. (2005) and Van Der Vorst et al. (2005).

CHAPTERS OF THIS THESIS

In the second chapter of this thesis, we describe alcohol use during adolescence and during the transition into young adulthood (age 12-30-years). The focus of this paper is on prevalence and trends of young people's alcohol use. This study was conducted because an overview of prevalence and trends of various aspects of drinking at the period in life in which drinking patterns develop (12-30-years) was not available in the Netherlands.

In Chapter 3 we examined the relative risks to drink regularly in adolescence and young adulthood (12-25-years) when having regular drinking fathers, mothers, co-twins, siblings and friends. Regular drinking was defined as drinking a few times a month and more. The aim of this paper was to examine univariate cross-sectional relations. Because of the relative strong similarities in drinking of parents, but also in drinking of siblings and friends of our participants, individual effects of family and friends' drinking might not become visible in multivariate analyses. Therefore we first explored univariate effects of drinking of family and friends on regular drinking and compared the strength of effects.

In addition to the univariate cross-sectional relations between family and friends' and adolescents' regular drinking described in Chapter 3, we examined the longitudinal relations between alcohol use of fathers, mothers, co-twins, siblings and friends in a multivariate approach in Chapter 4. This study was conducted to gain insight into the predictive value of drinking of family members and friends for regular drinking in adolescents and young adults (12-25-years) over a period of two and five years.

In Chapter 5 we applied the twin method to assess the relative contribution of genes and environment to variation in initiation of alcohol use and frequency of drinking and we examined whether the same genetic and environmental factors were related to variation in both indicators of drinking. We used data of twin pairs in the age of 12-15-years. Examination of the overlap in factors explaining initiation of alcohol use and frequency of drinking is particularly relevant at this age, because most adolescents initiate drinking between the age of 12-15.

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In Chapter 6 we used data from the "Family and Health Study" to examine effects of alcohol use of best friends on alcohol consumption in adolescents (13-17-years) in a within-family design. We assessed alcohol use of two adolescent siblings and friends of both siblings at two time points and we tested cross-lagged associations between all factors.

In Chapter 7 we evaluated the role of similarly behaving friends of twins in alcohol use of adolescent and young adult twins (16-25-years). Central questions in this chapter was whether having behaviorally similar friends affected estimates of heritability and common environment in frequency of drinking and regular drinking. To this aim, we also examined the whether MZ twins more often share their friends than DZ twins and whether friends of MZ twins were behaviorally more alike than friends of DZ twins.

Chapter 2 to 7 of this thesis focused on the initiation stage of alcohol use and regular drinking. In addition, we examine a more advanced stage of drinking in Chapter 8. In this chapter we aimed to detect cross-sectional and short- and long-term longitudinal predictors of adolescent and young adult (12-25-years) problem drinking. Drinking of parents, siblings and friends were examined as predictors. In the final chapter (Chapter 9), I will discuss the main findings from the studies presented in this thesis and will place these findings in a wider perspective. In addition, suggestions for future research will be discussed.

CHAPTER

PREVALENCE AND TRENDS OF ALCOHOL USE AND MISUSE AMONG ADOLESCENTS AND YOUNG ADULTS IN THE NETHERLANDS FROM 1993 TO 2000

ABSTRACT

This study presents an overview of Dutch studies on prevalence of alcohol use and adds findings from our own study on prevalence of drinking among adolescents and young adults aged 12 through 30 years in the Netherlands. Data were collected as part of a longitudinal study by the Netherlands Twin Register in 1993 ($n = 3885$), 1995 ($n = 4814$), 1997 ($n = 3772$) and 2000 ($n = 4090$). Measures included lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking. The main findings are: (a) alcohol use increased with age until the age of 25, after which it decreased; (b) males exceeded females on all aspects of alcohol use, with exception of the youngest age group and of lifetime alcohol use; (c) time trends indicated an increase in frequency and quantity of drinking among 12-15-year-old adolescents during the 1990s. Moreover, (d) 21-25-year-old females drank more frequently, consumed more drinks a week, had more experience with lifetime drunkenness and were drunk more often in 2000 than in 1993. Among 21-25-year-old males an increase of drunkenness and problem drinking was displayed during the 1990s.

INTRODUCTION

In most western societies, adolescents experiment with alcohol and alcohol use becomes a 'normal' phenomenon during adolescence. The majority of the adolescents develop a drinking pattern that is socially acceptable, but a small group of adolescents use alcohol more frequently and is exposed to the accompanying risks of heavy drinking (e.g., Bauman & Phongsavan, 1999; Van Laar et al., 2002). Alcohol is among the most commonly used substances in many Western societies including the Netherlands, but a complete overview in English of prevalence and trends concerning various aspects of drinking among young people in the Netherlands is not available. Previous studies on drinking among young people are described in Dutch reports. The aim of the present study was to give an overview of existing studies on alcohol use of Dutch adolescents and young adults and to add findings from our study on adolescents and young adults to this overview.

First, the Dutch situation regarding alcohol use in adolescents is described briefly. In the Netherlands it is illegal to sell light alcoholic beverages (for example, beer and wine) to people under the age of 16. This limit is 18 years for strong alcoholic beverages (liquor). Despite these strict criteria, it is not difficult for under-aged adolescents to obtain alcoholic beverages. Bieleman et al. (2002) showed that among 13, 14 and 15-year olds who ordered a light alcoholic beverage in catering establishments, 98% obtained this drink. Of the 14 and 15-year olds 73% successfully purchased strong alcoholic beverages in a liquor store. Among 16 and 17-year olds who wanted to order or buy strong alcoholic beverages in catering establishments and liquor stores, 98% and 85%, respectively, actually obtained these beverages.

During the 1990s, several changes have taken place that may have altered adolescent and young adult alcohol consumption. First, alcopops, consisting of soft drinks with a small amount of alcohol, were introduced and bottled mixed drinks became easily available. Alcopops and bottled mixed drinks are easy to drink and have a sweet and pleasant taste that tends to conceal the taste of alcohol. Recent studies in the Netherlands show that alcopops and mixed drinks are among the most popular alcoholic beverages among students in secondary education (De Zwart et al., 2000; Ter Bogt et al., 2002). Other European studies by Roberts et al. (1999) and Romanus (2000) reported that alcopops account for the increase of alcohol consumption among 13-16-year olds. Furthermore, in the Netherlands, the 1990s was a period of welfare. Figures of Statistics Netherlands (2001) and NIBUD (Nationaal Instituut voor Budgetvoorlichting;

National Institution for Budget Information, 2002) show an increase in income among adolescents and young adults during this period, providing them with more opportunities to go to pubs and discos, which is likely to have resulted in an increase in alcohol consumption. Data of research performed between 1994 and 2002 show that adolescents between 12 and 18 and particularly adolescents between 16 and 18 increased their expenses on alcohol. In fact, alcohol is the most important expense for Dutch adolescent males and the second most important expense for Dutch adolescent females (Statistics Netherlands, 2001; NIBUD, 2002).

Two studies systematically collected data on adolescent alcohol use in the Netherlands between 1992 and 2001 (De Zwart et al., 2000; Ter Bogt et al., 2002). The European School Survey Project on Alcohol and Other Drugs (ESPAD) collects data on alcohol use in European Countries including the Netherlands, in 15 and 16-year olds (Hibell et al., 2000). One other study on alcohol use among Dutch aged 12 and older (Abraham et al., 2002) did not differentiate between males and females. Findings of the last two studies have not been included in the present paper because of the restricted age range and the pooling of data from males and females. The study by De Zwart et al. (2000) is a large prevalence study on smoking, drinking, drug use and gambling among students from 12-20 years of age by the Trimbos Institute and Ter Bogt et al. (2002) present data from the Dutch part of the Health Behaviour in School-aged Children (HBSC) study on substance use. These studies show that prevalence rates of lifetime alcohol use, lifetime drunkenness and quantity of drinking increase with age and are higher among males than among females. De Zwart et al. (2000) conclude that alcohol use among adolescents has not changed in the period 1992-1999. Figures show that about 60% of 12-13-year-old males and about 50% of 12-13-year-old females have used alcohol at least once, by the age of 18 this percentage rises to about 90% for males and females. About 20% of 12-13-year-old males and 15% of females have been drunk at least once, for 16-17-year olds this was about 70% for males and about 60% for females. Prevalence rates on quantity of drinking show that about 80% of 12-13-year-old males and 90% of females drank one to four drinks on the last occasion they drank. At the age of 18 about 65% of males and about 35% of females drank more than four drinks on the last occasion they drank.

In our own study, we describe alcohol use during adolescence and during the transition into young adulthood (age 12-30 years). The focus of this paper is on prevalence and trends of young people's alcohol use in the Netherlands. This study adds to existing knowledge

on alcohol use for several reasons. First, the studies by De Zwart et al. (2000) and Ter Bogt et al. (2002) focused on students in secondary education. However, it may be useful to examine drinking after secondary education, because, in general, problems with alcohol consumption start during this period of life. Second, in our study a larger variety of alcohol measures than in existing Dutch studies was used: lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking. In addition, we examined age and gender differences. Until the age of 17 the prevalence of drinking increases, in particular between 12 and 15 year (De Zwart et al., 2000; Kuipers et al., 1997; Sutherland & Shepherd, 2001; Ter Bogt et al., 2002; Van Laar et al., 2002; Young et al., 2002). Prevalence rates of alcohol consumption show significant higher rates for males than for females in earlier Dutch studies (De Zwart et al., 2000; Kuipers et al., 1997; Ter Bogt et al., 2002, Van Laar et al., 2002) and in studies conducted in other western countries (Gross, 1993; Sutherland & Shepherd, 2001; Wilsnack et al., 2000; Young et al., 2002). However, recent figures from the United Kingdom show an increase in binge drinking by adolescent and young adult females (Plant et al., 2004; Plant & Plant, 2001). We want to investigate whether we see an increase in prevalences for different aspects of drinking behavior with age, whether the sex difference is becoming smaller and whether we can find time trends in drinking among Dutch adolescents and young adults during the 1990s.

METHODS

PROCEDURE AND PARTICIPANTS

Data reported in this study are part of an ongoing longitudinal survey study by the Netherlands Twin Register. From 1991 onwards families with twins have been questioned about lifestyle, personality and psychopathology roughly every two years. Twins were asked to participate in each wave (1991, 1993, 1995, 1997 and 2000); parents only in 1991, 1993 and 1995 and siblings only in 1995, 1997 and 2000. Some individuals participated once, while others participated several times. General information about sample and data collection is described in detail in Boomsma et al. (2002).

For this study, we used the 1993, 1995, 1997 and 2000 data of twins and siblings, as in these waves alcohol use was measured by identical instruments. Despite the longitudinal character of the data, we only focused on prevalence and trends of alcohol use. Developmental patterns in alcohol use will be examined in future studies. From these four measurement waves, we selected participants between 12 and 30 years of age. Participants included in one wave and aged over 30 in the following wave were excluded from further analyses. Participants were grouped in four age categories, the first category contained participants aged 12-15 years. At this age, adolescents are experimenting with alcohol and develop drinking patterns, however, they are not allowed to drink alcohol legally. At age 12, most Dutch adolescents are entering secondary education. In the second age category, 16-20-year olds were included. In the Netherlands as of the age of 16 adolescents legally are allowed to drink light alcoholic beverages. Moreover, young people are still of school age until the age of 17, only a 10% minority of our participants do not attend any kind of education. The third age category consists of 21-25-year olds. At this age, 49% of the males and 45% of the females still go to school/college while others have started a professional career. In the fourth age category (26-30 years), most of our participants are working (89% of the males and 95% of the females).

The sample consisted of 3885 adolescents and young adults in 1993 (all twins), 4814 in 1995 (70.8% twins, 29.2% siblings), 3772 in 1997 (71.5% twins, 28.5% siblings) and 4090 in 2000 (80.1% twins, 19.9% siblings). In 1993, the mean age of the participants was 17.8 (SD 3.1) with an age range from 12-27 years. The sample contained 55.4% females and 44.6% males. In 1995 the mean age of the participants was 20.3 (SD 3.7) with an age range from 12-30 years. The sample contained 54.2% females and 45.8% males. In 1997, the participants were on average 22.2 (SD 4.1) years old with an age range from 12-30

years. The sample included 58.3% females and 41.7% males. In 2000, the mean age of the participants was 24.3 (SD 3.9) ranging from 12-30 years. The sample included 63.6% females and 36.4 % males. In the current study 11.7% of the participants took part at all four measurements, 17.3% filled out three questionnaires, 28.4% filled out two questionnaires and 42.7% filled out one questionnaire. It should be noted that not all participants were invited to fill out a questionnaire at each measurement wave and we excluded participants aged over 30 in a subsequent wave from analyses. Still non-response or attrition may bias the findings of our study. However, results by Vink et al. (2004) suggest that our data on alcohol use are relatively unbiased.

Educational levels of fathers of the twins and siblings in our sample show that 18.3% completed primary education, 33.8% completed lower general education or vocational education, 23.4% followed intermediate vocational education or intermediate and higher general education and 24.4% finished higher vocational education or university.

MEASURES

To analyze drinking among adolescents and young adults, information about lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking (problem drinking was not assessed in 1993) was selected from the questionnaires from all four waves. *Lifetime alcohol* use was measured by the question: "Have you ever used alcohol?" The question had three response categories: (1) "no", (2) "a few times" and (3) "yes", which were summarized into two response categories: (1) "no" (original item 1), (2) "yes" (original item 2 and 3).

Participants were asked to report their *frequency of drinking* by the question: "How often do you drink alcohol?" The question had eight response categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week" and (8) "daily". Because of low frequencies in some categories, this item was summarized as a 4-point scale: (1) "seldom or never" (original items 1 and 2), (2) "a few times a year" (original items 3 and 4), (3) "a few times a month" (original items 5 and 6) and (4) "a few times a week" (original items 7 and 8).

In order to measure *quantity of drinking* participants were asked: "How many drinks do you drink on average per week (including the weekend)?" This question had seven response categories (1) "less than 1 drink a week", (2) "1-2 drinks a week", (3) "3-5 drinks a week", (4) "6-10 drinks a week", (5) "11-20 drinks a week", (6) "21-40 drinks a week" and (7) "over 40 drinks a week" and was summarized as a 4-point scale: (1) "less than 1 drink a week" (original item 1), (2) "1-5 drinks a week"

(original items 2 and 3), (3) "6-20 drinks a week" (original items 4 and 5) and (4) "over 20 drinks a week" (original items 6 and 7).

Participants were asked to report *lifetime drunkenness* by the question: "Have you ever been drunk?" The question had three response categories: (1) "no", (2) "once in my life", (3) "yes, more than once" and was dichotomized into: (1) "no" (original item 1), (2) "yes" (original item 2 and 3).

Frequency of drunkenness was measured by the question: "How often do you get drunk?" Responses were on a 6-point scale (1) "never", (2) "once a year or less", (3) "three or four times a year", (4) "about once in two months", (5) "about once or twice a month" (6) "once a week or more". Because of the low frequencies in some categories, this item was transformed into a 4-point scale: (1) "never" (original item 1), (2) "once a year or less" (original item 2), (3) "a few times a year" (original item 3 and 4) and (4) "a few times a month" (original item 5 and 6).

Problem drinking was assessed by the CAGE scale for drinking problems (Ewing, 1984). The CAGE questionnaire derives its name from the acronym of four questions: "Have you ever felt you ought to *cut* down on your drinking?", "Have people *annoyed* you by criticizing your drinking?", "Have you ever felt bad or *guilty* about your drinking?" and "Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover?" (*eye opener*). Responses were either: (1) "yes" and (2) "no". Two or more positive answers suggest that the existence of alcohol-related problems is likely (Ewing, 1984).

DATA ANALYSES

Prevalence rates for lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking were computed using SPSS 11.5.1 for Windows. Chi-square analyses were used to test these rates for age and gender differences and time trends. In addition, standardized residuals were used to examine data patterns that contribute to the significant Chi-square test. We examined time trends by testing age groups in 1993 and 2000 for changes in drinking behavior. Since problem drinking was measured as of 1995 we tested age groups in 1995 and 2000 for changes in problem drinking. Given the multiple tests performed, we set our level of significance at $p < 0.01$.

The inclusion of multiple individuals from the same family in this study could cause problems, because scores of participants are not statistically independent. To deal with this problem we repeated our analyses with a sample in which only one sibling (the firstborn twin) from each family was included. Results of these analyses showed same patterns, although Chi-squares values were lower.

Table 1

PREVALENCE OF LIFETIME ALCOHOL USE BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%).

		Male				Female			
		12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
1993	(*n*)	(557)	(855)	(308)	—	(673)	(1037)	(424)	(3)
		68.6*	94.7	97.7	—	60.3*	94.3	96.7	100.0
1995	(*n*)	(293)	(976)	(763)	(155)	(343)	(1127)	(963)	(163)
		67.6	93.9	96.9	98.7	68.2	92.3	95.0	95.1
1997	(*n*)	(91)	(553)	(618)	(299)	(93)	(763)	(899)	(434)
		70.3	96.9	97.6	98.3	60.2	96.6	98.1	98.2
2000	(*n*)	(43)	(282)	(627)	(530)	(69)	(475)	(1094)	(953)
		88.4	96.1	96.8	98.1	85.5	95.4	97.9	98.1

Note. * indicates significant gender differences (Chi-square tests $p < .01$). Chi-square for this difference is $(1, n = 1230) = 9.02$, $p = .00$. Chi-squares for age differences ranged from $\chi^2 (3, n = 1482) = 13.61$, $p = .00$ to $\chi^2 (3, n = 2187) = 267.30$, $p = .00$ for males and $\chi^2 (3, n = 2591) = 45.11$, $p = .00$ to $\chi^2 (3, n = 2137) = 415.97$, $p = .00$ for females.

RESULTS

Table 1 presents prevalence rates of lifetime alcohol use for each age group and gender. The majority of the adolescents and young adults had used alcohol at least once. Within each wave lifetime alcohol use sharply increased with age, showing significant differences between all age groups for both males and females. In 1993, significantly more 12-15-year-old males than females had used alcohol at least once. No significant differences for gender were found for other age categories and at other waves. Regarding time trends, lifetime alcohol use did not significantly change from 1993 to 2000. Due to the range of the age categories participants could be in the same age category at two waves. To examine effects of this overlap of participants, analyses were repeated on the age categories: 12-13, 14-15, 16-17, 18-19, 20-21, 22-23, 24-26, 27-28 and 29-30. These analyses showed similar results as those performed on the broader age ranges.

Table 2 shows prevalence rates of frequency of drinking for each age group and gender. With increasing age, participants drank alcohol more frequently, as indicated by significant differences between all age groups for both males and females within all four waves. Except for 12-15-year olds in 1995 and 1997, males drank significantly more frequently than females. Moreover, between waves, significant changes in frequency of drinking were found for 12-15-year-old males and females, for 16-20-year-old males and for 21-25-year-old females. These analyses showed that adolescents and young adults in these age categories drank more frequently in 2000 than in 1993.

Prevalence rates of quantity of drinking for each age group and gender are displayed in Table 3. Within each wave adolescents and young adults drank significantly more when they grew older, but quantity of drinking showed a decrease after the age of 25. Gender differences revealed that, except for 12-15-year olds in 1993, 1997 and 2000, males drank significantly more than females. Furthermore, over time , significant changes in quantity of drinking were found for 12-15-year-old males, for 16-20-year-old females and for 21-25-year-old females. Time trends showed that adolescents and young adults drank more in 2000 than in 1993.

Table 2

PREVALENCE OF FREQUENCY OF DRINKING BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%)

	Male				**Female**			
	12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
1993 (*n*)	(550)	(854)	(308)	—	(676)	(1038)	(422)	(3)
Seldom or never	50.5*	11.8*	7.5*	—	61.7*	16.1*	13.7*	0.0
A few times a year	33.1*	17.4*	12.3*	—	27.5*	31.5*	32.0*	66.7
A few times a month	14.2*	37.4*	30.2*	—	9.8*	38.9*	38.6*	0.0
A few times a week	2.2*	33.4*	50.0*	—	1.0*	13.5*	15.6*	33.3
1995 (*n*)	(292)	(975)	(767)	(155)	(342)	(1127)	(960)	(163)
Seldom or never	42.1	10.9*	7.7*	3.9*	44.4	15.0*	13.5*	12.9*
A few times a year	31.5	14.7*	11.9*	11.6*	35.1	29.3*	28.9*	35.0*
A few times a month	20.2	35.0*	28.2*	29.7*	17.3	43.2*	37.7*	30.7*
A few times a week	6.2	39.5*	52.3*	54.8*	3.2	12.5*	19.9*	21.5*
1997 (*n*)	(84)	(555)	(618)	(298)	(89)	(763)	(898)	(433)
Seldom or never	51.2	6.5*	6.1*	7.0*	53.9	9.0*	10.2*	13.9*
A few times a year	32.1	12.1*	7.8*	11.1*	24.7	27.9*	27.7*	28.4*
A few times a month	14.3	41.3*	27.5*	32.9*	20.2	48.1*	42.2*	37.6*
A few times a week	2.4	40.2*	58.6*	49.0*	1.1	14.9*	19.6*	20.1*
2000 (*n*)	(43)	(282)	(627)	(529)	(69)	(475)	(1093)	(953)
Seldom or never	16.3*	6.4*	7.2*	4.5*	27.5*	10.7*	9.9*	14.4*
A few times a year	27.9*	7.1*	8.3*	9.1*	40.6*	22.3*	24.7*	27.6*
A few times a month	41.9*	35.1*	24.1*	27.4*	31.9*	42.7*	39.3*	32.4*
A few times a week	14.0*	51.4*	60.4*	59.0*	0.0*	24.2*	26.1*	25.6*

Note. * indicates significant gender differences (Chi-square tests $p < .01$). Chi-squares for gender differences ranged from $\chi^2 (3, n = 112) = 13.00$, $p = .01$ to $\chi^2 (3, n = 1516) = 260.75$, $p = .00$. Chi-squares for age differences ranged from $\chi^2 (9, n = 1481) = 57.64$, $p = .00$ to $\chi^2 (6, n = 1712) = 573.80$, $p = .00$ for males and from $\chi^2 (9, n = 2590) = 63.23$, $p = .00$ to $\chi^2 (9, n = 2139) = 549.87$, $p = .00$ for females. Between 1993 and 2000, significant differences were found for 12-15-year-old males ($\chi^2 [3, n = 597] = 17.59$, $p = .00$) and females ($\chi^2 [3, n = 749] = 17.29$, $p = .00$), for 16-20-year-old males ($\chi^2 [3, n = 1137] = 12.39$, $p = .01$) and for 21-25-year-old females ($\chi^2 [3, n = 1520] = 17.22$, $p = .00$). $= 17.29$, $p = .00$).

Table 3

PREVALENCE OF QUANTITY OF DRINKING BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%)

		Male				Female			
		12-15	16-20	21-25	26-30	12-15	16-20	21-25	26-30
1993	(n)	(544)	(847)	(305)	—	(677)	(1027)	(415)	(3)
< 1 drink a week		90.3	32.7*	22.3*	—	94.2	55.7*	54.2*	66.7
1-5 drinks a week		8.5	28.5*	25.2*	—	5.3	30.7*	31.8*	0.0
6-20 drinks a week		1.3	32.0*	41.3*	—	0.4	12.6*	13.5*	33.3
> 20 drinks a week		0.0	6.8*	11.1*	—	0.0	1.1*	0.5*	0.0
1995	(n)	(291)	(973)	(765)	(154)	(341)	(1125)	(958)	(162)
< 1 drink a week		79.0*	29.5*	22.0*	20.1*	86.2*	53.2*	51.5*	54.9*
1-5 drinks a week		15.8*	27.7*	25.8*	38.3*	12.9*	32.8*	31.9*	35.2*
6-20 drinks a week		5.2*	35.0*	39.5*	35.7*	0.9*	13.2*	15.8*	8.6*
> 20 drinks a week		0.0*	7.7*	12.8*	5.8*	0.0*	0.8*	0.8*	1.2*
1997	(n)	(74)	(551)	(606)	(292)	(70)	(739)	(870)	(414)
< 1 drink a week		86.5	23.8*	14.7*	21.2*	77.1	41.9*	42.5*	51.0*
1-5 drinks a week		10.8	28.7*	24.8*	34.9*	20.0	40.3*	37.7*	36.2*
6-20 drinks a week		2.7	38.7*	43.7*	36.6*	1.4	16.5*	18.5*	12.1*
> 20 drinks a week		0.0	8.9*	16.8*	7.2*	1.4	1.2*	1.3*	0.7*
2000	(n)	(41)	(280)	(620)	(523)	(63)	(455)	(1067)	(920)
< 1 drink a week		53.7	17.5*	17.1*	15.5*	68.3	34.3*	42.0*	48.3*
1-5 drinks a week		39.0	25.4*	23.4*	27.9*	22.2	38.0*	33.1*	34.9*
6-20 drinks a week		7.3	47.1*	43.9*	45.5*	9.5	25.9*	23.9*	16.2*
> 20 drinks a week		0.0	10.0*	15.6*	11.1*	0.0	1.8*	1.0*	0.7*

Note. * indicates significant gender differences (Chi-square tests p <.01). With Chi-squares between χ^2 (2, n = 632) = 11.98, p = .00 and χ^2 (3, n = 1476) = 299.34, p = .00. Chi-square tests for age differences ranged from χ^2 (9, n = 1464) = 62.45, p = .00 to χ^2 (6, n = 1696) = 571.78, p = .00 for males and from χ^2 (9, n = 2093) = 47.04, p = .00 to χ^2 (9, n = 2122) = 327.21, p = .00 for females. Between 1993 and 2000 significant differences were found for 12-15-year-old males (χ^2 [3, n = 592] = 23.56, p = .00), for 16-20-year-old females (χ^2 [3, n = 1492] = 25.66, p = .00) and for 21-25-year-old females (χ^2 [3, n = 1499] = 25.57, p = .00).

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Table 4

PREVALENCE OF LIFETIME DRUNKENNESS BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%)

		Male				**Female**			
		12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
1993	(*n*)	(535)	(842)	(304)	—	(644)	(1030)	(420)	(3)
		9.9	61.8*	80.3*	—	8.7	40.8*	50.2*	66.7
1995	(*n*)	(290)	(976)	(764)	(155)	(340)	(1125)	(962)	(163)
		18.3	62.4*	77.7*	83.2*	12.1	42.1*	52.4*	58.3*
1997	(*n*)	(83)	(557)	(617)	(298)	(87)	(760)	(897)	(433)
		16.9	68.8*	84.9*	81.5*	11.5	53.6*	63.4*	65.8*
2000	(*n*)	(41)	(282)	(620)	(525)	(64)	(465)	(1082)	(942)
		22.0	75.2*	86.6*	87.6*	28.1	60.0*	69.9*	67.9*

Note. * indicates significant gender differences (Chi-square tests $p < .01$). With Chi-squares between $\chi^2 (1, n = 747) = 17.95$, $p = .00$ and $\chi^2 (1, n = 1726) = 118.30$, $p = .00$. Chi-squares for age differences ranged from $\chi^2 (3, n = 1468) = 134.06$, $p = .00$ to $\chi^2 (2, n = 1681) = 501.01$, $p = .00$ for males and from $\chi^2 (3, n = 2553) = 57.33$, $p = .00$ to $\chi^2 (3, n = 2097) = 258.77$, $p = .00$ for females. Between 1993 and 2000 significant differences were found for 21-25-year-old females ($\chi^2 [1, n = 1507] = 18.71$, $p = .00$).

Table 4 presents the prevalence rates for lifetime drunkenness for each age group and gender. A considerable part of the adolescents and young adults did not have any experience with drunkenness. However, within each wave, the percentage of participants who had been drunk at least once significantly increased with age. Except for 12-15-year olds, significantly more males than females had been drunk at least once. In addition, between waves, significant changes in frequency of lifetime drunkenness were found for 21-25-year-old females. This time trend showed that more females in this age category had been drunk at least once in 2000 than in 1993.

The prevalence rates for frequency of drunkenness for each age group and gender are shown in Table 5. Within each wave, frequency of drunkenness significantly increased with age until participants were 25; after the age of 25 frequency of drunkenness decreased. Except for 12-15-year olds, males had been drunk significantly more often than females. In addition, between waves, significant changes in frequency of drunkenness were found for 16-20-year- old males and for 21-25-year old males and females. Time trends showed that adolescents and young adults had been drunk more often in 2000 than in 1993.

Finally, problem drinking was examined. Table 6 reveals that irrespective of age and gender the vast majority of the adolescents and young adults were not problem drinkers, based on their CAGE scores. Within each wave the frequency of problem drinkers increased significantly with age for males in 1995 and in 1997, this frequency decreased after the age of 25. Except for 12-15-year olds, significantly more males than females were problem drinkers. Furthermore, in 2000 the prevalence of problem drinking among 21-25-year-old males increased compared to 1995.

Additional Chi-square analyses were carried out to examine whether students and working participants differed in their drinking in 1993 and 1995. For males, these analyses showed only significant differences for lifetime alcohol use in 1995; students had higher lifetime alcohol use than working participants. However, for females we showed that compared to working participants, students had higher lifetime alcohol use in 1995, higher frequency of drinking and higher quantity of drinking in both waves, higher lifetime drunkenness, frequency of drunkenness and problem drinking in 1995.

To examine differences in alcohol use between twins and singletons, univariate analyses of variance were conducted. These analyses did not show consistent differences between twins and singletons.

Table 5

PREVALENCE OF FREQUENCY OF DRUNKENNESS BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%)

	Male				**Female**			
	12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
1993 (*n*)	(533)	(827)	(301)	—	(646)	(1013)	(409)	(3)
Never	90.4	38.9*	19.9*	—	91.0	60.2*	51.1*	33.3
Once a year or less	6.8	34.0*	47.2*	—	7.7	30.5*	40.6*	33.3
A few times a year	2.4	21.2*	23.6*	—	1.1	8.4*	7.8*	33.3
A few times a month	0.4	5.9*	9.3*	—	0.2	0.9*	0.5*	0.0
1995 (*n*)	(290)	(960)	(752)	(152)	(340)	(1103)	(948)	(160)
Never	81.7	38.2*	22.6*	17.1*	87.9	59.0*	48.3*	42.5*
Once a year or less	12.4	33.4*	42.2*	53.3*	9.1	30.6*	42.1*	50.0*
A few times a year	5.5	22.5*	27.0*	25.0*	2.6	9.1*	8.9*	6.3*
A few times a month	0.3	5.8*	8.2*	4.6*	0.3	1.3*	0.7*	1.3*
1997 (*n*)	(79)	(486)	(546)	(266)	(81)	(617)	(726)	(309)
Never	87.3	35.8*	17.0*	20.7*	95.1	57.2*	45.2*	47.9*
Once a year or less	7.6	15.2*	24.7*	32.3*	0.0	16.0*	22.9*	33.3*
A few times a year	5.1	35.0*	42.9*	39.8*	3.7	23.7*	27.5*	17.5*
A few times a month	0.0	14.0*	15.4*	7.1*	1.2	3.1*	4.4*	1.3*
2000 (*n*)	(41)	(279)	(620)	(525)	(64)	(465)	(1082)	(940)
Never	82.9	49.1*	38.7*	44.6*	81.3	62.6*	64.0*	75.3*
Once a year or less	12.2	18.6*	18.9*	20.6*	14.1	19.4*	17.2*	14.0*
A few times a year	4.9	24.0*	31.3*	26.1*	4.7	16.8*	16.2*	9.7*
A few times a month	0.0	8.2*	11.1*	8.8*	0.0	1.3*	2.7*	1.0*

Note. * indicates significant gender differences (Chi-square tests $p < .01$). With Chi-squares between $\chi^2 (3, n = 744) = 31.87$, $p = .00$ and $\chi^2 (3, n = 1700) = 214.91$, $p = .00$. Chi-squares for age differences ranged from $\chi^2 (9, n = 1465) = 40.36$, $p = .00$ to $\chi^2 (6, n = 1661) = 500.60$, $p = .00$ for males and from $\chi^2 (9, n = 2551) = 53.48$, $p = .00$ to $\chi^2 (9, n = 2071) = 249.21$, $p = .00$ for females. Between 1993 and 2000 significant differences were found for 16-20-year-old males ($\chi^2 [3, n = 1123] = 11.28$, $p = .01$) and for 21-25-year-old males ($\chi^2 [3, n = 925] = 39.76$, $p = .00$) and females ($\chi^2 [3, n = 1501] = 40.38$, $p = .00$).

Table 6

PREVALENCE OF PROBLEM DRINKING BY AGE AND GENDER IN DUTCH ADOLESCENTS AND YOUNG ADULTS (%)

		Male				Female			
		12-15	16-20	21-25	26-30	12-15	16-20	21-25	26-30
1995	(*n*)	(283)	(958)	(754)	(154)	(327)	(1114)	(946)	(158)
Problem drinker		1.1[a]	7.0*[a]	10.1*[a]	12.3*[a]	1.8	2.2*	3.8*	3.8*
1997	(*n*)	(79)	(552)	(615)	(295)	(81)	(759)	(890)	(428)
Problem drinker		0.0	7.8*[a]	14.0*[a]	10.2*[a]	0.0	3.0*	4.5*	4.9*
2000	(*n*)	(40)	(280)	(619)	(526)	(59)	(461)	(1072)	(930)
Problem drinker		2.5	15.7*	16.0*	14.6*	1.7	4.8*	5.3*	4.8*

Note. * indicates significant gender differences (Chi-square tests $p < .01$). With Chi-squares between $\chi^2 (1, n = 723) = 7.38$, $p = .01$ and $\chi^2 (1, n = 1691) = 54.41$, $p = .00$. [a] indicates significant age differences (Chi-square tests $p < .01$). Chi-square in 1995 $\chi^2 [3, n = 2149] = 28.97$, $p = .00$) and in 1997 ($\chi^2 [3, n = 1541] = 21.84$, $p = .00$). Between 1995 and 2000 significant differences were found for 21-25-year-old males ($\chi^2 [1, n = 859] = 10.10$, $p = .00$).

DISCUSSION

The current study aimed at describing alcohol use among adolescents and young adults in the Netherlands. Our study showed that a substantial part of Dutch adolescents and young adults were exposed to alcohol use at early age, but rates of regular drinking and drunkenness were considerably lower in the Netherlands. A minority of the Dutch adolescents and young adults were excessive drinkers but excessive drinking was virtually absent among 12-15-year olds. These figures are consistent with findings for similar age categories from studies by De Zwart et al. (2000) and Ter Bogt et al. (2002).

Regarding time trends, it was striking to find that 12-15-year-old males and females drank more frequently and consumed more drinks a week in 2000 than in 1993. A possible explanation for this increase in alcohol use might be the increased popularity of alcopops among this age group. Young people who are not used to drinking alcohol probably prefer the sweet taste of these mixed drinks to, for example, beer or wine. This was in line with other studies in Europe by Roberts et al. (1999) and Romanus (2000). In addition, 21-25-year-old females drank more frequently, consumed more drinks a week, had more experience with lifetime drunkenness and were drunk more often in 2000 than in 1993. Because this age category consists, for a large part, of students and students in general consume more alcohol than other adolescents and young adults (Van Laar et al., 2002), the increase in alcohol use during the 1990's might be explained by the increase in female students in this time period (Statistics Netherlands, 2004). In 2000, 21-25-year-old males were drunk more often than in 1993 and were more often a problem drinker, according to the CAGE scale, than in 1995. An explanation for this increase in alcohol use over time is still unclear. Time trends in drinking were only found for 12-15-year-old males and females and 21-25-year-old males and females; overall alcohol consumption did not change substantially during the 1990's. This was in line with findings from De Zwart et al. (2000) and Ter Bogt et al. (2002).

The present study revealed that prevalence rates for lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking increased with age until the age of 25, after which the prevalence of these behaviors decreased. As our additional analyses indicated this decrease could, at least for females and partly for males, be explained by the fact that the majority of participants over 25 years of age finished their studies and started working. The decrease of alcohol use after the age of 25 might be caused by changes in social roles, particularly by women. For example, findings from a study by Hajema and Knibbe (1998) showed that acquisition of a partner role and a parental role was associated with a decrease in drinking.

This study showed that male adolescents and young adults reported a higher alcohol use (except lifetime alcohol use) than females at all ages except in the age category 12-15 years. These findings are in line with reports of the Substance Abuse and Mental Health Services Administration (SAMHSA; 2001, 2002) and Young et al. (2002) who found no gender differences for alcohol use for 12-15-year olds. It is possible that girls, who are usually ahead of boys in puberty, experiment with drinking at an earlier age, which may counteract the fact that boys drink more. A possible explanation for gender differences in alcohol use after the age of 15 could be the biological difference in sensitivity to alcohol effects (Ely et al., 1999; Frezza et al., 1990; Wilsnack et al., 2000). Compared to males, females are generally more sensitive to alcohol effects and hence they can drink less to obtain the same effects. In addition, gender differences in alcohol consumption might be explained by socio-cultural factors. In western societies a greater tolerance exists towards male drinking than towards female drinking (Carman & Holmgren, 1986; Wilsnack et al., 2000). Males may drink more than females, because drinking can be seen as a demonstration of masculinity. In contrast, females may drink less, because drinking does not fit with expectations of females' traditional domestic roles and public behavior.

In the current study we used the CAGE questionnaire to assess problem drinking. Previous studies on the validity of the CAGE questionnaire among adolescents pointed out that the CAGE items are not sensitive to problem drinking among adolescents (Chung et al., 2000; Knight et al., Sherritt, 2003; O'Hare & Tran, 1997). A low sensitivity indicates a risk for false negatives. Accordingly, our figures on problem drinking might underestimate the actual number of participants who experience alcohol related problems.

It should be noted that in the current study we presented data from a special sample of adolescents and young adults, namely twins and their siblings. Nevertheless, the findings seem to be generalizable to singletons. When comparing twins and singletons in the present study, no consistent differences were found.

In summary, in the Netherlands adolescent and young adult alcohol use showed clear age and gender effects. Drinking increased with age until the age of 25, after which it decreased. Males exceeded females on all aspects of drinking, with exception of the youngest age group and for lifetime alcohol use. Time trends indicated an increase in frequency and quantity of drinking among 12-15-year-old adolescents during the 1990s. Moreover, 21-25-year-old females drank more frequently, consumed more drinks a week, had more experience with lifetime drunkenness and were drunk more often in 2000 than in 1993. Among 21-25- year-old males an increase of drunkenness and problem drinking was displayed during the 1990s.

CHAPTER

3

RELATIVE RISKS OF ADOLESCENT AND YOUNG ADULT ALCOHOL USE: THE ROLE OF DRINKING FATHERS, MOTHERS, SIBLINGS AND FRIENDS

ABSTRACT

The present study examined to what extent regular drinking of fathers, mothers, co-twins, siblings and friends was related to adolescent regular drinking in three age groups: 12-15, 16-20 and 21-15-year olds. The sample consisted of 3760 twins (1687 boys, 2073 girls) with a mean age of 17.8 years. Data were based on twins' self-reported alcohol uses and reports about siblings' and friends' alcohol use and on parents' self-reports. Results showed that generally in each of the three age groups, regular drinking of same-sex co-twins and friends posed the highest risk for regular drinking. Age differences indicated that these risks decreased with age. Irrespective of age, regular drinking of fathers and mothers posed the lowest risk. Findings were generally the same for males and females.

INTRODUCTION

Alcohol misuse among adolescents is a substantial problem throughout the Western world. Recent figures indicate that experimentation with alcohol is rather normative in adolescence and that many of the adolescents develop a regular drinking pattern (Hibell et al., 2004; Poelen et al., 2005; Trimbos, 2004). For example, 85% of the secondary school pupils have experimented with alcohol and 58% had used alcohol in the previous month in 2003 in the Netherlands (Trimbos, 2004). Since adolescent alcohol use has been related to a wide range of problems such as school problems and aggression (Gruber et al., 1996; Wechsler et al., 1994), alcohol related injury and deaths (Hingson, et al., 2003), suicidal ideation (Light et al., 2003) and even impaired brain development (Tapert et al., 2004), ample research has been devoted to exploring the correlates of adolescent alcohol use. One substantial factor that has been identified is the drinking behavior of persons in the adolescents' direct social environment, most notably the peer group and the family. Various studies have examined the effects of parents' and friends' drinking, but have not yet provided a conclusive overview of the relative impact of the alcohol use of each of these persons. The aim of the present study was, therefore, to examine the relative risk of adolescent alcohol use by comparing the associations of adolescent alcohol use with fathers', mothers', siblings' and friends' use within a single sample.

DIRECT ASSOCIATIONS OF PARENTAL, FRIENDS' AND SIBLINGS' ALCOHOL USE WITH ADOLESCENT ALCOHOL USE

The direct link between parental drinking and adolescent drinking seems far from clear. A number of studies revealed that parental alcohol use is related to adolescent use (e.g., Ary et al., 1993; Ellickson & Hays, 1991; Hawkins et al., 1997; Van Der Vorst et al., 2005; Webb et al., 1991; Webb & Baer, 1995), and that adolescents who had heavy drinking parents were more likely to drink heavy as well (Cohen & Rice, 1997). In contrast, however, other studies found no direct links between parental drinking and adolescent drinking (Boyle et al., 2001; Ouellette et al., 1999; Peterson et al., 1994; Power et al., 2005; Reifman et al., 1998).

A vast body of research has documented that a strong association exists between friends' and adolescents' alcohol use (Andrews et al., 2002; Petraitis et al., 1995; Thombs et al., 1997; Sieving et al., 2000). For example, friends' drinking predicted adolescents' alcohol use initiation and cessation over a one-year period (Maxwell, 2002).

Bot et al., (2005a) reported that when an adolescent's best friend was drinking intensively, it was likely that the adolescent also drank intensively one year later, irrespective of whether the friendship was stable across this one-year period. Likewise, perceptions of the number of drinking friends have found to be predictive of adolescents' later alcohol consumption (Ouellette et al., 1999; Simons-Morton & Chen, 2005). Thus, it appears that friends' alcohol use constitutes a significant risk factor for adolescent drinking, although recent studies suggest that it is peer selection rather than peer influence that contributes to similarity in health risk behaviors (Jaccard et al., 2005).

Siblings' alcohol use may constitute another potential risk factor for adolescents' alcohol use. However, the role of siblings in relation to adolescent drinking has been explored only in a few studies. These studies report direct associations between siblings' and adolescents' substance use in general (Brook et al., 2003; Needle et al., 1986) and alcohol use in specific (Amico & Fromme 1997; Bahr et al., 2005; Boyle et al., 2001). All in all, previous research suggests that parents', siblings' and friends' alcohol use may be significantly related to adolescent drinking.

RELATIVE IMPACT OF PARENTAL, FRIENDS' AND SIBLINGS' ALCOHOL USE ON ADOLESCENT ALCOHOL USE

Most of the studies in this area have focused either on parents, siblings, or best friends, but only few have simultaneously examined the relative impact of drinking of each of these persons for adolescent drinking in one study. Comparison of parents' and peers' drinking has generally lead to the conclusion that the alcohol use of peers seems to be more important for adolescent alcohol use than parents' alcohol use. Jackson (1997) revealed that although parental alcohol use was significantly related to alcohol initiation and experimentation among adolescents, the association was much weaker than that of friends' use and number of using friends. Other studies provided further evidence for the dominance of peers' drinking over parents' drinking in that adolescent alcohol use was significantly higher related to friends' use than to parental use (Björkqvist et al., 2004; Reifman et al., 1998).

One potential limitation of some studies on parental alcohol use is that they have combined fathers' and mothers' alcohol use in one overall measure of parental alcohol use. Although the use of this measure can be informative, it may only tell part of the story since fathers and mothers may each exert a unique influence on their offspring' drinking. A small number of studies reported sex differences in the effects of parental drinking, but the findings were

mixed with respect to the dominance of the effects of one parent over the other. Zhang et al. (1999) reported that fathers' but not mothers' drinking was directly related to adolescent drinking. Seljamo et al. (2006) found that both mothers' and fathers' self-reported alcohol use was related to adolescents' problematic alcohol use, but that the fathers' alcohol use was the most potent predictor. In contrast, in the studies by Rittenhouse and Miller (1984) and Marsden et al. (2005), mothers' but not fathers' drinking was positively related to adolescent drinking. Furthermore, Hundleby and Mercer (1987), Reifman et al. (1998) and Björkqvist et al. (2004) did not find any differences between the direct associations of fathers' and mothers' drinking and adolescent alcohol use.

The relative importance of siblings' drinking compared to friends' or parents' drinking has received very little scientific attention until now. The few studies that exist on alcohol use point out that sibling effects may be similar to peer effects and stronger than parental effects. Windle (2000) reported that when parental, sibling and peer alcohol use were considered simultaneously in one model, the effects of the parents were weakest. Similar findings were reported by Ary et al. (1993). Moreover, in a study on parents and siblings, Boyle et al. (2001) reported small and non-significant associations between adolescents' and parental alcohol use, while the associations with sibling alcohol use were strong.

SEX AND AGE DIFFERENCES

Studies that explored the associations between parental, friends' and sibling use and adolescent alcohol use have occasionally documented on the lack of sex differences in these associations. Björkqvist et al. (2004) and Andrews et al. (2002) reported that friends' use was related to adolescents' or young adults' alcohol use and that this association did not differ for males and females. In addition, the studies by Björkqvist et al. (2004) as well as Seljamo et al. (2006) revealed that the associations with parental alcohol use were similar for boys and girls. Thus, it seems that female and male drinking is equally related to the drinking behavior of parents, friends and siblings.

Whereas much research has focused on early, middle, or late adolescence, relatively little is known to what extent alcohol use of fathers, mothers, siblings and friends is related to alcohol use in young adulthood. Findings from studies on adolescents can provide some insights, but may not be entirely generalized to young adults. While parents are still influential in the lives of adolescents, in young adulthood the influence of parents often declines, while the

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influence of friends remains (see Bot et al., 2008). Only a very small number of studies exist that have investigated the roles of parents, siblings, or friends in relation to young adults' drinking. They reported that friends' drinking was still associated with young adults' drinking in young adulthood (Andrews et al., 2002; Labouvie, 1996; Thombs et al., 1997), while parents' drinking was not (Thombs et al., 1997). These findings reflect that friends' drinking remains important in relation to adolescents' drinking from adolescence into young adulthood, while at the same time the impact of parents' alcohol use seems to decrease in importance.

THE PRESENT STUDY

The present study is one of the first to explore the relative risks of adolescent and young adult alcohol use, directly comparing the associations between adolescent alcohol use and fathers', mothers', siblings' and friends' alcohol use. We used a genetic informative sample of monozygotic (MZ) and dizygotic (DZ) twins, allowing to substantiate possible genetic influences on relative risk for adolescent alcohol use. Based on previous research we expected to find that both fathers' and mothers' drinking would show weaker associations with adolescent drinking than siblings' and friends' drinking would. Given the mixed findings in previous studies, however, we did not anticipate a consistent pattern of sex differences in the associations of fathers' versus mothers' drinking.

Friends' and siblings' drinking were expected to show similar associations with adolescent alcohol use. In addition, we expected that the difference in risk posed by MZ and DZ same-sex twins would increase with increasing age. This hypothesis was based on behavior genetic research showing that genetic factors explain a large amount of variance in regular drinking, especially in older adolescents and young adults (Heath et al., 1991; Hopfer et al., 2003; Maes et al., 1999; Viken et al., 1999).

Since evidence indicates no sex difference in the associations between adolescents' and parents', friends and siblings' use (e.g., Andrews et al., 2002; Björkqvist et al., 2004; Seljamo et al., 2006) we did not expect different findings for male and female adolescents. We did expect age differences in the associations, though. Based on previous research (Andrews et al., 2002; Labouvie, 1996; Thombs et al., 1997) we expected that with increasing age, the associations of adolescents' alcohol use with fathers' and mothers' use would weaken, but that the associations with friends' use would remain strong.

METHODS

PARTICIPANTS AND MEASURES

The present study is based on a large scale twin-family study of the Netherlands Twin Register. This register was started in 1991 by recruiting adolescent twins aged 13-22 year and their families. The addresses of these families were derived from city councils in the Netherlands. In later years, additional volunteers twin families also participated. In the longitudinal study, with two-to three-year intervals, twins and their parents fill out mailed questionnaires about health, lifestyle and personality. Some individuals participated once, while others participated several times. Data reported in the present study are based on the 1993 data collection. Detailed information about the sample and data collection procedures of the Netherlands Twin Register is provided by Boomsma et al. (2002).

For the present study we selected the following item from the questionnaires: "How often do you drink alcohol?" Twins and their parents could respond to this question on one of eight categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week" and (8) "daily". An extensive description of the distribution of scores on this scale can be found in Poelen et al. (2005). In this study we aim at describing the relative risk for adolescent and young adult regular drinking when having regular drinking family members and friends. Regular drinking for twins was defined as drinking a few times a month and more and for parents as drinking a few times a week and more. Self-reports were used to assess twins' alcohol use. If self-reported data were missing we used data co-twins provided on their twin siblings ($n = 31$). The participating twins were between the ages of 12 and 25 years with a mean age of 17.8 years (SD 3.1). The sample consisted of 628 males from MZ twin pairs, 546 males from same sex DZ twin pairs, 513 males from opposite sex DZ twin pairs, 920 females from MZ twin pairs, 641 females from same sex DZ twin pairs and 512 females from opposite sex twin pairs. Twins from one-parent families ($n = 117$ twins) were excluded from the analyses resulting in a total sample of 3760 twins.

For 3457 fathers and for 3738 mothers self-reported data on alcohol use were available. These vast majority of the fathers and mothers were the biological parents of the adolescents and young adults. In case data on alcohol use of father or mother were missing, data on alcohol use reported two years later were used ($n = 76$ for fathers and $n = 59$ for mothers), because there was a high stability of

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alcohol use over time (for fathers r = .75, p < .001 and for mothers r = .78, p < .001). If these data were also not available, we used twin reports on their parents' alcohol use (n = 219 for fathers and n = 67 for mothers). Pearson correlation analyses showed a satisfactory resemblance between twin reports and parents' reports of parental alcohol use (r = .71, p < .001 for fathers' drinking and r = .77, p < .001 for mothers' drinking).

Twins also provided information on their additional siblings other than their co-twin and we decided to take only the data of full siblings of twins into account. In total 1501 twins had at least one brother in addition to their co-twin and 1391 twins had at least one sister in addition to their co-twin. Twins indicated how often their brother(s) and sister(s) other than their co-twins drank alcohol, responses ranged from (1) "never" to (5) "daily". As in twins regular drinking of siblings was defined as drinking a few times a month and more. If at least one additional sibling drank a few times a month, this variable was categorized as regular drinking. The mean age of the siblings was 15.4 years for brothers of 12-15-year old twins, 15.8 for sisters of 12-15-year old twins, 19.6 years for brothers of 16-20-year old twins, 19.7 for sisters of 16-20-year old twins, 24.3 years for brothers of 20-25-year old twins and 24.1 for sisters of 20-25-year old twins. These figures indicate that most of the siblings in the analyses were older than the adolescents and young adults that were the targets of this study.

Twins were also asked how many of their friends drank alcohol regularly, with response categories being (1) "no-one", (2) "a few friends", (3) "half of the friends", (4) "most friends" and (5) "all friends". To dichotomize this item categories 1 and 2 and categories 3, 4 and 5 were combined together. For 3684 twins data on their friends regular drinking were available.

The participants were grouped into three age groups that were meaningful. The youngest group consisted of 12-15-year olds and included all adolescents that were under the legal age to buy and drink alcohol. The second group contained middle and late adolescents aged 16-20. This age period is the period in which the adolescents are allowed to buy alcoholic beverages and is also the period during which regular drinking patterns emerge. The oldest age group consisted of 21-25-year-old young adults and reflected the period in which individuals become more autonomous young adults who often leave home and are less guided by parental supervision and monitoring.

In the vast majority of the families, both twins and parents were born in the Netherlands. The other families came from all over the world, such as Surinam, the Netherlands Antilles, Morocco and Turkey, Asia, Europe and North America. Educational levels of

fathers in our sample show that 18.3% completed primary education, 33.8% completed lower general education or vocational education, 23.4% followed intermediate vocational education or intermediate and higher general education and 24.4% finished higher vocational education or university.

DATA ANALYSIS

We calculated prevalence rates and relative risks of regular drinking using SPSS 12.0.1 for Windows. The relative risk was calculated as the ratio of the percentage of regular drinkers with regular drinking family members and friends to the percentage of regular drinkers with non-regular drinking family members and friends. A relative risk is significant if the 95% confidence interval does not contain the value 1 and two relative risk are significantly different if there is no overlap in the two confidence intervals.

RESULTS

PREVALENCE OF REGULAR DRINKING

Prevalence rates of regular drinking showed an increase with age, in particular from 12-15-year olds to 16-20-year olds (Table 1). This increase was significant for twins, their additional brother(s), sister(s) and friends (chi-squares ranged from $\chi^2 (2, n = 1401) = 71.54$, $p < .001$ for sister(s) to $\chi^2 (2, n = 3684) = 883.16$, $p < .001$ for friends. Moreover, results showed that parents of 21-25-year olds were less often regular drinkers than parents of 12-15-year old and 16-20-year old twins, but, given small chi-square values, this difference was marginal ($\chi^2 (2, n = 3748) = 23.01$, $p < .001$ for fathers and $\chi^2 (2, n = 3746) = 23.74$, $p < .001$ for mothers). Moreover, males were more often regular drinkers than females ($\chi^2 (1, n = 1212) = 7.94$, $p < .01$ for 12-15-year old twins, $\chi^2 (1, n = 1852) = 66.80$, $p < .001$ for 16-20-year old twins and $\chi^2 (1, n = 696) = 53.19$, $p < .001$ for 21-25-year old twins).

Table 1

PREVALENCE OF REGULAR DRINKING FOR TWINS, SIBLINGS, FRIENDS, FATHERS AND MOTHERS (%)

	12-15 years		16-20 years		21-25 years	
	regular drinkers	***n***	**regular drinkers**	***n***	**regular drinkers**	***n***
Male twins	16.2	549	70.9	842	80.4	296
Female twins	10.7	663	52.3	1010	53.8	400
Brother(s)	41.3	487	64.5	719	82.6	304
Sister(s)	30.4	438	52.5	684	58.4	279
Friends	11.5	1170	62.1	1829	67.9	685
Fathers	71.5	1212	72.4	1844	62.9	692
Mothers	49.5	1210	46.7	1843	38.1	693

Note. Regular drinking of twins and siblings was defined as drinking a few times a month and more. Regular drinking of friends of twins was defined as half of the friends or more drink alcohol regularly, regular drinking of parents as drinking a few times a week and more.

RELATIVE RISKS

Relative risks in general show that the risk to be a regular drinker was higher if participants had regular drinking family members and friends than if participants had family members and friends who were non-regular drinkers (Table 2). For example 12-15-year old males with a regular drinking MZ twin brother were about 25 times more likely to be regular drinkers than 12-15-year old males with a non-regular drinking MZ twin brother and 12-15-year old males with a regular drinking mother were about 2.5 times more likely to be regular drinkers than 12-15-year old males with a non-regular drinking mother. All risk ratios were significant except the risk ratios calculated for fathers and mothers drinking among 12-15-year old females and fathers drinking among 21-25-year old males, DZ twin sister's drinking and drinking of additional brother(s) among 21-25-year old males and DZ twin brother's drinking among 21-25-year old females.

Table 2 shows that relative risks for regular drinking when having regular drinking versus non-regular drinking father and mothers were of comparable strength. Though these risk ratios were relatively low for both fathers and mothers. In contrast, results showed that relative risks for regular drinking accounting for drinking of friends were relatively high, except among 21-25-year olds. The risk to be a regular drinker was calculated separately for regular drinking of the MZ co-twin (always same sex), DZ same sex co-twin and DZ opposite sex co-twin and brother(s) and sister(s) other than the co-twin. Table 2 shows that the highest relative risks for regular drinking were found for regular, compared to non-regular drinking of the MZ co-twin followed by the risk ratio accounting for drinking of the DZ same sex co-twin. Relative risks for regular drinking when having a regular compared to a non-regular drinking DZ opposite sex co-twin, were of similar strength as those of brother(s) and sister(s) other than the co-twin and were non-significant in the oldest group.

SEX AND AGE DIFFERENCES

In general the same pattern of relative risks emerged for males and females. However, among 12-15-year old adolescents risk ratios accounting for regular drinking of siblings and friends where marginally higher among females compared to risk ratios among males, although these differences were not significant. Risk ratios accounting for regular drinking of fathers and mothers were marginally higher among males than among females (for females these ratios were not significant) in this age group. Additionally, regular drinking of 21-25-year old females was to a greater extent associated with regular drinking of their same sex twin sibling than regular drinking of males in this

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age group. Also, among 21-25-year old males drinking of friends was relatively more important than it was among females in this age group. The relative risk accounting for drinking of the MZ co-twin decreased with age for both males and females, only in 21-25-year-old females the relative risk remained relatively high and was higher than in 16-20-year-old females. Further decreases in relative risk ratios were most prominent in males from 12-15-year to 16-20-year olds.

Table 2
RELATIVE RISKS FOR ADOLESCENT AND YOUNG ADULT ALCOHOL USE WHEN HAVING REGULAR DRINKING OF FAMILY MEMBERS AND FRIENDS COMPARED TO NON-REGULAR DRINKING FAMILY MEMBERS AND FRIENDS

		12-15			16-20			21-25		
		RR	**95% CI**	**_n_**	**RR**	**95% CI**	**_n_**	**RR**	**95% CI**	**_n_**
Males	Father	1.76	1.06-2.93	549	1.23	1.11-1.37	839	1.13	1.00-1.28	296
	Mother	2.30	1.51-3.49	548	1.15	1.06-1.25	838	1.13	1.01-1.25	295
	Friends	4.79	3.41-6.75	530	2.19	1.88-2.55	828	1.76	1.36-2.27	290
	MZ twin brother	25.12	11.26-56.02	217	3.67	2.54-5.29	302	1.58	1.11-2.26	107
	DZ twin brother	10.00	4.97-20.11	161	2.29	1.72-3.04	285	1.79	1.08-2.92	97
	DZ twin sister	4.61	2.59-8.23	166	1.47	1.24-1.74	254	1.06	0.87-1.29	89
	Brother(s)	2.70	1.47-4.96	239	1.29	1.11-1.50	317	0.93	0.77-1.12	111
	Sister(s)	4.53	2.45-8.36	186	1.38	1.19-1.60	290	1.41	1.14-1.73	120
Females	Father	1.67	0.96-2.93	663	1.43	1.21-1.69	1005	1.44	1.16-1.79	396
	Mother	1.42	0.91-2.21	662	1.40	1.24-1.58	1005	1.25	1.05-1.50	398
	Friends	7.55	5.11-11.16	640	2.50	2.13-2.93	1001	1.86	1.49-2.34	395
	MZ twin sister	25.45	12.36-52.39	313	3.50	2.71-4.53	440	4.23	2.69-6.65	166
	DZ twin sister	10.67	5.28-21.55	182	2.53	1.94-3.30	317	1.94	1.36-2.78	139
	DZ twin brother	5.71	2.46-13.24	167	2.21	1.49-3.25	251	1.34	0.80-2.25	93
	Brother(s)	3.43	1.23-9.55	248	1.22	1.00-1.49	402	1.74	1.08-2.79	193
	Sister(s)	3.69	1.82-7.49	254	1.79	1.45-2.20	394	1.82	1.27-2.62	159

ADDITIONAL ANALYSES

Our focus was on the relative risks posed by each of the parents, siblings and friends separately. To nevertheless examine whether a particular relationship or the overall exposure of multiple influences was associated with to adolescent and young adult regular drinking we computed an index that assessed the number of regular drinkers the participants were exposed to. This index ranged from (0) indicating the participants were exposed to 0 regular drinkers (neither parents, friends nor siblings were regular drinkers) to (6) indicating that the participants' fathers, mothers, friends, co-twins and additional brothers and sisters were all regular drinkers. We used this index to compute the odds ratios for regular drinking in relation the number of regular drinkers the participants were exposed to. Table 3 shows that participants were of higher risk for regular drinking if they were exposed to more regular drinkers. Results did not show significant interaction effects with sex and age (odds ratios ranging from .01 (p = .999) to .35 (p = .302), indicating that this relation was similar among both males and females and among 12-15-year olds, 16-20-year olds and 21-25 year olds.

Table 3

ODDS RATIOS (OR) FOR ADOLESCENT AND YOUNG ADULT ALCOHOL USE IN RELATION TO NUMBER OF REGULAR DRINKERS THEY WERE EXPOSED TO

	OR	**95% CI**	***n***
Not exposed to regular drinkers	—	—	317
Exposed to 1 regular drinker	3.53	2.02-6.19	670
Exposed to 2 regular drinkers	9.65	5.64-16.48	954
Exposed to 3 regular drinkers	30.57	17.87-52.28	831
Exposed to 4 regular drinkers	78.43	45.15-136.23	656
Exposed to 5 regular drinkers	129.06	69.52-239.58	289
Exposed to 6 regular drinkers	412.73	91.08-1870.276	43

Note. All odds ratios were significant at p < .001.

DISCUSSION

The present study examined the relative risks to drink regularly in adolescence and young adulthood when having regular drinking parents, siblings and friends. We found that generally the risk to be a regular drinker when parents, siblings and friends were regular drinkers was significant in adolescence as well as young adulthood. Nevertheless, the relative risks to drink regularly turned out to be age dependent as it showed that the risk of drinking siblings and friends declined with age. Our study also shows that despite the decline, in late adolescence the risk posed by drinking friends is still significantly larger than the risk of drinking parents. In young adulthood, this is still the case for males.

In contrast to the majority of studies on the association between parental alcohol use and adolescent alcohol use, we examined fathers' and mothers' alcohol use separately. Our study corroborated previous studies that reported that fathers' and mothers' drinking was equally related to adolescent alcohol use (Björkqvist et al., 2004; Hundleby & Mercer, 1987; Reifman et al., 1998). They contradict those who suggested that fathers were more important (Seljamo et al., 2006; Zhang et al., 1999) or that mothers were more important (Marsden et al., 2005; Rittenhouse & Miler, 1984). An explanation for the fact that we, in contrast to other studies, did not find differences in risk posed by father and mother drinking, may be that our study examined adolescent and young adult regular drinking whereas other studies examined other stages of alcohol use. For example, Marsden et al. (2005) reported on drinking intensity Zhang et al. (1997) on average alcohol consumption and Seljamo et al. (2006) on frequency of intoxication. It may be the case that fathers and mothers have the same impact on how often their children drink, but not on how much they drink per se.

We found that friend's regular drinking posed a considerable risk for adolescents' and young adults' regular drinking. This risk was highest in the younger group but was still substantial in the late adolescent and young adult groups. For example, 12-15-year-old males and females had a relative risk of 4.79 and 7.55, respectively, to drink regularly when having regular drinking friends, whereas this was 1.76 and 1.86 for young adult males and females. Finding that friends' drinking still poses a risk for drinking in young adulthood is in line with results from other studies (Andrews et al., 2002; Labouvie, 1996; Thombs et al., 1997). Our findings make clear that friends continue to play a significant role with respect to regular drinking during the transition from adolescence into young adulthood.

Our study also provides information about the role of sibling drinking in adolescence and young adulthood that has not been reported in previous research. We used a genetic informative design, allowing to explore whether adolescents were at higher risk to drink regularly when they had a regular drinking MZ twin compared to DZ twin. Such findings may give some indication about the genetic influences on regular drinking. Genetic influences can be identified by comparing the degree of similarity in drinking behavior of MZ and DZ (same-sex) twin pairs. Genetic effects would be indicated by significant differences between the risk of having drinking MZ twins and having drinking DZ twins. As was shown, the relative risk to drink regularly when having a MZ twin was not significantly higher than having a same-sex DZ twin who drinks regularly. This was true for the younger age group, as was expected, but also for the older age groups. The findings on the younger adolescents support the idea that alcohol use in this age period may be to a large extent affected by environmental factors (McGue et al., 1996a, b). Our results on the older groups suggest that environmental factors may be substantially related to regular drinking in this age period too, as has also been reported in previous studies. For example, Pagan et al. (2006) found that environmental factors accounted for up to 80% of the variance in regular drinking in 25-year old females. Our study suggests that environmental factors, most notably siblings and friends, contribute to regular drinking but does not provide evidence for genetic effects on regular drinking in adolescence or young adulthood, as has been reported in previous research (Heath et al., 1991; Hopfer et al., 2003; Maes et al., 1999; Viken et al., 1999). However, it should be kept in mind that our type of analyses does not qualify for decomposing genetic and shared and unique environmental influences and that behavior genetic analyses are necessary to elucidate whether regular drinking in during this age period is genetically influenced.

According to social learning theory (Bandura, 1977) modeling of behavior is likely to occur when an individual is similar to the model, for example, in age or sex. Consequently, it could have been expected that same-sex siblings would have been more powerful models than opposite-sex siblings and that regular drinking of same-sex siblings would be a greater risk than regular drinking of opposite-sex siblings. Previous studies have documented that alcohol use of siblings is related to adolescent alcohol use but have usually not differentiated between same- and opposite-sex siblings (Bahr et al., 2005; D'Amico & Fromme, 1997; Needle et al., 1986). Our study showed that having a regular drinking opposite-sex siblings was a considerable risk, comparable to the risk of having a same-sex sibling who drinks regularly. This finding is in line with Boyle et al. (2001)

and suggests that irrespective of the sex of the sibling, the sibling context constitutes a major source of influence on adolescent and young adult drinking. In addition to genetic factors which may affect sibling similarity, siblings may influence adolescents and young adults in much the same way as a regular drinking friend does, through modeling, encouragement and social facilitation (Rowe & Gulley, 1992).

With respect to age differences in the risks posed by drinking family members and friends, our findings were in accord with our expectations. As other studies also revealed, the alcohol use of friends remained a considerable correlate of drinking when adolescents entered young adulthood, being more important than alcohol use of parents (Andrews et al., 2002; Labouvie, 1996; Thombs et al., 1997). Nevertheless, the overall pattern of age differences indicated that the risk posed by having drinking fathers, mothers, siblings, as well as friends decreased with age. The largest decrease was witnessed for MZ and same-sex DZ twins, who constituted large risk factors in 12-15-year olds, but seemed to be less strongly related to regular use in the older age groups, except for the 21-25-year-old females. An explanation why the decrease in the risk posed by drinking of twins was substantial may be that in late adolescence and young adulthood in the Netherlands, adolescents often leave home and start a life on their own. As a result, the interactions with siblings (including twins) are likely to become less frequent and consequently the influence of siblings will decline.

As expected, there were few sex differences in the relative risk for regular drinking. In general, the drinking of fathers, mothers, friends and siblings seems to have the same role for males and females, as was also shown in other studies (Andrews et al., 2002; Björkqvist et al., 2004; Seljamo et al., 2006). Not finding sex differences in the associations of paternal and maternal drinking with males' and females' drinking questions the assumption that alcohol use of the same-sex parent is more influential (Harburg et al., 1982; Newcomb et al., 1983). The only sex difference that emerged from our study was the risk posed by regularly drinking MZ twins in young adulthood. In case of having such a co-twin, females were more likely to drink regularly than males were. It may be that female MZ twins more frequently interact with each other than male MZ twins when they are older or have left home, resulting in more similarity in drinking behavior. An alternative hypothesis would be that the social environment differs for males and females and that genes are expressed to a greater extend in females.

While interpreting our findings, a number of caveats should be kept in mind. Our study was cross-sectional and does not allow for drawing any causal conclusions. The goal of the study was to examine what the relative risks were for regular drinking among adolescents and young adults when

having regular drinking family members and friends. We can only know what the risk to drink regularly, for example, among 12-15-year olds is when having drinking fathers or mothers. We can not infer from our data, however, that drinking of fathers and mothers actually exerts an influence on changes in adolescent or young adult drinking over time.

In the analyses we looked at regular drinking of family members and friends as risk factors, but did not examine additional predictors or potential confounders such as socioeconomic status or alcohol specific parenting. For example, recent studies (Van Der Vorst et al., 2006) showed that alcohol specific rule enforcement and norms were related to adolescent alcohol use. Adding these factors to the analyses might have significantly changed the risk factors.

We have used self-reports to assess parental and MZ and DZ twin alcohol use. Self-reports are considered a satisfactory method to assess alcohol use if confidentiality is assured and questionnaires are filled in alone (Botvin et al., 1986). Data on the alcohol use of the friends were based on adolescent reports, which might raise concerns about the validity of this measure. The validity of using adolescents' perceptions of alcohol use by their friends is open to debate. Whereas some scholars argue that adolescents may quite accurately estimate the alcohol use of close friends (Engels & Bot, 2006), others have pointed to the existence of the false consensus effect (Sherman et al., 1983; Wolfson, 2000). According to this notion, adolescents may over- or underestimate their peers' alcohol use as a function of their own alcohol use. Thus, it may be that the relative risk for friends' drinking is slightly overestimated.

The data we used came from a data collection from 1993. The reason for using this data collection instead of more recent ones was that in this data collection, in contrast to other data collections, we obtained adolescent and parent self-reports on alcohol use. Furthermore, only in the 1993 data collection the younger age group (i.e., 12-15-year olds) was present and the sample size was largest. Using this data collection may nevertheless raise the question about the relevance of the data and findings. Although recent studies have revealed some age trends in alcohol consumption in this data set (Poelen et al. 2005), there is no theoretical nor empirical indication that the associations between alcohol use of family members and friends and that of adolescents, have changed.

Different stages of adolescent drinking may be differently affected by alcohol use of parents, siblings and friends. Previous research, for example, suggests that parental drinking may impact initiation more than transition to regular drinking or problem drinking (e.g., Colder & Chassin, 1999; Power et al., 2005; Simons et al., 1988). Our findings pertain to regular drinking in adolescence and young adulthood, but may not translate to other stages of drinking.

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We examined the relative risk posed by additional brothers and sisters, but we did not differentiate between older and younger siblings in these analyses. The reason was that the sample sizes and thus statistical power, would have become too small. It is generally believed that the direction of effects is primarily from the older to the younger sibling (Boyle et al., 2001; Van Der Vorst et al., 2006). Thus, the relative risk of having older siblings who drink is likely to be higher than the relative risk of having younger siblings who drink. By combining older and younger siblings in our study we could not distinguish between these two risks and the relative risk of additional sibling drinking we described is therefore approximate.

Finally, the findings from this study pertain to the Dutch situation. In the Netherlands, the legal age to purchase and drink alcoholic beverages is 16 and governmental campaigns are implemented to persuade parents to discourage their offspring to drink. Nevertheless, recent figures show that the majority of adolescents under age 16 have used alcohol (Trimbos, 2004; Engels et al., 2006) and that in ninety percent of the cases, 12-16-year olds will succeed in buying alcohol from supermarkets, bars or liquor stores (Bieleman et al., 2004). Because of the specific Dutch situation, findings may not be readily generalized to other countries. It is recommended that replication studies are conducted in countries in which the legal ages to buy and drink alcohol are different from those in the Netherlands. It might, for example, be expected that because of the changes in parental and friend influence from early adolescence to young adulthood, relative risks may be quite different in countries where individuals are not allowed to drink until the age of 21. Furthermore, future studies should look at the differences in effects of older or younger siblings in order to be more accurate in establishing the risks posed by drinking siblings.

All in all, during adolescence and young adulthood, having regular drinking parents, twins, siblings and friends was a risk factor for adolescent regular drinking. Same-sex sibling and friend drinking was more important than father and mother drinking, which did not seem to change in importance over time. Although the risk posed by drinking twins and friends decreased with age, it was still associated with regular drinking in late adolescence and young adulthood. Generally, the results were similar for males and females. These findings suggest that social influences on regular drinking change with age and are sex independent. They also imply that prevention programs might broaden their focus in terms risk factors. That is, when prevention programs focus on peer influences in early adolescence, they usually consider the friend context. Our study makes clear that especially among the younger adolescents, sibling alcohol use poses a significant risk as well and parents might be made aware of this.

CHAPTER

DRINKING BY PARENTS, SIBLINGS, AND FRIENDS AS PREDICTORS OF REGULAR ALCOHOL USE IN ADOLESCENTS AND YOUNG ADULTS: A LONGITUDINAL TWIN-FAMILY STUDY

ABSTRACT

The aim of this study was to examine whether drinking of parents, siblings and friends was related to the regular drinking in adolescents and young adults, cross-sectionally as well as longitudinally. Data of 12-30-year-old twins from the Netherlands Twin Register were analysed. Information on regular drinking was collected in 1993, 1995 and 2000. Logistic regression analyses were conducted on cross-sectional data of 1993 ($n = 3760$), short-term longitudinal data of 1993-1995 ($n = 2919$) and the long-term longitudinal data of 1993-2000 ($n = 1779$). Results show that age, sex and own previous drinking were important predictors of regular drinking. Drinking of parents showed small but persistent positive associations. Alcohol use of the co-twin was strongly related to alcohol use of the participants, especially in the cross-sectional analyses, while alcohol use of additional siblings other than the co-twin was relatively unimportant. Cross-sectionally, friends' alcohol use showed a high association with regular drinking, but this association decreased over time. Cross-sectional analyses showed that a substantial part (29%) of the variance in regular drinking of adolescents and young adults was explained by drinking of family members and friends, in particular by drinking of co-twins and friends. But over time, drinking of family members and friends could only explain a relatively small part (4-5%) of the variance in adolescents' and young adults' alcohol use.

INTRODUCTION

Alcohol use in adolescents and young adults reflects alcohol use of family members (e.g., Cleveland & Wiebe 2003; Li et al., 2002; Needle et al., 1986; Wood et al., 2004). Parental alcohol use is associated with adolescent and young adult drinking in some studies (Cleveland & Wiebe 2003; Duncan et al., 1996; Engels et al., 1999; Green et al., 1991; Hops et al., 1996; Koopmans & Boomsma 1996; Li et al., 2002; Windle 2000; Wood et al., 2004), but not in others (Beal et al., 2001; Boyle et al., 2001; Reifman et al., 1998). Most studies that have explored the influence of parental alcohol use on their offspring's drinking combined maternal and paternal drinking into one overall parental alcohol use score but did not examine the effect of alcohol use of mothers and fathers separately. Furthermore, studies in which the role of siblings in adolescents' substance use was examined showed that drinking of siblings (Ary et al., 1993; Boyle et al., 2001; D'Amico & Fromme 1997; Duncan et al., 1996; Needle et al., 1986; Windle, 2000), even when biologically unrelated (McGue et al., 1996a), is associated with alcohol use of adolescents and young adults. Only three of these studies examining the role of siblings' drinking in adolescent alcohol use had a longitudinal design and time periods were relatively short (not more than a three year period) (Ary et al., 1993; Duncan et al., 1996; Windle, 2000).

Not only the drinking behavior of family members may be associated with alcohol consumption in adolescence, but factors outside the family also require consideration. In research on adolescents' substance use much attention is paid to the role of friends. Young people tend to form an identity independent from their families and foster tighter bonds with their friends during adolescence. In general, friends' drinking patterns are considered to be one of the strongest predictors of adolescents' and young adults' alcohol use (Petraitis et al., 1995). Friends' drinking is a robust predictor of adolescents' alcohol use, both cross-sectionally and over a short period of time (within a year) (Andrews et al., 2002; Ary et al., 1993; Beal et al., 2001; Bot et al., 2005a; Engels et al., 1999; Graham et al., 1991; Reifman et al., 1998; Urberg et al., 1997; Webster et al., 1994; Windle, 2000; Wood et al., 2001). However, two longitudinal studies, covering a longer period of time (two years and three years or more), have shown that the influence of friends on drinking is important in early adolescence, but decreases over time (Andrews et al., 2002; Engels et al., 1999). In addition, in a study over a 1-year period, Jaccard et al. (2005) conclude that close friends are less relevant in affecting adolescent drinking than is often assumed.

The behavior of family members and friends is a relevant contributor to the development of adolescent and young adult alcohol consumption, but it is unclear who most strongly affects changes in frequency of alcohol use over time. The influence of parents, siblings and friends on alcohol consumption is seldom examined simultaneously. In the current study we examine the influence of alcohol use of parents, siblings and friends on adolescents' and young adults' regular drinking over time. Furthermore, we examine whether these influences were moderated by age and sex. In addition to the relative impact of alcohol use of parents (fathers and mothers), siblings (brothers and sisters) and friends we also compare data from monozygotic (MZ) and dizygotic (DZ) twins. Because MZ twins are genetically identical while DZ twins share (like non-twin siblings) on average 50% of the genes, a higher association between alcohol use of MZ co-twins than of DZ co-twins indicates genetic influences on alcohol use. Our study extends on existing studies in three ways, first we examine drinking of family members and friends simultaneously, second we focus on differences between cross-sectional and longitudinal analyses and third we use twin data.

METHODS

PROCEDURE AND PARTICIPANTS

Data reported in this study are part of an ongoing longitudinal questionnaire study of the Netherlands Twin Register. From 1991 onwards families with twins have been questioned about health, lifestyle and personality roughly every two years. Twins were asked to participate every time (1991, 1993, 1995, 1997 and 2000), parents in 1991, 1993 and 1995, and siblings in 1995, 1997 and 2000. Some individuals participated only once, while others participated several times. Information about sample and data collection is described in detail in Boomsma et al. (2002).

In the present study we used data from the 1993, 1995 and 2000 surveys. At the first wave the mean age was 17.8 years (SD 3.1) with an age range from 12 to 25 years. Participants were grouped in three age categories: 12 to 15 years, 16 to 20 years, and 21 to 25 years. For the cross-sectional analyses of 1993, the sample consisted of 1550 MZ twins and 2213 DZ twins. The sample for the short-term longitudinal analyses consisted of 1227 MZ twins and 1692 DZ twins who participated both in 1993 and in 1995. For the long-term longitudinal analyses, the sample consisted of 834 MZ twins and 945 DZ twins who participated both in 1993 and in 2000 (Table 1 depicts the sample constitution in more detail).

Table 1

NUMBER OF PARTICIPANTS IN THIS STUDY DERIVED FROM THE LONGITUDINAL TWIN-FAMILY STUDY OF THE NETHERLANDS TWIN REGISTER

	1993	**1993-1995**	**1993-2000**
MZM	628	478	284
DZM	546	412	182
DOSM	513	396	177
MZF	920	749	550
DZF	641	487	338
DOSF	512	397	248
Total MZ	1548	1227	834
Total DZ	2212	1692	945

Note. MZM = Monozygotic males; DZM = Dizygotic males; DOSM = Dizygotic males from opposite sex pairs; MZF = Monozygotic females; DZF = Dizygotic females; DOSF = Dizygotic females from opposite sex pairs.

MEASURES

Participants were asked to report their frequency of drinking with the question: "How often do you drink alcohol?" This question had eight response categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week", and (8) "daily". For extensive descriptive information on the distribution of alcohol consumption at each wave see Poelen et al. (2005).

For 3457 fathers and for 3738 mothers self-reported data on frequency of drinking were available in 1993. In case data on alcohol use of father or mother were missing, data on alcohol use of 1995 were used, because there was a high stability of frequency of drinking over time (for fathers $r = .75$, $p < .001$ and for mothers $r = .78$, $p < .001$). If these data were also not available, we used twin reports on their parents' alcohol use. Correlation analyses showed a sufficient resemblance between twin reports and parents reports of parental frequency of drinking ($r = .71$, $p < .001$ for fathers' drinking and $r = .77$, $p < .001$ for mothers' drinking). In our sample 117 twins were from single parent (only mother) families, these families were excluded from further analyses, as data on father's drinking was unknown.

For 3697 co-twins self-reported data on frequency of drinking in 1993 were available, missing data on frequency of drinking could be completed by twins' reports on their co-twins' drinking. In 1993, twins were asked about frequency of drinking of their brother(s) and sister(s) other than their co-twins. Based on these answers, drinking of brother(s) and sister(s) were categorized as: (1) "one or more brother(s) or sister(s) seldom alcohol", (2) "one or more brother(s) or sister(s) a few times a month alcohol", (3) "one or more brother(s) or sister(s) a few times a week alcohol" and (4) "no additional brother(s) or sister(s)". In our study 1501 participants had at least one brother besides their co-twin and 1391 participants had at least one sister besides their co-twin.

In 1993 twins were also asked how often their friends drank alcohol. Frequency of drinking by friends was categorized as: (1) "no drinking friend", (2) "a few friends drink", and (3) "more than half of the friends drink". This was answered by 3684 participants.

DATA ANALYSIS

To examine whether alcohol consumption of family members and friends was cross-sectionally associated with regular drinking of adolescents and young adults multivariate logistic regression analyses were conducted for the data collected in 1993 (see for similar type of analytic strategy to assess the role of parents and siblings on individual

substance use, Harakeh et al., 2005; Vink et al., 2003). To determine whether drinking of family members and friends predicted alcohol consumption of adolescents and young adults on the short-term and the long-term we conducted multivariate logistic regression analyses for the short-term (1993-1995) longitudinal data, and for the long-term (1993-2000) longitudinal data. In both longitudinal analyses predictor variables, including drinking of the co-twin, were assessed in 1993 while drinking of twins was assessed in 1995 and 2000.

We aimed to predict regular drinking, therefore frequency of drinking was transformed into (0) non-regular drinking and (1) regular drinking; regular drinking was defined as drinking a few times a month and more. In the cross-sectional analyses age and sex were entered in the model at the first step and in the longitudinal analyses age, sex and respondents' alcohol use in 1993 were entered in the model at the first step, thus our analyses were controlled for these variables. Both cross-sectionally and longitudinally, the variables regarding drinking of parents, co-twin, additional siblings, and friends were entered in the model at the second step. Interaction terms between drinking of family members and friends and age and sex were entered in the model at the third and fourth step respectively. These interaction terms were used to test whether the relation between family and friend's drinking and twins' alcohol use was different for 12-15-year olds, 16-20-year olds and 21-25-year olds and for males and females.

RESULTS

Table 2 depicts prevalence rates of regular drinking of adolescent and young adult twins. Results show that regular drinking is more prevalent among age groups aged 16 years and older than among 12-15-year olds (chi-square tests for age differences ranged from $\chi^2 (2, n = 1126) = 14.50$, $p = .001$ to $\chi^2 (2, n = 1687) = 496.48$, $p < .001$). Prevalence rates were higher in males than in females (chi-square tests ranged from $\chi^2 (1, n = 1212) = 7.94$, $p = .005$ to $\chi^2 (1, n = 1852) = 66.80$, $p < .001$), with exception of the youngest age group.

Table 2

THE NUMBER OF PARTICIPANTS (N) AND PERCENTAGE OF INDIVIDUALS REPORTING REGULAR DRINKING BY AGE AND SEX

	Male				**Female**			
	12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
Regular drinking								
1993, *n*	549	842	296	—	663	1010	400	—
%	16.2	70.9	80.4	—	10.7	52.3	53.8	—
1995, *n*	193	682	404	—	266	830	529	—
%	28.5	73.6	80.7	—	23.7	56.1	56.1	—
2000, *n*	—	95	354	185.0	—	174	581	371
%	—	89.5	86.7	85.9	—	71.8	68.3	58.0

Note. Prevalence rates differed significantly between males and females (Chi-square tests $p < .05$) except for regular drinking among 12-15-year olds in and 1995. Chi-square tests for sex differences ranged from $\chi^2 (1, n = 1212) = 7.94$, $p = .005$ to $\chi^2 (1, n = 1852) = 66.80$, $p < .001$. All prevalence rates differed for age groups except for males in 2000. Chi-square tests for age differences ranged from $\chi^2 (2, n = 1126) = 14.50$, $p = .001$ to $\chi^2 (2, n = 1687) = 496.48$, $p < .001$.

CROSS-SECTIONAL ASSOCIATIONS WITH REGULAR DRINKING

Table 3 shows the results from the cross-sectional multivariate logistic regression analyses. These analyses examined whether alcohol use of parents, co-twin, additional siblings, and friends was related to regular drinking in 1993 after controlling for age and sex. Results show that age

and sex were significantly related to regular drinking. Odds ratios indicated that 16-20 and 21-25-year olds were at higher risk for regular drinking than 12-15-year olds. Males were at higher risk for regular drinking than females. Further, having a father who drank daily and having a mother who drank a few times a week or daily was associated with a higher risk for drinking than having parents who drink never or seldom. Having a co-twin who drank a few times a month and having a co-twin who drank a few times a year was associated with a higher risk for regular drinking than having a co-twins who drank never or seldom. Odds ratios were higher if co-twins drank a few times a month than if co-twins drank a few times a year. Further, an association was found for having one or more additional sister(s) besides the co-twin who drank a few times a month and a few times a week. Drinking of additional brother(s) was not significantly related to regular drinking. For friends, it was shown that having a group of friends of whom a few drank alcohol regularly increased the risk for regular drinking compared to having a group of friends of whom no one drank alcohol. This increased risk for regular drinking was even higher when having a group of friends of whom more than half drank.

The cross-sectional model with alcohol use of parents, co-twin, additional siblings, and friends explained 60% of the variance of regular drinking. This was an increase of 29% relative to the model with age and sex.

LONGITUDINAL ANALYSES FOR REGULAR DRINKING

As with the cross-sectional analyses, both short-term and long-term longitudinal analyses indicated a strong association between age and sex, and regular drinking (Table 3). The age effects in both longitudinal analyses indicated that participants who were 16-20-year old or 21-25-year old in 1993 were at lower risk to be a regular drinker in 1995 and 2000 than 12-15-year olds in 1993. Both analyses pointed out that males were at higher risk to become regular drinkers than females. Furthermore, being a regular drinker in 1993 was an important predictor of regular drinking in 1995 and 2000.

Having a mother who drank a few times a week in 1993 was positively associated with respondents' regular drinking in 1995 and 2000, whereas this association was not found for fathers. The association for mother indicated that having a mother who drank a few times a week in 1993 was related to a higher risk for regular drinking in 1995 and 2000 compared to having a mother who drank never or seldom in 1993. Both daily drinking of fathers and mothers was related to regular drinking in 1995, but not to regular drinking in 2000. Odds ratios indicated that participants with daily drinking parents in 1993 were at higher risk for regular drinking in 1995 than participants with never or seldom drinking parents in 1993.

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Table 3

CROSS-SECTIONAL AND LONGITUDINAL ASSOCIATIONS BETWEEN
ALCOHOL CONSUMPTION OF PARENTS, SIBLINGS, AND FRIENDS AND
REGULAR DRINKING OF ADOLESCENTS AND YOUNG ADULTS

Variable	1993		1993-1995		1993-2000	
	OR	95% CI	OR	95% CI	OR	95% CI
Step 1						
Age 1993						
12-15 year	1		1		1	
16-20 year	2.68***	2.05-3.50	0.67**	0.51-0.87	0.31***	0.22-0.45
21-25 year	2.86***	2.08-3.94	0.38***	0.27-0.54	0.16***	0.10-0.26
Sex						
Males	1		1		1	
Females	0.48***	0.39-0.58	0.56***	0.46-0.68	0.35***	0.26-0.47
Regular drinking 1993						
Non-regular drinking	—	-	1		1	
Regular drinking	—	-	10.83***	8.28-14.16	6.35***	4.49-8.97
Step 2						
Alcohol use father						
Never/seldom	1		1		1	
Few times a week	1.25	0.96-1.63	1.20	0.92-1.57	0.98	0.70-1.37
Daily	1.47*	1.10-1.96	1.38*	1.03-1.86	1.35	0.93-1.96
Alcohol use mother						
Never/seldom	1		1		1	
Few times a week	1.33*	1.07-1.65	1.37*	1.10-1.71	1.78***	1.34-2.37
Daily	1.49*	1.11-2.00	1.62*	1.20-2.20	1.46	0.99-2.14
Alcohol use co-twin						
MZ never/seldom	1		1		1	
MZ a few times a year	3.52***	2.09-5.91	2.14***	1.48-3.09	1.48	0.94-2.31
MZ a few times a month	27.81***	16.65-46.47	3.09***	2.03-4.72	1.99**	1.19-3.35
DZ never/seldom	2.46**	1.34-4.51	1.28	0.85-1.93	0.97	0.60-1.58
DZ a few times a year	4.74***	2.75-8.17	2.59***	1.72-3.90	1.14	0.66-1.97
DZ a few times a month	19.59***	11.70-32.80	3.29***	2.12-5.10	1.78*	1.04-3.06
DOS never/seldom	3.37***	1.81-6.28	1.50	0.98-2.30	1.60	0.89-2.86
DOS a few times a year	9.20***	5.28-16.02	2.28***	1.48-3.53	1.02	0.56-1.85
DOS a few times a month	14.31***	8.57-23.88	2.31***	1.52-3.51	2.06**	1.21-2.99

(Table continues)

Table 3 (continued)

Variable	1993		1993-1995		1993-2000	
	OR	95% CI	OR	95% CI	OR	95% CI
Alcohol use brother(s)						
Seldom	1		1		1	
Few times a month	1.32	0.90-1.93	0.95	0.65-1.39	1.11	0.69-1.79
Few times a week	1.25	0.89-1.77	1.39	0.96-1.99	1.33	0.84-2.10
No additional brother(s)	1.05	0.80-1.39	1.07	0.83-1.39	1.40	1.00-1.96
Alcohol use sister(s)						
Seldom	1		1		1	
Few times a month	2.02***	1.43-2.85	1.41	0.98-2.04	1.19	0.74-1.93
Few times a week	2.39***	1.53-3.72	1.73*	1.04-2.85	1.29	0.70-2.39
No additional sister (s)	1.24	0.97-1.60	1.27	1.00-1.61	1.34	0.98-1.83
Alcohol use friends						
No one drinks	1		1		1	
A few drink	1.82***	1.30-2.55	1.49**	1.14-1.96	0.66*	0.46-0.95
More than half drink	8.56***	6.11-11.97	1.62**	1.18-2.23	0.74	0.49-1.13

Note. MZ = Monozygotic; DZ = Dizygotic same sex; DOS = Dizygotic opposite sex.
* $p < .05$. ** $p < .01$. *** $p < .001$.
Nagelkerke R^2 = .31 for the cross-sectional model with age and sex; Δ Nagelkerke R^2 = .29 for the cross-sectional model with age, sex and drinking behavior of family members and friends. Nagelkerke R^2 = .41 for the short term longitudinal model with age, sex and regular drinking 1993; Δ Nagelkerke R^2 = .05 for the short term longitudinal model with age, sex, regular drinking 1993 and drinking behavior of family members and friends. Nagelkerke R^2 = .27 for the long term longitudinal model with age, sex and regular drinking 1993; Δ Nagelkerke R^2 = .04 for the long term longitudinal model with age, sex, regular drinking 1993 and drinking behavior of family members and friends.

Short-term longitudinal analyses showed a similar pattern as in the cross-sectional analyses for drinking of the co-twin, although odds ratios were lower. Results indicated that having a MZ, DZ same sex or DZ opposite sex co-twin who drank a few times a month or a few times a year in 1993 was associated with a higher risk for regular drinking two years later compared to having a MZ co-twin who drank never or seldom. In contrast, in the long-term longitudinal analysis only having a MZ, DZ same sex or DZ opposite sex co-twin who drank a few times a month in 1993 was associated with a higher risk for regular drinking, while drinking a few times a year

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by the co-twin in 1993 was no longer associated. Odds ratios indicated that participants with a MZ or DZ co-twin who drank a few times a month in 1993 were at higher risk for regular drinking than participants with a MZ co-twin who drank never or seldom. Having additional sister(s) who drank a few times a week marginally predicted regular drinking on the short term in 1995, this association disappeared on the long term. The odds ratio indicated that participants with additional sister(s) who drank a few times a week were at higher risk for regular drinking than participants with additional sister(s) who drank seldom. For drinking of additional brother(s) no associations over time were found. Short-term longitudinal analyses showed that having a group of friends of whom a few or more than half drank, increased the risk of regular drinking two years later, compared to having a group of friends of whom no one drank. In contrast, in the long run, having a group of friends of whom a few drank regularly decreased the risk of regular drinking after seven years and the odds ratio of having a group of friends of whom more than half drank was no longer significant.

The short-term (1993-1995) longitudinal model with alcohol use of parents, co-twin, additional siblings, and friends explained 46% of the variance of regular drinking and this was 31% for the long-term (1993-2000) longitudinal model. These were increases to the model with age, sex and regular drinking in 1993 of 5% and 4% respectively.

ADDITIONAL ANALYSES

In addition, interaction terms between variables on familial and friends' drinking and age and sex were tested. These analyses did not show significant interaction terms neither in the cross-sectional nor in the longitudinal analyses, indicating that the relations between family and friends' drinking were not significantly different in 12-15-year olds, 16-20-year olds and 21-25-year olds, nor in males and females.

To examine whether the results we found were biased by attrition or the fact that participants from the same family are not statistically independent, the analyses were repeated in a sample of participants who completed questionnaires at all three waves ($n = 1585$) and a sample of participants in whom only one twin was included ($n = 1880$). These additional analyses showed similar patterns as described previously.

DISCUSSION

We examined the relative role of parents', siblings', and friends' drinking on adolescents' and young adults' regular drinking. In general, alcohol use of parents showed small but persistent associations with drinking in their offspring in multivariate cross-sectional and longitudinal analyses, in particular for mothers. In the cross-sectional analyses, alcohol use of the co-twin was strongly associated with adolescents' and young adults' alcohol consumption, while alcohol use of additional brother(s) and sister(s) was relatively unimportant. Effects of drinking of the co-twin were persistent over two years and if co-twins scored relatively high on drinking behavior, effects maintained after seven years. In line with others (Andrews et al., 2002, Engels et al., 1999), we found that friends' alcohol use was also strongly associated with adolescents' and young adults' alcohol use in cross-sectional analyses it was still relevant in the prediction of individual drinking over a period of two years. However, over a period of seven years drinking of friends decreased the risk for regular drinking, but this effect was relatively small.

Moreover, our study showed that age and sex were important predictors of regular drinking. With regard to age differences cross-sectional analyses indicated that 16-20 and 21-25-year olds were at higher risk for regular drinking than 12-15 year olds. But, the age effects in both longitudinal analyses indicated that participants who were 16-20-years old or 21-25 years old in 1993 were at lower risk to be a regular drinker in 1995 and 2000 than participants who were 12-15-years old in 1993. We expect that this age effect might be explained by the fact the older adolescents and young adults were more likely to have finished their studies and started working in 1995 and 2000. It might also be caused by changes in social roles, as previous research indicated that acquisition of a spouse role and a parental role was associated with a decrease in alcohol consumption (Hajema & Knibbe, 1998). Results with regard to sex differences were in line with previous studies that repeatedly indicated that males drink more and more often than females (e.g., De Zwart et al., 2000, Sutherland & Shepherd, 2001, Young et al., 2002).

The relative influence of mothers on regular drinking appeared to be stronger than that of fathers. Previous research has shown comparable effects of paternal drinking on their offspring's alcohol use (e.g., Chassin et al., 1996, Wood et al., 2004). However, it is crucial to understand that because of the relative strong similarities in drinking in partners (so, parents) it is also possible that fathers are almost as important

as mothers but that in multivariate analyses, partly due to the correlation in drinking between parents, the effect of paternal drinking becomes not visible. Previous analyses of our data did not show differences in magnitude of relative risks for drinking in adolescents accounting for father's and mother's drinking (Scholte et al., 2007).

Alcohol use of young people was to a relatively large extent associated with alcohol consumption of the co-twin, in particular in cross-sectional analyses. The analyses showed higher odds ratios for MZ twins than for DZ twins. This shows that genetic factors are relevant in alcohol use of young people, because MZ twins share all their genes identical by descent while DZ twins share on average 50% of the genes. Classical twin studies have shown that environmental factors are relatively more important in predicting initiation of use in younger adolescents, while genes are more important in explaining continuation of use and more problematic use (e.g., Rhee et al., 2003; Viken et al., 1999). This seems to contrast our findings which suggest that genetic factors become less important over time, because differences between odds ratios of MZ and DZ twins decreased over time, in particular for regular drinking. However, because different strategies of analyses used in classical twin studies and in the current study, comparison of results should be done with caution. Future twin analyses on the data used in this study are required to draw conclusions on the relative influence of genes and environment on alcohol consumption.

Although alcohol use of the co-twin was one of the most important predictors of drinking among young people, the associations with drinking of the co-twin and drinking decreased over time. This might be explained by the fact that social contact within twin pairs decreased over time. At the first wave the majority of the twins were still living with their co-twin (about 86%), but when the twins grew older a decreasing number of twins were living together (about 76% in 1995 and about 38% in 2000). Decreased social contact within twin pairs may contribute to decreased intra-pair similarity for alcohol use. Or it could be vice versa, decreased intra-pair similarity for alcohol use could cause less social contact within twin pairs, as it is unclear what the direction is in this relation (Kaprio et al., 1990; Lykken et al., 1990; Rose et al., 1990).

Small or non-significant associations were found between alcohol use of additional brother(s) and sister(s) other than the co-twin, and regular drinking in young people. Previous univariate analyses on our data showed that drinking of in particular a MZ co-twin was a greater risk factor for drinking of adolescents than drinking of additional brother(s) and sister(s) other than the co-twin (Scholte et al. 2007). This might be explained by the fact that twins are of the same

age and since alcohol use is highly age dependent, at least in the teenage and young adult years, twins may therefore be more similar in alcohol use than non-twin siblings. Closeness in age is also likely to result in spending more time together through adolescence. This will result in more shared experiences within the family environment, at school and with friends (Boyle et al., 2001).

We found that alcohol use of friends was strongly associated with regular drinking in cross-sectional analyses. Even in the short-term longitudinal analyses, in which we controlled for age, sex, own previous drinking and effects of family members, friends' drinking predicted adolescent and young adult regular drinking. However, in terms of explained variances (5% and 4% in addition the model with age, sex and own previous drinking) we could not conclude that friends as well as family members strongly predicted adolescent drinking over time. Several recent studies argue that the role of friends in the development of substance use in young people might be less significant than is often assumed, because friendships could be formed on the basis of common alcohol use (peer selection) (Andrews et al., 2002; Bauman & Ennett 1996; Engels et al., 1997; Fisher & Bauman 1988; Sieving et al., 2000). Cross-sectional studies often interpret similarities in drinking in terms of influence processes, while in fact both selection and influence processes could be operating (Urberg et al., 2003). Jaccard et al. (2005) showed in a short-term longitudinal study that peer influence was limited if peer selection effects were controlled for. According to the authors, peer influences are often overestimated and are probably not more important than parental influences. Our results indeed show that drinking of friends was not more important than alcohol use of parents in predicting regular drinking. Because we did not know whether twins still had the same friends after two and seven years we could not differentiate selection effects from influence. In addition, our analyses displayed some unexpected findings regarding the prediction of regular drinking by friends' alcohol use over a seven year period. Having a group of friends of whom more than half drank alcohol, was cross-sectionally and short-term longitudinally related to a higher risk for regular drinking, but after seven years a reverse trend appeared. This finding is in contrast with the hypothesis that being in a group of drinking friends will put people at a higher risk for regular drinking. A speculative explanation could be that being in a group of drinking friends at a certain point in time is related to frequent drinking at that specific time point. After a few years these adolescents have ample experience with drinking and they might have matured out of drinking more quickly than adolescents who were not in a group of drinking friends a few years earlier.

A few limitations need to be mentioned. We used self-reports of parents and twins to assess regular drinking, but alcohol use of friends and additional siblings was reported by twins. This might have caused an overestimation of the effects of alcohol use of siblings and friends, since people tend to project their behavior to that of their friends and perceived reports on drug use may therefore correlate more than actual reports (Bauman & Ennett, 1996). Concerning friends' drinking, this might have played a role if we would have found strong associations between friends' drinking and individual alcohol use over time. However, this was not the case. In 1995 there was self-report of additional siblings as well as twin-reports over their sibs and examination of these self-reports and twin reports on their additional siblings' alcohol use showed that these reports were highly correlated (correlations around .74, $p < .001$). This indicates that twins were capable to report on their siblings' alcohol use. Our results were probably not largely biased by overestimation of the effects of alcohol use of siblings and friends. In addition, drinking of family and friends was assessed in 1993 to predict drinking of twins in 1993, 1995 and 2000 respectively. It should be noted that, in contrast to relationships with family members, participants likely have formed new relationships with friends within the research period. These new friends might be of greater importance than the group of friends in 1993. This might have caused an underestimation of the (short-term) effects of friends on alcohol use. Moreover, this study was aimed at predicting regular drinking, therefore our results might not be applicable to other indicators of drinking such as quantity of drinking.

Though explained variances ranged from 59% for regular drinking in the cross-sectional model to 31% for the long-term longitudinal model, the impact of drinking of family and friends on individual drinking was moderate to small (5% to 4% explained variance), in particular in the longitudinal analyses. This indicates that there are other explanatory factors that were not included in this study. These may include personality (Hampson et al., 2006), more explicit peer pressure or direct imitation effects (Engels et al., 2008), and direct influences of parents, such as socialization efforts (Jackson et al., 1999; Yu 2003; Van Der Vorst et al., 2005). Future research should explore the relative role of these factors.

In conclusion, cross-sectional analyses showed that a substantial part of the variance in regular drinking of adolescents and young adults was explained by drinking of family members and friends, in particular by drinking of co-twins and friends. However, drinking of family members and friends did not add much to the prediction of regular drinking in adolescents' and young adults' alcohol use over a two and seven year period.

CHAPTER

5

THE RELATIVE CONTRIBUTION OF GENES AND ENVIRONMENT TO ALCOHOL USE IN EARLY ADOLESCENTS: ARE SIMILAR FACTORS RELATED TO INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING?

ABSTRACT

The present study assessed the relative contribution of genes and environment to individual differences in initiation of alcohol use and frequency of drinking among early adolescents and examined the extent to which the same genetic and environmental factors influence both individual differences in initiation of alcohol use and frequency of drinking. Questionnaire data collected by the Netherlands Twin Register were available for 694 twin pairs aged of 12-15 years. Bivariate genetic model fitting analyses were conducted in Mx. We modeled the variance of initiation of alcohol use and frequency of drinking as a function of three influences: genetic effects, common environmental effects and unique environmental effects. Analyses were done conditional on sex. Findings indicated that genetic factors were most important for variation in early initiation of alcohol use (83% explained variance in males and 70% in females). There was a small contribution of common environment (2% in males, 19% in females). In contrast, common environmental factors explained most of the variation in frequency of drinking (82% in males and females). In males the association between initiation and frequency was explained by common environmental factors influencing both phenotypes. In females, there was a large contribution of common environmental factors that influenced frequency of drinking only. There was no evidence that different genetic or common environmental factors operated in males and females. Different factors were involved in individual differences in early initiation of alcohol use and frequency of drinking once adolescents have started to use alcohol.

INTRODUCTION

  The international representative Health Behavior in School-aged Children study of the World Health Organization shows that among those young people who initiated alcohol use before the age of 16 (about 80%), boys reported drinking for the first time at an average age of 12.3 years and girls at an average age of 12.9 (Currie et al., 2004). As in many other countries, Dutch adolescents start experimenting with alcohol and establish a drinking pattern during this period of early adolescence. However, in the Netherlands, but also in the United Kingdom and Denmark, adolescents start drinking regularly at a younger age than in most other western countries. Among Dutch adolescents 21% of the 13-year-olds and 52% of the 15-year-olds drink alcohol weekly, while the average in western countries is respectively 12% in 13-year-olds and 29% in 15-year-olds (Currie et al., 2004). These figures indicate that it is particularly relevant to examine the etiology of initiation and frequency of drinking in early adolescents. In the present study we assessed the relative contribution of genes and environment to individual differences in initiation of alcohol use and frequency of drinking among early adolescents (12-15 years).

  Studies on the genetic contribution to the variation in alcohol use in adolescence found that the largest part in the variance of initiation of alcohol use is explained by environmental factors (e.g., Maes et al., 1999; Rose et al., 2001; Stallings et al., 1999), while genetic factors become more important as adolescents grow older and develop more regular drinking patterns (see Hopfer et al., 2003). Most research on alcohol use in adolescents, however, focused on initiation and few studies paid attention to drinking beyond initiation. More importantly, until now little is known about the overlap in etiology of initiation of alcohol use and the adoption of more regular drinking patterns. The present study assessed the relative contribution of genes and environment to individual differences in initiation of alcohol use and to frequency of drinking among early adolescents and examined whether the same genetic and environmental factors were related to the two indicators of drinking.

  Twin studies are commonly used to examine the relative contribution of genetic and environmental influences on individual differences in behavior. These studies partition the variance of individual differences into (1) the heritability or additive genetic influences (a^2), (2) common environmental influences which are environmental influences that family members have in common and make them similar to each other (c^2), and (3) unique environmental influences which are

environmental influences that family members experience uniquely and make them different from each other (e^2). Table 1 depicts an overview of univariate and bivariate twins studies on initiation of alcohol use and frequency or quantity of drinking. Twin studies demonstrate that the variation in initiation of alcohol use is moderately heritable, with heritabilities ranging from 0% to 43% (average approximately 30%) (Fowler et al., 2007; Koopmans & Boomsma, 1996; Maes et al., 1999; Pagan et al., 2006; Rhee et al., 2003; Rose et al., 2001; Viken et al., 1999). Common environmental influences explained most of the variation in initiation, with c^2 ranging from 32% to 79% (average approximately 65%). Only Han et al., (1999) reported a relatively high heritability estimate (84%) for males and did not find significant influences of common environment.

In addition to initiation of alcohol use, some twin studies on adolescents' drinking have also focused on other indicators of alcohol consumption, such as frequency of drinking. Viken and colleagues (1999) showed higher heritabilities (37%-47%) and unique environmental influences (27%-32%), and smaller common environmental influences (35%-22%) for frequency of drinking than for initiation of alcohol use. In contrast, Rhee et al. (2003) found genetic effects for initiation while genes did not contribute to alcohol use. Differences in findings between Viken et al. (1999) and Rhee et al. (2003) might be due to differences in the assessment of alcohol use: Viken et al. assessed frequency of drinking with a categorized measure ranging from drinking never to drinking daily, while Rhee et al. defined alcohol use as having six or more drinks during one's lifetime. Moreover, differences in findings might also be explained by age differences between samples and cultural differences between the US and Finland.

Viken et al. (1999) and Rhee et al. (2003) examined initiation of alcohol use and frequency of drinking independently. Only two twin studies on adolescents' alcohol use applied a multivariate approach to explore the overlap in factors influencing variation in both initiation and continuation of alcohol use. Pagan et al. (2006) found common environmental factors to play an important role in the variance of initiation (about 60%), and a moderate role in the variance of frequency of use (about 30%), while genes explained a more or less equal part (respectively around 30% and 40%) of the variance in both initiation and frequency of use. Consequently, unique environmental factors explained about 10% of the variance in initiation of alcohol use and around 30% in the variance of frequency of use. Largely the same factors influenced both the variance of initiation and frequency of drinking. Genetic factors influencing the variance of initiation also explained 26% of the variance of frequency of drinking and common

Table 1

OVERVIEW OF UNIVARIATE AND BIVARIATE TWIN STUDIES ON INITIA-TION OF ALCOHOL USE AND FREQUENCY OR QUANTITY OF DRINKING

	Sample	Age	Measure	Sex and age differences	Univariate results a^2	c^2	Bi-variate results
Koopmans & Boomsma (1996)	Dutch	15-17+	initiation	15-16 17+	.34 .43	.58 .37	—
Han et al. (1999)	US	17-18	initiation	male female	.84 —	— .76	—
Maes et al. (1999)	US	13-16	initiation	—	—	.71	—
Viken et al. (1999)	Finnish	16-17	initiation frequency	16 17 16 17	.14 .26 .37 .47	.79 .67 .35 .22	—
Rose et al. (2001)	Finnish	14	initiation	male female	.18 —	.76 .76	—
Rhee et al. (2003)	US	12-19	initiation use[1]	— —	.39 —	.32 .45	—
Pagan et al. (2006)	Finnish	17	initiation frequency	— —	.30 .40	.60 .30	a 26% overlap c 66% overlap
Fowler et al. (2007)	UK	11-19	initiation quantity	— —	.26 .64	.65 —	in total 23% overlap

Note. [1] alcohol use was defined as having six or more drinks during one's lifetime.

environmental factors influencing the variance of initiation also explained 66% of the variance in frequency of drinking. Moreover, Fowler and colleagues (2007) reported comparable results for the variance of initiation (heritability 26%; common environment 65%). In addition to initiation of alcohol use they measured quantity of drinking during a typical week in the past year. Results indicated that the variance of quantity of drinking was largely predicted by genetic factors (64%) and for a smaller part by unique environmental factors (36%), while common environmental factors did not contribute to the variance of quantity of drinking. The variance of quantity of drinking was partly (23%) due to factors also affecting the initiation of alcohol use. In sum, both studies showed comparable results for initiation of alcohol use, but the results for continuation of use diverged.

Previous twin studies which tested for differences in genetic and environmental influences between males and females in adolescent samples revealed contradictory findings. Maes et al. (1999), Rhee et al. (2003) and Viken et al. (1999) did not find sex differences in the magnitude of genetic and environmental effects on the variance of initiation and alcohol use. In contrast, Han et al. (1999) reported higher heritabilities and smaller environmental influences on initiation of alcohol use in males than in females. Rose et al. (2001) found that heritabilities of initiation were higher for females than for males. Common environmental influences were equally important among males and females, while unique environmental factors were more important in males. Results with respect to qualitative sex differences (i.e., do the same or different factors operate in males and females) have also provided mixed results. While some twin studies on adolescent alcohol use reported that mainly the same genetic and common environmental factors operate in males as in females (Maes et al., 1999; Rhee et al., 2003; Rose et al., 2001), others indicated that partially different factors operate (Koopmans & Boomsma, 1996; Viken et al., 1999).

In the current study we examined the relative contribution of genes and environment to individual differences in initiation of alcohol use and frequency of drinking among early adolescents (12-15 years). This relatively young homogeneous group of adolescents was examined because the initiation of alcohol use is typical for early adolescents and should preferably be assessed in this age period. We examined whether the relative contribution of genes and environment differed between males and females and whether the same factors operated in males and females. Further, we tested the overlap in factors related to the variance of initiation of alcohol use and frequency of drinking.

METHODS

PARTICIPANTS

Data reported in this study are part of an ongoing longitudinal survey study of the Netherlands Twin Register. Since 1991, adolescent and young adult twins and their family take part in survey studies on health, lifestyle and personality roughly every two years. Twins were asked to participate every two years (1991, 1993, 1995, 1997, 2000, 2002 and 2004); parents in 1991, 1993, 1995, 2002 and 2004 and siblings from 1995 onwards. Some individuals participated only once, while others participated several times. Information about sample and data collection is described in detail in Boomsma et al. (2006; 2002).

In the present study we used data from the 1993, 1995, 1997 and 2000 surveys to create a large cross-sectional dataset. We selected all twins who were between 12 and 15 years of age in 1993, 1995, 1997 or in 2000. At this age, adolescents are experimenting with alcohol and may start to drink regularly, although in the Netherlands young people are legally not allowed to drink alcohol before the age of 16. Initially we used data on alcohol use of twin pairs from the 1993 wave, but if data of both twins were not available at this wave we used data of the 1995 wave. This was continued until we used data of all five measurement waves as a possible source to construct one cross-sectional dataset. In total, the sample consisted of 694 twin pairs within the age range of 12-15-years, of these pairs 125 were monozygotic males (MZM), 89 pairs were dizygotic males (DZM), 183 pairs were monozygotic females (MZF), 106 pairs were dizygotic females (DZF), and 191 pairs were dizygotic opposite sex (DOS). Zygosity was based on DNA polymorphisms, or if not available, on survey questions on the physical similarity of the twins and confusion in identifying twins by family members, friends and strangers. Agreement between zygosity based on DNA results polymorphisms and zygosity based on questionnaires is 97% (Willemsen et al., 2005).

INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING

To assess initiation of alcohol use the twins were asked at what age they first tried alcohol. Response categories were: (1) "never", (2) "11 or younger", (3) "12" - (8) "17", and (9) "18 or older". When examining the variation in initiation and frequency of use in multivariate, or so-called multiple-stage genetic models that allowed overlap of risk factors for both indicators of drinking, initiation should be defined as a multiple category trait (e.g., never versus early onset versus later

onset) instead of a binary variable (Heath et al., 2002; Pagan et al., 2006) or else estimates of genetic (or environmental) correlations between initiation and continuation of use might be biased (Heath et al., 2002). We therefore categorized initiation of alcohol use as follows: (1) "never initiated", (2) "at age 13 or after", and (3) "before age 13". This categorization was used because our participants were 12-15-years old and initiation before age 12 was less prevalent.

In the surveys, twins were also asked: "How often do you drink alcohol?". Twins could respond to this question on one of eight categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week", and (8) "daily" (Poelen et al., 2005). The frequency of alcohol use was recoded to : (1) "once a year or less", (2) "a few times a year", (3) "about once a month", (4) "a few times a month", (5) "once a week or more". Categories 6, 7 and 8 of the original measure were summarized into one category (new category 5). If participants did not drink alcohol, in other words, if they scored (1) "never initiated" on the initiation item, they consequently had a missing value on the frequency of drinking scale.

STRATEGY OF ANALYSES

Genetic model fitting was conducted with the software package Mx (Neale et al., 2003). We first calculated the polychoric correlations for twin pairs in all zygosity groups (MZM, DZM, MZF, DZF and DOS). Because initiation of alcohol use and frequency of drinking are categorical a liability model was used (Falconer and Mackay, 1996). A liability model assumes that a categorical trait reflects an underlying (latent) liability with a normal distribution (with unit variance) and thresholds that divide the sample into for example non-initiators, late initiators and early initiators. The thresholds are obtained from the prevalences and can be interpreted as a z-value. Polychoric correlations represent the resemblance of twins on the liability distribution. A comparison of MZ and DZ correlations provides insight into the relative contribution of genes and environment to the variation in initiation of alcohol use and frequency of drinking. A higher correlation among MZ twins than among DZ twins indicates genetic influences, but if the correlations among MZ and DZ twins are of similar magnitude, environmental factors, not genetic factors are the main determinants of individual differences in drinking behavior.

In order to examine the relative contribution of genes and environment to individual differences in initiation of alcohol use and frequency of drinking we used a structural equation modeling (SEM) approach. We modeled the variance of drinking as due to three latent

factors: (1) additive genetic effects (A), (2) common environmental effects (C), and (3) unique environmental effects (E) (Figure 1). Unique environmental effects also included measurement error. The estimation of the contributions of A, C and E (i.e., a, c and e) was based on the differences in genetic relatedness of MZ and DZ twins. In genetic model fitting the correlation between the latent A factors for MZ twins (r_A) was fixed to 1, while the correlation between A factors for DZ twins was fixed to .5. The correlation between the common environmental (r_C) latent factors was fixed to 1 and the unique environmental (E) latent factors were not correlated, for both MZ and DZ twins. Figure 1 presents the structural model used in our analyses. We tested whether the genetic and environmental factors related to the variation in initiation of alcohol use were also related to the variation in frequency of drinking and/or whether genetic and environmental factors were specific for the variation in initiation of alcohol use and frequency of drinking. Comparable types of multivariate modeling strategies are described by Heath et al. (2002) and Pagan et al. (2006), our modeling procedure was conform these studies.

The bivariate model tested in this study implies structural missing data for frequency of alcohol use in those twins who never initiated alcohol use. Related to these structural missing data, Heath et al. (2002) indicated that initiation should be defined using multiple categories (e.g., never versus early onset versus later onset) instead of two categories, to have enough information to estimate polychoric correlations between initiation of use (3 categories) and frequency of drinking (5 categories) (Heath et al., 2002). The approach outlined by Heath is based on the fact that the frequency of drinking data are Missing at Random (MAR) as the probability of missingness is determined by scores on initiation of alcohol use. Little and Rubin (2002) have shown that if missing data are MAR, Full Information Maximum Likelihood procedures provide unbiased parameter estimates and are recommended (Heath et al., 2002). Therefore, we used the Full Information Maximum Likelihood estimator to estimate the parameters in our models.

Models were fit directly to the raw data using Mx. We fitted the complete model as depicted in Figure 1 and tested whether model parameters for males and females were equal, by comparing the fit of a model in which all parameter estimates are allowed to be different in males and females with the fit of a model in which all parameter estimates are constrained to be equal in males and females. In addition to these tests for quantitative sex differences (i.e., differences in the magnitude of the parameter estimates), we examined qualitative sex differences (i.e., do different factors operate in males and females). Qualitative sex differences were investigated by comparing the fit of a

model which freely estimates the genetic correlation in DOS twin pairs with the fit of a model which constrains the genetic correlation at .5, as in same-sex DZ twin pairs. A decreased genetic correlation (lower than .5) in DOS twin pairs indicates that different genetic factors are related to initiation of alcohol use and frequency of drinking in males and females. In addition, we subsequently constrained the estimates for a, c, or e parameter specific for the variance of initiation or frequency of drinking at zero or one of the shared a, c or e parameters from the baseline model. The significance of the constrained parameters are tested by examining the change in −2 log likelihood between the baseline model and the sub model; this difference is evaluated using a chi-square distribution. A significant decrease in chi-square in the constrained model compared to the baseline model indicates a deterioration of the model fit if this particular parameter is not modeled, therefore this parameter should be included in the model.

Figure 1
BIVARIATE MODEL OF ALCOHOL INITIATION AND FREQUENCY OF DRINKING
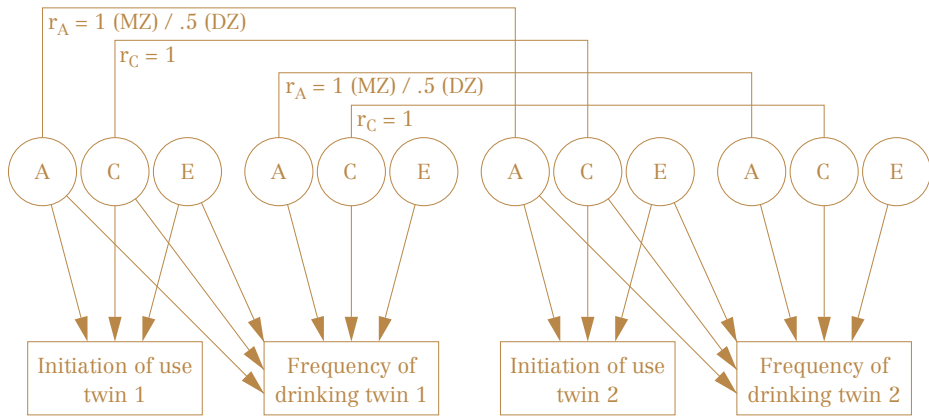
MZ, monozygotic; DZ, dizygotic
The variance of the observed variables initiation of alcohol use and frequency of drinking is due to three latent factors: (1) the additive genetic factor (A), (2) the common environmental factor (C), and (3) unique environmental factor (E). The correlation between the genetic (r_A) latent variable in twins was fixed at 1 for MZ twins and r_A was fixed at .5 for DZ twins. The correlation between the common environmental (r_C) latent factors was fixed at 1 for both MZ and DZ twin pairs.

RESULTS

DESCRIPTIVES

As can be seen from Table 2 the majority of our participants initiated alcohol use. Females less often initiated than males ($\chi^2(2) = 8.25$; $p = .016$). Around half of the participants who initiated alcohol use, started at age 13 or after, and around half started before the age of 13. A relatively small part of the adolescents who had initiated, drank alcohol a few times a month or more. The distribution of frequency of drinking among adolescents who had initiated was not significantly different in males and females ($\chi^2(7) = 7.98$; $p = .092$).

Table 2

PERCENTAGE OF INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING AMONG TWINS WHO HAVE INITIATED ALCOHOL USE BY SEX

	Males	**Females**
Initiation of alcohol use	**$n = 561$**	**$n = 727$**
Never	32.3	40.0
At age 13 or after	36.7	32.9
Before age 13	31.0	27.1
Frequency of drinking	**$n = 379$**	**$n = 433$**
Once a year or less	25.6	31.9
A few times a year	35.9	37.2
About once a month	10.6	9.5
A few times a month	15.3	9.9
Once a week or more	12.7	11.5

Table 3 depicts the correlations of initiation of alcohol use and frequency of drinking within twin pairs and between initiation and frequency of drinking of twin 1 and twin 2 for the five zygosity groups. For initiation of alcohol use, MZ twin correlations were higher than DZ twin correlations, indicating that genes played a role in the variance of initiation of alcohol use. For frequency of use, the correlations indicated common environmental influences on the variation, because the correlations were relatively high and the MZ and DZ correlations barely differed. The twin correlations for frequency of drinking for

DOS twins were relatively low compared to the correlations in same sex twin pairs, suggesting qualitative sex differences in frequency of drinking. The fact that the same picture arises for MZ and DZ twins indicates that the covariance between initiation and frequency of drinking is not likely to be explained by genetic factors. Correlations between initiation of alcohol use and frequency of drinking within one person and between co-twins were relatively low. Previous research also indicated low correlations between initiation of alcohol use and frequency of drinking within one person (Pearson correlation around .08) (Engels et al., 1997).

Table 3

NUMBER OF TWIN PAIRS IN EACH GROUP AND TWIN CORRELATIONS FOR INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING

	MZM $n = 125$	**DZM** $n = 89$	**MZF** $n = 183$	**DZF** $n = 106$	**DOS** $n = 191$
Initiation twin 1 - Initiation twin 2	.84	.60	.88	.66	.56
Frequency twin 1 - Frequency twin 2	.85	.77	.84	.79	.36
Initiation twin 1 - Frequency twin 1	.24	.31	.29	-.06	-.28
Initiation twin 2 - Frequency twin 2	.05	.11	.31	-.14	.14
Initiation twin 1 - Frequency twin 2	.22	.16	.33	.08	.02
Initiation twin 2 - Frequency twin 1	.13	.28	.24	-.09	.15

Note. MZM, monozygotic males; DZM, dizygotic males; MZF, monozygotic females; DZF, dizygotic females; DOS, dizygotic opposite-sex twins.

GENETIC ANALYSES

We examined the bivariate genetic model as shown in Figure 1. Table 4 shows the model fitting results, with the best fitting model in bold. The saturated model (Table 4, model 1) does not place any constraints on the covariance structure of MZ and DZ twins. The full genetic model (Table 4, model 2) allows for qualitative and quantitative sex differences. This model provides a good fit compared to the saturated model, indicating that a genetic model fits the data well. Next, we examined whether model parameters for males and females were different (quantitative sex differences) and whether different genetic factors were related to the variance of initiation of alcohol use and frequency of drinking in males and females (qualitative sex diffe-

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Table 4

BIVARIATE MODEL FITTING RESULTS FOR INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING

	-2LL	*n* par	vs	$\Delta\chi^2$ (df)	*p*
1. Saturated model	4630.15	90	—	—	—
2. ACE model with quantitative and qualitative[1] sex diff	4644.48	76	1	14.33 (14)	.43
3. ACE model, qualitative sex diff dropped	4644.48	74	2	0.00 (2)	>.99
4. ACE model, quantitative sex diff dropped	4654.38	69	2	9.90 (7)	.19
5. ACE model quantitative and qualitative sex diff dropped	4661.86	67	2	17.38 (9)	.04
6. ACE model, quantitative sex diff, shared A dropped	4646.67	72	3	2.20 (2)	.33
7. ACE model, quantitative sex diff, shared C dropped	4652.65	72	3	8.17 (2)	.02
8. ACE model, quantitative sex diff, shared E dropped	4644.93	72	3	0.45 (2)	.80
9. ACE model, quantitative sex diff, shared A and shared E dropped	4648.89	70	3	4.41 (4)	.35
10. ACE model initiation, CE model frequency, shared A and shared E dropped	**4652.94**	**68**	**9**	**3.95 (2)**	**.14**

Note. A, additive genetic variance component; C, common environmental variance component; E, unique environmental variance component. -2LL, -2 loglikelihood. *n* par, number of parameters. Vs, versus and indicates to which model the submodel is compared to.
[1] genetic correlation in dizygotic opposite-sex twins is estimated at the boundary of .5. Best fitting model in bold.

rences). Dropping qualitative sex differences from the model (Table 4 model 3) did not cause a significant change in the model fit, implying that the same genetic factors operated in males and females for both initiation and frequency of drinking. Dropping quantitative sex differences from the model (Table 4 model 4) did cause an decrease in the model fit, but this decrease was not significant. We also dropped quantitative and qualitative sex differences simultaneously from the model (Table 4 model 5), this did result in a significant decrease of the model fit. Thus, in subsequent models sex specific parameters were estimated. In addition we tested respectively whether the factor loading of the shared genetic factor, the shared common environmental factor and the shared unique environmental factor on initiation and frequency of drinking could be dropped from the model (Table 4 model 6, 7 and 8). Model fitting results showed that only the elimination of the loading of the shared common environmental factor on frequency of drinking caused a significant decrease in model fit, the other parameters could be eliminated without a significant decrease of the model fit. Thus, in subsequent models, the shared genetic and unique environmental parameters were not included. Finally, as the twin correlations suggested that there is no influence of genes on the variation in frequency of drinking, we dropped the genetic factor specific to the variation in frequency of drinking from the model (Table 4 model 10). The resulting model appeared to be the best fitting model.

Table 5 depicts the parameter estimates and 95% confidence intervals of the best fitting model. For males the common environmental factor loading specific for the variance of initiation of alcohol use and the common environmental factor loading specific for the variance of frequency of drinking were not significant. For females the common environmental factor loading on both initiation and frequency was not significant (confidence intervals of these factor loadings included zero). These insignificant factor loadings were retained in the model. As constraining these factor loadings to zero would result in a cross-twin correlation of zero for frequency of drinking and in a cross-twin cross-trait correlation of zero for initiation and frequency of drinking in DOS twins. Table 5 also presents the percentages of explained variance for initiation of alcohol use and frequency of drinking. Among males 83% of the variance of initiation of alcohol use was explained by additive genetic factors, 15% was explained by unique environmental factors. In females the largest part of the variance of initiation of alcohol use was explained by additive genetic factors (70%), 19% was explained by common environmental factors and 11% by unique environmental factors.

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In males the same common environmental factor that explained a small part of the variance of initiation of alcohol use also explained the largest part (81%) of the variance of frequency of drinking. Another 18% of the variance in frequency of drinking in males was explained by unique environmental factors specific to frequency of drinking. In females the overlapping common environmental factor explained a smaller part of the variance (13%) in frequency of drinking than in males. However, the variance of frequency of drinking in females was also for the largest part explained by common environment as specific common environmental factors explained 69% of the variance. The remaining part of the variance in frequency of drinking in females was explained by unique environmental factors (18%).

Table 5

PARAMETER ESTIMATES OF THE BEST-FITTING MODEL AND 95% CONFIDENCE INTERVALS AND PERCENTAGES OF EXPLAINED VARIANCE FOR SPECIFIC AND SHARED A, C AND E FACTORS LOADING ON INITIATION OF ALCOHOL USE AND FREQUENCY OF DRINKING

	A		C		E	
	a (C.I.)	%	c (C.I.)	%	e (C.I.)	%
Males						
Specific for Initiation	.91 (.84-.95)	83%	.15 (-.08-.37)	2%	.38 (.29-.48)	15%
Specific for Frequency	—	—	.10 (-.64-.55)	1%	.43 (.34-.53)	18%
Shared factors	—	—	.90 (.71-.94)	81%	—	—
Females						
Specific for Initiation	.84 (.69-.93)	70%	.44 (.18-.64)	19%	.33 (.26-.41)	11%
Specific for Frequency	—	—	.83 (.21-.93)	69%	.42 (.34-.52)	18%
Shared factors	—	—	.35 (-.12-.89)	13%	—	—

Note. A, additive genetic influences; C, common environmental influences; E, unique environmental influences. The percentages of explained variance were obtained by squaring the standardized loadings.

DISCUSSION

The present study assessed the relative contribution of genes and environment to individual differences in initiation of alcohol use and frequency of drinking among early adolescents (12-15-years old). The modeling procedure we used allowed a test of whether and to what degree the same factors were related to individual differences in initiation of alcohol use and frequency of drinking. Results showed that genetic factors were most important in explaining the variance of initiation of alcohol use, as they explained 83% of the variance in males and 70% of the variance in females, and that a much smaller part of the variance was explained by common environmental factors (2% in males and 19% in females). In contrast, common environmental factors explained most of the variance of frequency of drinking (82% of the variance in both males and females), while genetic factors were not involved in the explanation of the variance of frequency of drinking. In males, these factors almost completely overlapped with the factors explaining variation in initiation of alcohol use, while in females variation in frequency of drinking was mainly predicted by common environmental factors specific to frequency of drinking. Our analyses showed that only common environmental factors influencing variation in initiation of alcohol use overlapped with common environmental factors influencing variation in frequency of drinking, while genetic and unique environmental factors did not overlap. Our findings further indicated that parameter estimates were different for males and females, but that the same genetic and common environmental factors operate in males and females.

Our finding that genetic factors are important in explaining the variance of initiation of alcohol use is partly in contrast with previous studies which showed that the variance of initiation of alcohol use was moderately heritable and largely explained by common environmental influences (Fowler et al., 2007; Koopmans & Boomsma, 1996; Maes et al., 1999; Pagan et al., 2006; Rhee et al., 2003; Rose et al., 2001; Viken et al., 1999). The difference between our findings and those of these previous studies may be explained by age differences between samples. Most previous studies examined mainly older adolescents or examined adolescent samples that were less homogeneous in age (i.e. samples included also older adolescents), while we examined early adolescents as the experimentation with drinking is typical for early adolescents and should preferably be assessed in this age period. We defined early initiation as starting to use alcohol before the age of 13. In contrast to other previous studies, our definition of

initiation of alcohol use apparently discriminated between the more problematic (and genetically induced) early adolescent onset and less problematic behaviors (later onset and abstinence until at least 16).

Our finding that common environmental factors mainly affected the variance of frequency of drinking in 12-15-year olds is in line with the findings of Rhee et al. (2003), but in contrast with others (e.g., Pagan et al., 2006; Viken et al., 1999). Common environmental factors are those influences from the environment that twins have in common and make them similar to each other. During early adolescence, twins are likely to spend a lot of time with their families and have shared experiences at school and with friends. Therefore, it is likely that shared familial influences and peer influences were incorporated in the common environment. Dutch figures show that about half of the adolescents report to drink with their parents at age 12-13. This percentage remains rather stable during adolescence (NIGZ, 2006). Many Dutch parents allow adolescents to drink alcohol at home and it is likely that they provide the same rules regarding drinking for their twins (e.g., Van Der Vorst et al., 2005). Moreover, peer influences are also considered to be important factors in adolescents' alcohol use (e.g., Andrews et al., 2002; Petraitis et al., 1995; Urberg et al., 1997). Peer influence will operate as common environmental influence when twins share peers or have similar experiences with peers. Indeed, in our sample 24% indicated to share all friends and 44% of the twins shared at least part of their friends. Our findings indicated that in males the same common environmental factors explained variation in initiation and frequency of drinking. In females, different factors from the common environment mainly explained variation in initiation and frequency of drinking. This finding implies that for a part different common environmental factors explain the variance in frequency of drinking in males and females. We can only speculate about what factors in the common environment are different for males and females. The sex difference might have it's origin in differences in pubertal development in early adolescence (i.e., girls mature faster) (Dick et al., 2000). Adolescents tend to form an identity independent from their parents and foster tighter bonds with their peers during adolescence. Girls do this earlier than boys, because they mature earlier, and girls at that age may therefore be more influenced by their peers than boys. Studies on this topic showed that early matured girls are likely to affiliate with older and deviant peers (Caspi et al., 1993). Previous analyses of our data indeed showed a trend being indicative that friends' drinking was a greater risk factor for drinking in females compared to males (Scholte et al., 2008).

Unique environmental factors explained only a relatively small part in the variance of both initiation of alcohol use and frequency of drinking. This probably reflects tendencies that during early adolescence twins still spend a lot of time with their families and have shared experiences at school and with friends. It also implies a small contribution of measurement error, which shows that we use reliable indicators of initiation and frequency of drinking.

Estimates of explained variances of initiation of alcohol and frequency of drinking considerably differ between different twin studies. Differences in estimates of genetic and environmental influences are likely to be explained by cultural differences between samples and the definition or measurement of alcohol use (see also Table 1). Our study was the first that showed the genes were most relevant in explaining the variance in early initiation of alcohol use. Therefore, we encourage other scholars with twin data also to examine early adolescent onset of alcohol use to determine whether our findings can be confirmed in other samples.

A few limitations of our study need to be mentioned. We obtained the largest possible sample size by using several measurement waves of longitudinal survey data to create a cross-sectional data set. While constructing this data we assumed that it was not likely that cohort effects in genetic or environmental influences on drinking occurred in this period of seven years. This cross-sectional approach does not allow us to draw conclusions on predictors of development of individual drinking patterns. Furthermore, while interpreting our results it should be noted that initiation of alcohol use was assessed by asking participants at what age they first tried alcohol. This makes it conceivable that initiation is in fact experimentation (which may lead to initiation). Table 2 shows that 25.6% of the boys and 31.9% of the girls who indicated that they have tried alcohol drink only once a year or less, these adolescents probably only have experimented and have not actually initiated (yet). The other adolescents who indicated that they have tried alcohol drink at least a few times a year and have actually initiated alcohol use. Moreover, it should be noted that we assessed frequency of drinking and not quantity of drinking. Descriptive statistics of quantity of drinking show that the vast majority of 12-15-year-old adolescents drink less than one drink a week (this was the lowest category on this measure; see also Poelen et al., 2005). So most of the participants in this age category drink in relative low doses. The frequency of drinking measure shows more variance in this age group (see Table 2) and is therefore more suitable for the analyses we applied in this study. However, frequency of drinking and quantity of drinking are significantly correlated (r (n = 539) = .57, p < .001). When children

have their first drinks within a family context at special occasions like New Year's Eve, or within a deviant peer context where they drink with (older) friends, this might have different meanings and consequences, with the latter indicative of a deviant-prone orientation (Moffitt, 1993). Future research should reveal whether also genetic and environmental effects on alcohol initiation differ for these groups. It is also relevant to pay attention to the fact that in the Netherlands and also other Northern European countries such as the United Kingdom and Denmark adolescents start drinking regularly at a younger age than in most other western countries such as the United States. Young people in the Netherlands may start drinking regularly at a relatively young age, because of permissive attitudes of parents towards drinking (Van Der Vorst et al., 2005) and the cultural embedding of alcohol use in the Netherlands (Engels & Knibbe, 2000). Moreover, twin studies have shown that estimates of genetic and environmental influences depend upon the age of onset of regular drinking (e.g., Hopfer et al., 2003; Rose & Dick, 2005). This implies that the relative high drinking levels in the Netherlands and some other Northern European countries might affect the generalizability of our findings. Therefore, we suggest for future research to test models with A, C and E influences on initiation of alcohol use and frequency of drinking in countries with similar drinking cultures to the Dutch and in countries with different drinking cultures than the Dutch. In addition, the prevalence data from a study by Currie et al. (2004) presented in the introduction section seem to be higher than our prevalence rates of frequency of drinking (Table 2). However, it should be noted that differences in age between samples and differences in measurements cause this discrepancy in prevalence rates.

CHAPTER

6

BEST FRIENDS AND ALCOHOL CONSUMPTION IN ADOLESCENCE: A WITHIN-FAMILY ANALYSIS

ABSTRACT

Although friends and siblings are considered to be important role models in adolescents' peer contexts, these peer influences on adolescent alcohol consumption over time are seldom examined simultaneously in a within-family design. The present study examined the relative impact of alcohol use of the best friend, adolescent sibling and sibling's best friend on the development of alcohol consumption during adolescence. Data reported in this study are part of an ongoing longitudinal questionnaire study among families with two adolescent siblings (N = 416). Results from structural equation modeling showed a strong similarity in drinking between best friends and adolescents cross-sectionally. Over time, however, only marginal effects of friends alcohol use on drinking of the youngest sibling, and no effects for the oldest sibling were found. Robust evidence was found for peer-selection processes. In addition, we found a moderate to high relative similarity in drinking within sibling pairs, but no longitudinal effect of sibling's drinking. We also found no support for a possible additional influence of sibling's best friend's drinking on adolescent drinking. Therefore, we tested several potential moderating variables on peer influences, but found no effects of a set of relationship characteristics or individual characteristics on the links between peer and adolescent drinking over time.

INTRODUCTION

In their review on prevailing theories explaining adolescent involvement in drug use Petraitis et al. (1995) stated that peer influences are the most consistent and strongest factors. Moreover, following the homophily theory of Lazarsfeld and Merton (1954), many have argued that peer influence is a major cause of initiation and persistence of alcohol consumption (e.g., Duncan et al., 2005; Schulenberg et al., 1999; Urberg et al., 1997). Survey studies have shown a strong similarity in drinking between friends (e.g., Andrews et al., 2002; Beal et al., 2001; Bogenschneider et al., 1998; Engels et al., 1999; Gaughan, 2006; Kandel, 1980), and also for example in educational and occupational aspirations (Duncan et al., 1968), which is often interpreted as the result of a young person's tendency to adjust to peer norms. This interpretation is emphasized by experimental studies showing strong effects of alcohol consumed by a confederate on individual drinking (see review by Quigley & Collins, 1999). Thus, when people are often in the company of drinking friends, the direct impact of imitation, as well as the more indirect impact through the role of group norms, on alcohol use might lead young people to adjust their behavior to group norms. The period of adolescence is characterized by an increase in time spent with peers, and young people have a strong need for social approval, group membership, and close friends (e.g., Hartup, 1996). Therefore, persons are generally more susceptible to conform to prevailing norms in the teenage years than in any other period (Finkenauer et al., 2002), making them vulnerable to initiate or maintain risky habits such as heavy drinking.

All this may produce a picture which allows to assume that friends' drinking is a strong predictor of adolescents' alcohol use. However, longitudinal research correcting for past drinking and peer-selection processes reveals a different perspective. Longitudinal studies have shown that alcohol consumption of best friends, classmates, intimate partners, members of the immediate peer group, or other peers does not substantially explain changes in juvenile drinking over time (e.g., Andrews et al., 2002; Bauman & Ennett, 1996; Bot et al., 2005a; Fisher & Bauman, 1988; Gaughan, 1999; Urberg et al., 1997). For example, in a longitudinal study on the effects of best friend's alcohol use and sexual behavior on the changes in individual behavior in a sample of 13 to 17-year-olds, Jaccard et al. (2005) conclude that close friends and other peers are less relevant in affecting adolescent risk behaviors than is often assumed. Although they carefully examined various moderator variables (such as parental behavior

and quality of friendship), strong effects of best friend's drinking on adolescent use over time were lacking. Thus, the influence of friend's drinking in adolescent alcohol use might not be as robust as is often assumed.

SIBLING'S ALCOHOL USE

Most studies on the role of peers in adolescent alcohol consumption ignore the fact that siblings are an important source of influence for many adolescents (Engels et al., 2005; Epstein et al., 1999). Particularly when siblings are close in age and spend time together at home or outside the home without parental supervision, siblings can act as important role models. Cross-sectional studies have shown similarities in drinking between adolescent siblings (e.g., Brook et al., 1990; D'Amico & Fromme, 1997; Duncan et al., 1996; Windle, 2000). Conger and Reuter (1996) suggest that siblings also play an indirect role in adolescents' alcohol use; i.e. siblings' drinking tends to affect adolescents' selection of drinking friends, which in turn predicts adolescents' alcohol use later in adolescence (see also Stormshak et al., 2004). In contrast to effects of friends' drinking which might stem from peer selection or peer influence processes, the effects of siblings' drinking cannot stem from selection effects.

Besides friends and siblings, other peers might play a role in adolescent's social environments. Adolescents interact not only with their own friends, but also with friends of their siblings. Thus, in addition to alcohol use of friends and siblings as important sources for adolescent drinking, sibling's best friends might also play a role in adolescent's drug use. As with friends and siblings, the alcohol norms and actual drinking of the friends of siblings might have not only an indirect effect on the other sibling's behavior but also directly, especially if the contacts between friends and siblings are intense.

In summary, we postulate that the role of best friend's drinking in adolescent use should be examined taking into account the effect of selective peer affiliation and sibling's drinking on individual use, as well as the effects of the sibling's best friend's use on the other sibling's drinking. There are conflicting results concerning the relative value of peer influences on adolescent's alcohol use. Therefore it is important that future longitudinal studies on peer influences control for (a) previous individual drinking levels, (b) peer-selection processes, and (c) influence of sibling's drinking. The current study examines the effects of best friend's alcohol use on the development of drinking using longitudinal data of a within-family study including two adolescent siblings.

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MODERATING FACTORS

Not all adolescents are affected in similar ways by the prevailing behaviors and norms in their immediate social environments. Some adolescents may be more susceptible to peer pressure than others (e.g., Bot et al., 2005; Engels et al., 2005). Urberg et al. (2003) stressed that relationship characteristics (such as friendship quality), and individual characteristics (such as the personality factor sensation seeking) may place young people at extra risk to adopt their peers' behaviors. For relationship characteristics, there is some evidence that adolescents who have few conflicts in their friendships (Urberg et al., 2003), have friends with high social status among classmates (Bot et al., 2005a), and have a positive quality of friendship (Jaccard et al., 2005) are more likely to be susceptible to peer pressure. For individual characteristics, several personality factors have been found to be related to susceptibility to peer influences (Engels et al., 2005 and Vitaro et al., 2000). We focus on the Big Five personality factors (e.g., Dubas et al., 2002), because the Big Five represent the most important dimensions of personality. In sum, individual differences in susceptibility to peer influences may be explained by relationship characteristics and individual characteristics, and need to be taken into account when studying the link between peer and adolescent alcohol use.

DRINKING STAGES

As with other types of drug use, alcohol consumption may be regarded as a developmental process in which different stages are identified (Werch, 2001). Some argue that the predictors of adolescents' future drinking patterns may differ across the stages of drinking acquisition (e.g., Aas et al., 1998). In line with this hypothesis, the effects of peer drinking on individual drinking might vary depending on adolescents' drinking experience. Indications have been found for possible differences in peer influences across different stages of drinking acquisition (Ellickson and Hays, 1991; Reifman et al., 1998). Particularly the initiation of alcohol use is likely to be affected by drinking among friends (see Spijkerman et al., 2006), whereas adolescents who experimented with alcohol are more likely to continue drinking not only to acquire a positive social image associated with drinking friends, but also because of other factors such as the social and enhancement consequences of alcohol use (Kuntsche et al., 2005).

THE PRESENT STUDY

Data from a 12-month two-wave prospective study among 416 sibling pairs were used to examine whether best friend's drinking is related to adolescent use. We also tested whether sibling's alcohol use as well as sibling's best friend's use is related to individual drinking over time. In these analyses, we controlled for possible peer-selection processes by including links between adolescent's drinking at the first wave, and friend's drinking at the second wave (see Engels et al., 1999; Sieving et al., 2000). Possible differences in findings with regard to same-sex and opposite-sex sibling pairs, and differences in the relative popularity of friends between siblings were examined. In addition, we tested whether the associations between friend's and adolescent's drinking over time would be stronger in high-quality friendships. We also tested whether the Big Five personality factors (e.g., Dubas et al., 2002), such as extraversion or agreeableness, affected the magnitude of peer influences. Finally, the associations between friend's and adolescent's drinking were examined in a group of adolescents who were abstainers at the first wave, and in the group of adolescents who were drinkers at the first wave. This enabled us to draw conclusions on differences in predictors of changes at distinctive stages in the drinking acquisition process.

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METHODS

PROCEDURE AND PARTICIPANTS

Data in this study were collected as part of a longitudinal questionnaire study called "Family and Health", which was designed to examine socialization processes underlying several health behaviors in adolescents. In this project families with at least two adolescent siblings aged between 13 and 16 years were invited to take part. The addresses of these families were derived from registers of 22 municipalities in the Netherlands. Approximately 5000 families were approached by mail, they were asked if all family members would be willing to become involved in all subsequent measurement waves, and 885 of these families agreed to participate. Families were included if adolescents and their parents were biologically related, and parents had to be married or living together. In addition, families with twins or with offspring with mental or physical disabilities were excluded from the study. Furthermore, families were selected to obtain an equal distribution of education levels and sibling dyads (i.e., boy-boy, boy-girl, girl-girl, girl-boy). All four family members individually filled out the questionnaires at their home in the presence of a trained interviewer. The participants were not allowed to discuss the questions or answers with each other. Finally, 428 families participated in this longitudinal study at the first wave (T1) and 416 participated one year later at the second wave (T2). The data of the adolescent siblings participating in both waves were used in the current study.

At the first wave the mean age of the older siblings was 15.22 (*SD* = .60) years (range 14 to 17 years), and that of the younger siblings was 13.36 (*SD* = .50) years (range 13 to 15 years). The sex of both siblings was almost equally distributed: 52.8% older boys and 47.7% younger boys at the first wave. The sample consisted of 108 boy-boy dyads, 118 boy-girls dyads, 96 girl-boy dyads and 106 girl-girl dyads (See Table 1). The majority of the participating adolescents were of Dutch origin (> 95%). At the first wave, approximately one-third of both siblings attended special or low education, one-third attended intermediate general education, and the remaining adolescents attended college or university. For further details of the sample and data collection see Harakeh et al. (2005) and Van Der Vorst et al. (2005).

MEASURES

Alcohol consumption. Both siblings were asked how often they consumed alcohol in the previous four weeks. They had to respond on a 6-point scale ranging from (1) "have not been drinking" to (6) "every day" (Engels & Knibbe, 2000). Because of low frequencies in the last three categories, these were summed into one category. Quantity of drinking was assessed by the number of alcoholic beverages the siblings had consumed in the previous week during weekdays and in weekends, separately for the contexts at home and outside the home (Engels et al., 1999). By asking about these four specific situations, respondents are forced to actively recall episodes in their memory, which is supposed to increase the reliability of response (Bot et al., 2005b). The scores on these four questions were summed to obtain the total number of glasses of alcohol each sibling consumed in the previous week before administration of the questionnaires. Because of the skewness of these scores, we divided the quantity of drinking into four categories: (1) "0 glasses", (2) "1 to 3 glasses", (3) "4 to 9 glasses", (4) "more then 10 glasses."

Table 1

*DESCRIPTIVE OVERVIEW OF THE SAMPLE (MEANS, STANDARD
DEVIATIONS AND PERCENTAGES) AT TIME 1*

	%	M	SD
Age oldest T1		15.22	0.60
Age youngest T1		13.36	0.50
Sex (N=428)			
Oldest male	52.8		
Oldest female	47.2		
Youngest male	47.7		
Youngest female	52.3		
Siblings dyads (N=428)			
Boy - boy	25.2		
Boy - girl	27.6		
Girl - boy	22.4		
Girl - girl	24.8		
Relative popularity of friends oldest T1 (N=428)			
Friends sibling more popular	16.4		
Friends sibling as popular	20.3		
Friends sibling less popular	63.3		
Relative popularity of friends youngest T1 (N=428)			
Friends sibling more popular	21.3		
Friends sibling as popular	32.5		
Friends sibling less popular	46.3		
Quality relationship with best friend oldest T1		4.00	0.59
Quality relationship with best friend youngest T1		4.02	0.61
Extraversion oldest T1		4.83	1.10
Extraversion youngest T1		4.89	1.00
Conscientiousness oldest T1		4.24	1.15
Conscientiousness youngest T1		4.03	1.08
Agreeableness oldest T2		5.48	0.63
Agreeableness youngest T1		5.31	0.76
Emotional stability oldest T1		4.34	0.93
Emotional stability youngest T1		4.26	0.97
Openness oldest T1		4.85	0.85
Openness youngest T1		4.74	0.84

Note. M, means; SD, standard deviations. The scale Quality relationship with best friend ranged from 1 "not true at all" to 5 "very true". The scales of the Big Five personality characteristics ranged from 1 "absolutely disagree" to 7 "absolutely agree".

Best Friend's Alcohol Use. Adolescents were asked to write down the full first name and the first letter of the last name of their best friend. We explicitly asked them not to give the name of an intimate partner. They were then asked to fill out almost identical items for their friends concerning the frequency and quantity of alcohol use as for themselves.

To establish whether the adolescents were relatively accurate in their reports about their friends drinking habits, we gathered data among the adolescent friends in a sub-sample. At the second wave, 301 of the mentioned friends filled out a questionnaire on (amongst other items) their own drinking behavior. Comparison of the scores on best friend's drinking reported by the participant and best friend's self-reports, revealed relatively high agreement (for a similar strategy, see Harakeh et al., 2006; Wilcox and Udry, 1986). Concerning the oldest adolescent, 67% had similar scores for drinking at least weekly (χ^2 (1, 147) = 20.94, $p < .001$), and 73% for drinking at least 4 glasses per week (quantity) (χ^2 (1, 147) = 29.81, $p < .001$). Concerning the youngest adolescent, 74% had similar scores for drinking at least weekly (χ^2 (1, 148) = 18.83, $p < .001$), and 80% for drinking at least 4 glasses per week (χ^2 (1, 148) = 15.76, $p < .001$).

Relative Popularity of Friends. A part of the Sibling Inventory of Differential Experience (SIDE; Daniels & Plomin, 1985) was employed to examine potential sibling differences in the popularity of friends. In the present study we used the subscale Differential Peer Popularity; this has 5 items with answers ranging from 1 "My sibling has had a peer group much more like this than my peer group", 3 "My sibling and I have had the same type of peer group in this way" and 5 "I have had a peer group which is much more like this than my sibling's peer group". The participants had to give responses to the following items: popular, outgoing, extraverted, friendly, achieving "status" in social situations, and having a boy/girlfriend. The reference period was the last 12 months. At T1 the alphas were .61 (oldest adolescent) and .60 (youngest adolescent).

Quality of Relationship with the Best Friend. The quality of relationship at T1 was measured by an adaptation of an instrument developed by Rusbult et al. (1998). This scale consists of 8 statements about the extent to which a person is satisfied with and committed to the relationship with his/her best friend. Examples of questions are: "The relationship with my best friend is almost perfect" and "I am very committed to the relationship with my best friend". Response categories ranged from 1 "not true at all" to 5 "very true". Cronbach's alpha was .89 for the oldest adolescent and .90 for the youngest adolescent.

Personality. Personality traits at T1 were measured with the factors of the Five-Factor Model of Personality (e.g., Dubas et al., 2002). In a list consisting of 30 traits, participants were asked to rate on a 7-point

scale to what degree he/she possessed the specific trait. The dimension *extraversion* was assessed with items such as quiet, withdrawn and shy ($\alpha = .84$ (oldest adolescent) and .77 (youngest adolescent)). The dimension *conscientiousness* was measured by items such as organized, orderly and efficient ($\alpha = .85$ (oldest adolescent) and .84 (youngest adolescent)), *agreeableness* with items such as kind, likeable and cooperative ($\alpha = .77$ (oldest adolescent) and .79 (youngest adolescent)), *emotional stability* with items such as nervous, fearful and sensitive ($\alpha = .73$ (oldest adolescent) and .75 (youngest adolescent)), and *openness* with items such as creative, artistic and versatile ($\alpha = .70$ (oldest adolescent) and .65 (youngest adolescent)). Responses ranged from 1 "absolutely disagree" to 7 "absolutely agree". For information concerning the psychometric properties of this shortened version of the Big Five questionnaire, we refer to Akse et al. (2004) and Dubas et al. (2002).

STRATEGY FOR ANALYSES

Descriptive analyses were conducted to calculate the means and standard deviations for the alcohol measures of siblings and friends. Pearson correlations were calculated to examine the associations between sibling's and friend's drinking cross-sectionally and longitudinally.

To test our models we used structural equation modeling (SEM) with the software package MPlus (Muthén & Muthén, 2001). First, we tested the initial model with alcohol use of both siblings and their best friends. At T1 and T2, latent variables for best friend's and sibling's alcohol use were defined by two indicators: frequency and quantity of drinking. Error terms of corresponding indicators between T1 and T2 are allowed to correlate. As Byrne states: "Given the known possibility of memory carryover effects associated with measuring instruments, such correlated error parameters would appear to be perfectly reasonable" (Byrne, 1998, pp. 359-360). Because siblings reported on their best friend's alcohol consumption, error terms of corresponding indicators of sibling's and best friend's drinking were also allowed to correlate within one measurement wave.

Cross-sectional relations between latent variables and stability relations over time between corresponding latent variables were tested. The question whether alcohol use of best friends and siblings at T1 were related to adolescent drinking at T2, was examined with cross-lagged panel analysis (Finkel, 1995). Cross relations over time allow to test causal predominance: Is best friend's drinking the 'cause' of sibling's drinking, or can sibling's drinking be seen as the 'cause' of best friend's drinking (Byrne, 1998).

In addition, we tested whether the parameters differed for same-sex and opposite-sex sibling pairs, for boy-boy, girl-girl and opposite-

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sex sibling pairs, and for adolescents whose friends were more popular, as popular, or less popular than those of their sibling. We examined the similarities in reports of the older and younger sibling's relative peer popularity. This agreement was not high enough (Cramer's V was .23; $p < .001$) to use one model with three groups instead of using one model with perceptions of the younger adolescent on relative peer popularity and one model with reports of the younger adolescent.

Second, a series of analyses focused on testing the models separately for data of the oldest and youngest adolescent. We did this to be able to test moderating effects of quality of friendship and personality of the individual sibling. Thus, for all participants, associations between the best friend's use and the adolescent's use over time were tested in the separate samples of older and younger siblings.

Moderation effects of gender, relative popularity of friends, quality of friendship, and personality on cross-lagged effects were tested by multi-group analysis (Bollen, 1989). The cross-lagged model for same-sex siblings was compared with the one for opposite-sex siblings. For the Big Five personality variables, two groups were formed using a median split, resulting in a group with lower scores on one particular Big Five variable and a group with higher scores on the same variable. A similar strategy was carried out for the relative popularity of friends and quality of friendship. Differences in structural paths between the two groups were compared with chi-square difference tests.

Third, we tested whether the model parameters differed for abstainers at T1 and drinkers at T1. Thus, we computed two models, for each sibling separately, with one including abstainers at T1 and predicting initiation of alcohol use at T2, and one including drinkers at T1 and predicting continuation of or increase in alcohol use at T2. The model for drinkers and the model for abstainers basically differ, because drinking at T1 in the abstainers models is omitted from the model, because there is no variance at T1 on this variable. While the drinkers model does contain the drinking variable at T1 (thus incomparable models), this makes it impossible to statistically test the differences between these models, because models have to be identical.

Because all variables were relatively skewed and the measurement levels were more ordinal (ordered categorically) than interval, maximum likelihood estimation methods (demanding multivariate normality of the scores) were less suitable. Instead, we applied the Weighted Least Square with adjusted Means (WLSM) estimator, an estimation method specifically developed for ordered categorical dependent variables (Muthén & Muthén, 2001). Standard chi-square tests are replaced by robust chi-square variates to test model fit.

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Together with the robust chi-square variates we used two fit measures recommended by several authors: the Root Mean Square Error of Approximation (RMSEA; Byrne, 1998), and the Comparative Fit Index (CFI) of Bentler (Marsh et al., 1996). RMSEA is utilized to assess approximate fit preferably with values less than or equal to .05, but values between .05 and .08 are indicative of fair fit (Kaplan, 2000, p.113-114). CFI is a comparative fit index, values above .95 are preferred (Kaplan, 2000, p. 107), but should not be lower than .90 (Kline, 1998).

Because differences between robust chi-square variates do not have a standard chi-square distribution, the robust chi-square values are first rescaled to standard chi-square values according to the procedure as described in Satorra and Bentler (1999) and Muthén and Muthén (2001).

Table 2
MEANS (M), STANDARD DEVIATIONS (SD) AND SAMPLE CORRELATIONS OF THE MODEL VARIABLES AT TIME 1 AND TIME 2

	M	SD	1.	2.	3	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Frequency oldest T1	2.13	.90															
2. Frequency oldest T2	2.32	.89	.41														
3. Frequency youngest T1	1.56	.74	.31	.20													
4. Frequency youngest T2	1.81	.80	.28	.32	.52												
5. Frequency friend oldest T1	2.22	.85	.59	.32	.17	.24											
6. Frequency friend oldest T2	2.38	.87	.36	.53	.20	.23	.43										
7. Frequency friend youngest T1	1.61	.80	.21	.19	.49	.36	.19	.22									
8. Frequency friend youngest T2	1.86	.79	.19	.16	.38	.48	.14	.12	.43								
9. Quantity oldest T1	4.37	6.81	.53	.33	.22	.20	.43	.29	.21	.13							
10. Quantity oldest T2	7.15	10.62	.37	.54	.19	.22	.32	.40	.19	.18	.51						
11. Quantity youngest T1	1.23	3.41	.15	.17	.57	.32	.12	.14	.37	.23	.22	.18					
12. Quantity youngest T2	3.12	8.36	.11	.20	.40	.42	.11	.17	.33	.35	.22	.21	.57				
13. Quantity friend oldest T1	4.82	7.68	.35	.23	.14	.15	.53	.30	.18	.10	.72	.39	.20	.22			
14. Quantity friend oldest T2	6.43	12.40	.20	.28	.15	.15	.14	.38	.09	.12	.27	.73	.08	.14	.25		
15. Quantity friend youngest T1	1.51	2.81	.14	.19	.44	.31	.11	.17	.65	.33	.18	.11	.45	.42	.15	.09	
16. Quantity friend youngest T2	2.84	6.22	.19	.20	.36	.36	.08	.19	.34	.44	.16	.26	.42	.63	.19	.21	.37

Note. All Pearson correlations were significant at $p < .05$, except correlations of .10 and below.

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RESULTS

DESCRIPTIVE ANALYSES

As shown in Table 2, at T1 the older siblings on average drank more often than the younger ones ($t_{\text{wave 1}}$ (424) = 11.85, $p < .001$), and also one year later ($t_{\text{wave 2}}$ (422) = 10.36, p < .001). The increase in the frequency of drinking was significant for both siblings (t_{oldest} (422) = 3.79, $p < .001$ and t_{youngest} (424) = 6.70, $p < .001$). Table 2 shows comparable results for the frequency of drinking of the best friends of both siblings. Moreover, at T1 120 older siblings reported that did not drink alcohol, two years later 70 adolescents (58.3%) had initiated alcohol use, among the younger adolescents 40.7% (98 of 241 adolescents) had initiated alcohol use in the time between the first and the second wave.

In addition, the older siblings consumed 4.37 drinks a week at T1 (ranging 0 to 51 glasses). One year later at T2, alcohol use of the older siblings increased to an average of 7.15 glasses a week (range 0 to 56 glasses). At T1 the younger siblings drank on average 1.23 glasses a week (range 0 to 36 glasses) and T2 this had increased to 3.12 drinks a week (range 0 to 72 glasses). The rise in alcohol consumption of both siblings was significant (t_{oldest} (407) = 6.50, $p < .001$ and t_{youngest} (423) = 5.94, $p < .001$). Siblings differed in the quantity of drinking at both waves ($t_{\text{wave 1}}$ (417) = 9.30, $p < .001$ and $t_{\text{wave 2}}$ (412) = 8.24, $p < .001$). Moreover, the figures in Table 2 on the quantity of drinking for best friends of both siblings were comparable to those of the siblings themselves.

Table 2 seems to indicate that the means of friends' alcohol use were slightly higher than the means of drinking of adolescents themselves. We conducted t-tests to examine whether differences in means were significant; the results ranged from t (368) = -0.23, $p = .897$ to t (407) = -1.74, $p = .082$, indicating that reports of friends' drinking and adolescents own drinking did not significantly differ.

SIMILARITIES IN DRINKING BETWEEN SIBLINGS AND FRIENDS

Concerning the relative similarity in drinking among siblings, data showed moderate correlations (ranging from .21 to .31, $p < .001$) between the frequency and quantity of sibling drinking (Table 2). With respect to similarities between best friend's and respondents' alcohol use, for the quantity of drinking, correlations were high for the oldest adolescent (r (428) = .72, $p < .001$ at T1, and .73, $p < .001$ at T2), and moderate to high for the youngest adolescent (r (428) = .45, $p < .001$ at T1, and .63, $p < .001$ at T2). For frequency of drinking, subsequent correlations were observed for the oldest adoles-

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cent (r (428) = .59, $p < .001$ at T1, and .53, $p < .001$ at T2), and the youngest adolescent (r (428) = .49, $p < .001$, and .48, $p < .001$ at T2). In sum, it seems that, according to the adolescents themselves, best friends and adolescents were similar in their drinking pattern.

Not many siblings share the same best friend: zero pairs reported at T1 to have the same best friend, and only three pairs at T2.[1] Thus, there is only limited overlap in friendships of siblings in one family. Interestingly, although siblings do not share the same friends in general, the drinking of the best friends is correlated suggesting similarities in selective peer affiliation between siblings or, as an alternative explanation, correspondence in susceptibility to peer influences among siblings. Thus, drinking of the sibling's best friend was related to adolescent drinking. Small to moderate cross-sectional associations were found for frequency of drinking (rs .16 to .23, $p < .05$) and quantity of drinking (rs .14 to .21, $p < .05$).

TOTAL MODEL

Initial Model. The fit of the initial model as depicted in Figure 1 was satisfactory (χ^2 (60) = 102.92, p = .001; CFI = .996; RMSEA = .041). Further, the factor loadings of the latent variables in this model were high, ranging from .83 to .95. This implies that the indicators accurately measured the latent variables of drinking in siblings and friends.

The cross-sectional correlations between the latent variables and the parameter estimates of the structural model are also presented in Figure 1. First, cross-sectionally, positive associations were found between drinking of siblings and friends at T1 and T2. Second, drinking of the sibling's friend is associated with adolescent drinking in both the younger and the older adolescent at T1.

For the longitudinal associations, we found relatively strong stability in drinking of both the younger and older sibling over time. Somewhat weaker but still substantial stability paths were found for the friends' drinking over time. More important for of our study, no prospective associations were found between best friend's drinking and adolescent's drinking over time for the older sibling, and a small but significant association (β = .15, $p < .05$) for the younger sibling. However, for both the younger and older sibling, associations were found between adolescent's use and friend's use over time, providing support for friendship selection processes (see Engels et al., 1999). No cross-lagged associations were found between sibling's alcohol use over time, or between sibling's best friend's drinking and adolescent alcohol use.

1. We examined how many siblings mentioned each other as best friend. At T1, 3 of the oldest siblings mentioned their younger brother or sister (at T2, this was the case for 2 siblings). At both waves, none of the younger siblings mentioned their older sibling as being their best friend.

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Figure 1

INITIAL MODEL: LONGITUDINAL ASSOCIATIONS BETWEEN BEST FRIEND'S DRINKING AND ADOLESCENT'S DRINKING
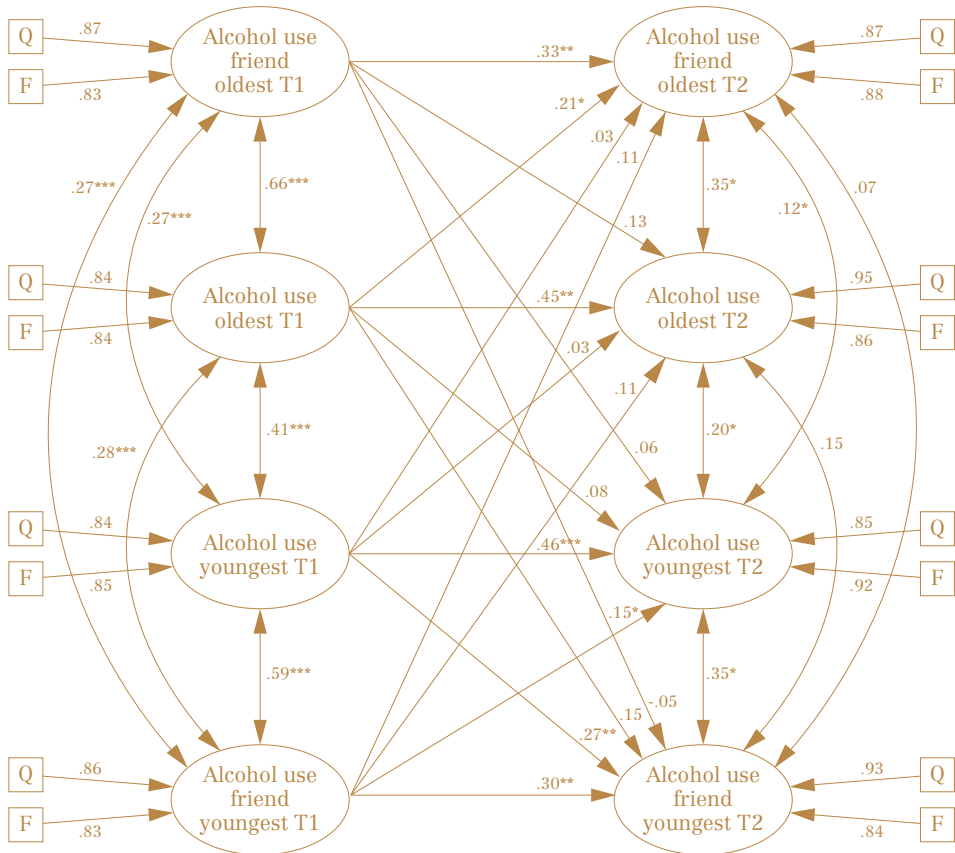
χ^2 (60) = 102.92, p = .001; CFI = .996; RMSEA = .041. F = frequency of drinking and Q = quantity of drinking.

Multi-group Analyses. A multi-group testing procedure was used to examine whether the model parameters differed for opposite-sex and same-sex sibling pairs. No significant differences in model parameters were found when we calculated the model for opposite-sex and for same-sex sibling pairs ($\Delta\chi^2$ (16) = 11.93, p = .749). Similarly, no significant differences were found between the model for boy-boy siblings pairs, girl-girl sibling pairs and opposite sex sibling pairs ($\Delta\chi^2$ (32) = 20.21, p = .948). Furthermore, we tested whether the effects

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of especially the sibling's friend and adolescent's own friend's alcohol use on individual drinking over time depend on the perceived relative popularity of friends. We used a multi-group procedure with reports of the oldest adolescent on the relative popularity of friends: one group consisting of adolescents with more popular friends than the other sibling ($n = 157$); and one group of adolescents with equally or less popular friends ($n = 271$). This procedure was also conducted for reports of the youngest sibling ($n = 198$ and $n = 230$, respectively, for adolescents with more popular, and equal or less popular friends). In the models with reports of the youngest adolescent on relative peer popularity, we indeed found a difference in the effect of friend's drinking on adolescent use, namely the effects ($\beta = .23$, $p = .001$) were stronger in the case adolescent's own friends were more popular than in the case their friends were equal or less popular than those of their sibling ($\beta = .05$, ns; $\Delta\chi^2 (16) = 30.14$, $p = .017$). We found no evidence that relative popularity of friends moderated the impact of friends on individual drinking in the oldest adolescent; $\chi^2 (10) = 12.50$, $p = .253$.

## SEPARATE MODELS FOR OLDEST AND YOUNGEST SIBLING

Initial Model. The fit of the model for the oldest adolescent (as depicted in Figure 2) was good, $\chi^2 (6) = 6.59$, $p = .360$; CFI = 1.00; RMSEA = .015. Besides the stability paths and the cross-sectional associations between friend and adolescent's drinking cross-lagged paths between friend and adolescent's drinking were significant. Higher engagement in drinking of friends was related to higher drinking of the older sibling over time, and vice versa. The fit of the model for the youngest adolescent (as depicted in Figure 3) was also good, $\chi^2 (6) = 11.02$, $p = .087$; CFI = .999; RMSEA = .044. The pattern of findings was similar to that for the oldest sibling.

Multi-group Analyses. Further, we tested whether the quality of friendship moderated the links between best friend and adolescent drinking over time. This was done by creating two groups differing on quality of friendship. Using the multi-group approach, we found no evidence for a moderating effect of quality of friendship (oldest adolescent $\Delta\chi^2 (4) = 2.90$, $p = .575$; youngest adolescent $\Delta\chi^2 (4) = 2.51$, $p = .643$).[2]

2. The question may arise why we did not test the effects of all moderating variables in the initial model. In our opinion, it seems inappropriate to examine the moderating role of, for instance, personality of the youngest adolescent, on associations between friend's drinking and the older adolescent's alcohol use. Thus, we decided to test the possible moderating effect of characteristics not linked to the siblings in a simpler model including only friend's and adolescent's alcohol use. We believe that our findings would remain unchanged if we tested it in the format of the initial model because (a) there was no influence of sibling's and sibling's friend's drinking on individual drinking, and (b) the moderating role of these factors (personality, quality of friendships) was in almost all cases non-existent.

Figure 2

INITIAL STRUCTURAL MODEL OLDEST ADOLESCENT: LONGITUDINAL ASSOCIATIONS BETWEEN BEST FRIEND'S DRINKING AND ADOLESCENT'S DRINKING AMONG THE OLDEST ADOLESCENTS
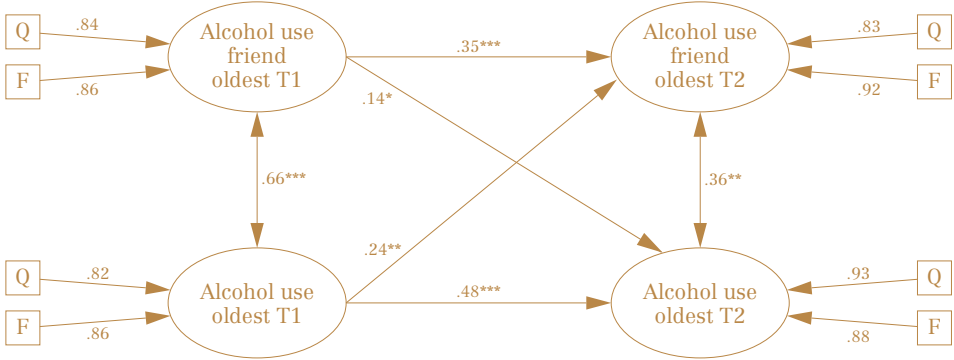
χ^2 (6) = 6.59, p = .360; CFI = 1.000; RMSEA = .015. F = frequency of drinking and Q = quantity of drinking.

Figure 3

INITIAL STRUCTURAL MODEL YOUNGEST ADOLESCENT: LONGITUDINAL ASSOCIATIONS BETWEEN BEST FRIEND'S DRINKING AND ADOLESCENT'S DRINKING AMONG THE YOUNGEST ADOLESCENTS
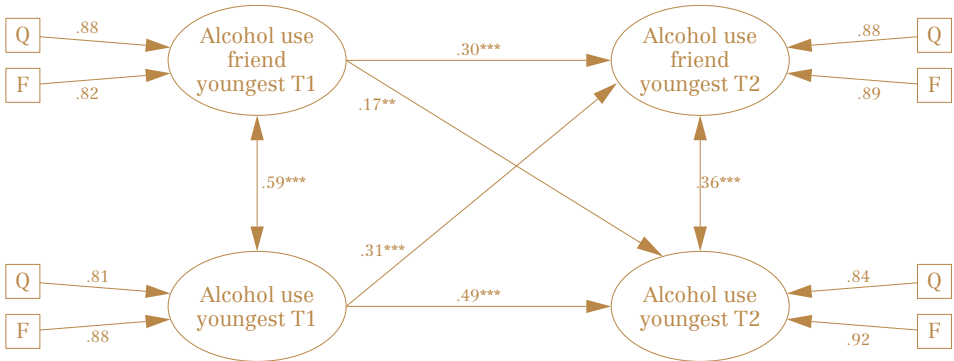
χ^2 (6) = 11.02, p = .087; CFI = .999; RMSEA = .044. F = frequency of drinking and Q = quantity of drinking.

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With respect to personality traits, we calculated five multi-group analyses for all of the five personality traits. No differences in model parameters were found for groups differing on openness, emotional stability, agreeableness, conscientiousness and extraversion (oldest adolescent openness $\Delta\chi^2(4) = 1.52$, $p = .824$; youngest adolescent openness $\Delta\chi^2(4) = 3.68$, $p = .451$; oldest adolescent emotional stability $\Delta\chi^2(4) = 5.72$, $p = .221$; youngest adolescent emotional stability $\Delta\chi^2(4) = 2.63$, $p = .621$; oldest adolescent agreeableness $\Delta\chi^2(4) = 7.34$, $p = .119$; youngest adolescent agreeableness $\Delta\chi^2(4) = 3.95$, $p = .413$; oldest adolescent conscientiousness $\Delta\chi^2(4) = 1.13$, $p = .863$; youngest adolescent conscientiousness $\Delta\chi^2(4) = 2.88$, $p = .579$; oldest adolescent extraversion $\Delta\chi^2(4) = 6.67$, $p = .154$; youngest adolescent extraversion $\Delta\chi^2(4) = 3.89$, $p = .421$).

We conducted additional multi-group analyses in which we examined the group of adolescents with the same best friend at T1 and T2, and adolescents with a new best friend at T2. For the older adolescents there was no significant difference between these two groups ($\Delta\chi^2(4) = 9.06$, $p = .060$), but a significant difference was found for the youngest adolescents ($\Delta\chi^2(4) = 14.04$, $p = .007$). Results show that the relation between friends drinking at T1 and T2 was stronger in case adolescents had the same best friend at the two time points ($\beta = .61$, $p < .001$), than when adolescents had affiliated with a new friend at T2 ($\beta = -.01$, ns). More importantly, the relation between alcohol use of the adolescent at T1 and alcohol use of the best friend at T2 was weaker in case adolescents had the same best friend at the two time points ($\beta = .10$, ns), than when adolescents had affiliated with a new friend at T2 ($\beta = .56$, $p < .001$).

Drinking Stages. Variations in model findings between the prediction of onset of drinking and continuation of drinking were tested (Table 3). The fit statistics of the four models were satisfactory (oldest adolescent abstainer at T1 $\chi^2(5) = 4.64$, $p = .461$; CFI = 1.000; RMSEA = .000; oldest adolescent drinker at T1 $\chi^2(6) = 10.95$, $p = .122$; CFI = .997; RMSEA = .052; youngest adolescent abstainer at T1 $\chi^2(4) = 3.43$, $p = .488$; CFI = 1.000; RMSEA = .000; youngest adolescent drinker at T1 $\chi^2(6) = 10.05$, $p = .122$; CFI = .997; RMSEA = .061).

For the oldest adolescent, friend's drinking at T1 appeared to predict initiation of drinking at T2, whereas participants who had already started to consume alcohol at T1 were not affected by their friend's drinking. For younger siblings, the situation was the opposite. Only for the prediction of alcohol use by those who reported to drink at T1, a significant positive association was found between friend's drinking at T1 and adolescent's drinking at T2.

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Finally, it is interesting that only for those adolescents who indicated to drink at T1 were stability paths found between best friend's drinking over time whereas in the models for drinkers at T1, moderate associations were found between adolescent's drinking at T1 and friend's drinking at T2.

Table 3
STANDARDIZED ESTIMATES FOR THE TWO DRINKING STAGES MODELS SEPARATELY FOR THE OLDEST AND THE YOUNGEST SIBLING

	Oldest sibling: abstainer T1	Oldest sibling: drinker T1	Youngest sibling: abstainer T1	Youngest sibling: drinker T1
	n = 121	*n* = 307	*n* = 241	*n* = 184
Cross-sectional correlations between latent variables				
Alcohol adolescent T1 – Alcohol friend T1		.58***		.43***
Alcohol adolescent T2 – Alcohol friend T2	.52***	.40*	.62***	.26
Stability paths (Betas)				
Alcohol adolescent T1 – Alcohol adolescent T2		.41**		.53**
Alcohol friend T1 – Alcohol friend T2	.49***	.20	.37**	.20
Cross-lagged paths (Betas)				
Alcohol adolescent T1 – Alcohol friend T2		.26*		.48*
Alcohol friend T1 – Alcohol adolescent T2	.29*	.06	.12	.21*

Note. $*p < .05$ $**p < .01$ $***p < .001$.

DISCUSSION

The current study aimed to test the effects of best friend's drinking on the development of drinking in adolescence in a within-family design, in which we simultaneously examined the cross-sectional and longitudinal associations between friend's drinking, sibling's drinking, and sibling's best friend's drinking.

First of all, our findings show that although there was high homogeneity in drinking habits within friendship dyads in both early and middle adolescence, the impact of friend's drinking on individual alcohol use over time was limited. We found an effect of best friend's drinking on drinking of the younger sibling which was consistent across various models, but the magnitude of the effect was limited, explaining only 3-5% of the variance. Effects for younger adolescents were significant whereas the effects for older adolescents were not, although it should be noted that differences between effects for older and younger sibling were only minimal (e.g., β of .13 not significant and β of .15 significant). In the models explaining phase transitions in drinking, friend's drinking did not substantially predict initiation or continuation of drinking. The pattern of findings in this study substantiate earlier studies on drug use among Dutch adolescents (e.g., Bot et al., 2005a; Engels et al., 1999). One may argue that Dutch adolescents may be fairly autonomous and not easily pressured to drink by their friends. It is important to stress that also in many fine-grained prospective analyses predicting drinking over time with samples from other countries (see review by Bauman & Ennett, 1996; Jaccard et al., 2005), no support for a strong effect of friends' drug use has been found.

Similar to Jaccard et al. (2005), we tested a variety of possible moderator variables that might provide information on subgroups particularly susceptible to the influence of their friends' behaviors. After testing the moderating roles of relationship characteristics (such as relative popularity of friends and quality of friendship), and several individual characteristics (such as gender and personality traits), it was surprising that most relations between friends' and adolescents' drug use were not moderated. Although other studies reported (small) effects of moderating variables on the link between friends and adolescent drug use (Bot et al., 2005a; Urberg et al., 2003) and deviancy (Vitaro et al., 2000), we did not. This illustrates the robustness of the lack of effects of friends' drinking in our data.

Our results show consistent support for selective peer affiliation. The evidence for these selection effects arises from the path from adolescent's drinking at the first wave to the friend's drinking at the second wave. One might argue that this path should be interpre-

ted in terms of peer influence, namely that participants affected peer drinking. However, almost half of our participants reported that they were affiliated with a new friend at the second wave. In addition, if the impact of adolescents on their friends was interpreted as exclusively influence processes this would lead to the conclusion that our sample comprised an overrepresentation of adolescents with friends who are likely to conform to the alcohol use of their peers. The sample procedure we used makes this very unlikely (see Engels et al., 1999). These findings are in line with those of other studies showing substantial empirical evidence for selection processes (Bauman & Ennett, 1996). Additionally, other studies revealed that 'selection' may take place even in ongoing friendships. Dishion and Medici Skaggs (2000) examined the covariation between monthly bursts of drug use and contacts with drug using friends. They showed that the period in which youth increased their drug use, was the interval of those months in which they increased affiliations with drug using friends. Furthermore, in older age groups (like student samples) it would be informative to test the effects of friend drinking in an experimental design in which persons are randomly assigned – or based on their drinking behavior – to room or class mates (see Duncan et al., 2005).

A novelty of this study is the inclusion of siblings and sibling's best friends while examining the role of adolescents' best friend's drinking. With respect to siblings, our descriptive data demonstrate strong differences in frequency and quantity of drinking between the oldest and the youngest adolescent. This can largely be explained by age differences: older adolescents drink more than younger adolescents. Although there are strong differences in drinking habits, the relative similarity is moderate to high. Older adolescents who drink heavily and frequently are more likely to have siblings who drink substantially relative to their peers (Epstein et al., 1999). However, we found no longitudinal cross-lagged paths between drinking of siblings and adolescents at T1 and T2 (see also Ary et al., 1993), suggesting that similarities at T1 might be affected by previous mutual influence processes within the sibling pair, shared peer influences, or by a third variable, such as parental drinking or socialization efforts. Further, genetic resemblance might also account for similarities in sibling pairs (Rose, 1998). Additionally, no support was found for possible influence of sibling's best friend's drinking on individual drinking. Because we found no effects of the adolescents' best friend's drinking, it would be highly unlikely if, instead, we found effects from the sibling's best friend.

This study provided only limited support for the influence of peer alcohol use on adolescent drinking. However, we think that the use of surveys might lead to underestimation of the role of peer influence in adolescent drug use. Our results show that drinking at the T1

was the strongest predictor of drinking at T2, which was also found in almost all short-term prospective research projects (see, for example, Pape & Hammer, 1996). These relatively strong stability paths between drinking over time in adolescents emphasize the importance of the length of intervals between the waves in longitudinal research. One might argue that, because friendships change rapidly in adolescence (Ennett & Bauman, 1994), peer influences on adolescent risk behaviors can only be detected in longitudinal designs with short-term follow-up assessments. On the other hand, using short-term intervals increases the estimates of stability of individual drinking. The longer the interval between the waves, the less stable will be the drinking behavior of adolescents, leaving more space for prediction by theoretically relevant concepts such as peer alcohol consumption. Because we found no strong evidence for peer influences, future studies could examine peer influences over longer time periods.

Another reason for a possible underestimation of peer influences, is that survey studies do not actually examine peer interaction processes. Experimental studies on alcohol use and modeling in the 1970s and 1980s (see reviews by Collins & Marlatt, 1981; Quigley & Collins, 1999) show that when people are in the company of a drinker, the drinking pace of the other (a confederate) affects individual drinking rates and consumption levels (Quigley & Collins, 1999). In addition, studies systematically observing communication in chumships demonstrate that the content and structure of communication between close friends are related to the development of deviant behaviors, including drinking (Dishion & Owen, 2002; Dishion et al., 2004). Furthermore, Bot and co-workers (2005b) showed that drinking levels in a one-hour ad lib drinking session in a bar lab together with those they normally go out with (groups of 7-9 persons) are strongly affected by the average drinking levels of the group. These results from observational and experimental studies might indicate that the use of surveys underestimates the role of peer influence in adolescent drug use. We suggest for future research, to combine longitudinal studies survey studies and observational data to better elucidate how friends actually affect individual differences in drinking.

A limitation of our study is that we rely heavily on adolescents' reports of their best friend's behaviors. Perceived friend's drug use generally correlates higher with individual behavior than actual reports from friends, because people tend to project their behavior on that of their friends (Bauman & Ennett, 1996; Wilcox & Udry, 1986); this could cause an overestimation of the effects of best friend's drinking. Therefore, we recommend to collect data on alcohol use as well as on relationship characteristics from the friends themselves. However, we assume that our general pattern of findings would not have changed if

we had used the friend's reports on their drinking. Because the effects of friends' drinking based on the adolescents' reports were already small, they would have been even smaller if we had used the friend's reports. Furthermore, other longitudinal studies using information of the friends themselves to avoid perception biases found only small effects of drinking by a unilateral or reciprocal best friend (Bot et al., 2005a), and smoking by a reciprocal best friend (e.g., Engels et al., 2004) on the adolescent's behavior (see also studies reviewed in Jaccard et al., 2005).

Some other limitations need to be mentioned. First, the sample in this study consisted of adolescents from predominantly autochthonous, two-parent families without mental or physical disabilities. This could have an effect on generalizing the results to the general population in the Netherlands. However, with regard to external validity to other cultures, our findings concerning the longitudinal effect of friends' and siblings' drinking on changes in drinking in Dutch adolescents may well agree with studies from other western countries (Ary et al. 1993; Bauman & Ennett, 1996; Duncan et al. 1996; Jaccard et al., 2005; Windle 2000). Furthermore, we did consider mixed-gender best friend dyads, because mixed-gender best friend dyads are relatively uncommon in our sample; only 9% of the older adolescents and 4% of the younger adolescents had mixed-gender best friends and this is typical for this age group. In order to explore the highly relevant question on the effects of alcohol use by different kinds of peers we would suggest that future studies examine older adolescents in whom mixed-gender best friend relations (and romantic relationships) are more common. In addition, it should be noted that agreement in reports of older and younger sibling's relative peer popularity was relatively low (Cramer's V was .23; $p < .001$). Apparently, relative peer popularity was rather subjective and should be interpreted carefully. Moreover, sample sizes for some of the multi-group analyses were relatively small and future studies should include larger sample sizes. Finally, in our study families filled out questionnaires in their homes; this could cause underestimation of alcohol consumption because children might worry that their parents will find out about their drug use patterns. However, family members completed the questionnaires individually and separately in the presence of an interviewer to guarantee privacy.

In sum, the results of this study provide only limited evidence for a substantial role of peers in adolescent drinking. However, robust evidence was found for peer-selection processes. In addition, the relation between peer and adolescent drinking was not moderated by relationship characteristics and individual characteristics. To find more convincing support for the role of peer drinking in adolescent drug use, we suggest to examine peer-interaction processes using a combination of survey and observational data.

CHAPTER

7

SIMILARITIES IN DRINKING BEHAVIOR OF TWIN'S FRIENDS: MODERATION OF HERITABILITY OF ALCOHOL USE

ABSTRACT

Previous research has indicated that friends' drinking may influence alcohol use in adolescents and young adults. We explored whether similarities in the drinking behavior of friends of twins influence the genetic architecture of alcohol use in adolescence and young adulthood. Survey data from the Netherlands Twin Register were available for 1,526 twin pairs aged 16-25 years. We categorized the twin pairs as concordant (both report similar alcohol use in their friends) or discordant for the alcohol use of their friends. Genetic moderator models were tested by carrying out multi-group analyses in Mplus. Findings showed a significant moderation effect. Genetic factors were more and common environment less important in the explanation of variation in alcohol use in twins concordant for alcohol use of friends than in twins discordant for alcohol use of friends.

INTRODUCTION

Twin studies have shown that genes are important in the prediction of individual differences in alcohol use of adolescents who have developed regular drinking patterns (see review by Hopfer et al., 2003). Pagan et al. (2006) and Viken et al. (1999) found in 16-17-year olds that genetic factors explained approximately 40% of the variance in frequency of drinking, while Fowler et al. (2007a) found that genes played even a larger role in the variance of quantity of drinking in 11-19-year olds, predicting 64% of the individual differences in alcohol use.

While studies have shown genetic factors to be important, they also point to a role of environmental factors in explaining individual differences in drinking. One of these environmental factors may be the drinking behavior of friends. Several non-twin studies have indicated that friends' drinking is one of the strongest predictors of young people's alcohol use (e.g., Andrews et al., 2002; Ary et al., 1993; Graham et al., 1991; Petraitis et al., 1995; Urberg et al., 1997; Wood et al., 2001), though the extent of the influence may change with the duration of the follow-up (Poelen et al., 2007). The influence of friends is also supported by a twin study of Walden et al. (2004), that pointed to the relevance of friends' behavior (i.e., friends' substance use and friends' delinquency) in explaining adolescents' substance use.

The drinking behavior of friends may also interact with genetic influences. In a study of Dick et al. (2007) in 17-year old Finnish twins, genetic influences on adolescent drinking were higher and common environmental influences were lower among adolescents with a larger number of drinking friends compared to adolescents with a small number of drinking friends. According to the authors these results suggest that environments characterized by high levels of friends' drinking create opportunities for genetic predispositions to be expressed.

If the drinking behavior of friends modifies genetic influences, twin studies taking the drinking behavior of the friends of twins into account, would provide a more complete picture of the factors influencing alcohol use in adolescence. When doing so, the extent to which twins share their friends becomes highly relevant. Several twin studies have indicated that in adolescence monozygotic (MZ) twins are more likely than dizygotic (DZ) twins to share all or nearly all of their friends (Horwitz et al., 2003; Rende et al., 2005; Rose, 2002; Walden et al., 2004). According to Horwitz et al. (2003), twin studies may overestimate the strength of genetic influences and underestimate the strength of common environmental influences, because higher similarities in behavior among MZ compared to DZ twins do

not only arise through genetic differences but also through social influences (i.e., friends). In other words, when MZ twins are more similar for a trait than DZ twins because they share more aspects of their environments than DZ twins, the actual environmental effect on this trait will be attributed to genetic effects. Rende and colleagues (2005) examined whether having mutual friendships in twin pairs moderated the genetic and shared environmental estimates of alcohol use in seven through twelve graders in a US sample. Their findings showed that the heritability of alcohol use was not significantly moderated by the extent to which twins shared their friends, but shared environmental effects were stronger in twin pairs with more mutual friends than in twin pairs with few mutual friends.

Both the sharing of friends and the similarities in alcohol use of friends might affect estimates of heritability and common environment. In addition to sharing the same friends, twins can also have different friends who behave similarly. In this respect, research showed that MZ twins were more likely to have similarly behaving friends than DZ twins (Horwitz et al., 2003; Rose et al., 2002). No study so far has tested whether heritability is moderated by the concordance for the alcohol use of their friends.

The main aim of this study was to examine whether concordance (both twins report similar alcohol use in their friends) or discordance for the alcohol use of friends moderates the influence of genetic factors and common environment on alcohol use. We focus on similarity in drinking among the friends of twins and not on drinking behavior itself of friends. If twins have the same friends or behaviorally similar friends, this should be reflected in an increased similarity in the twins' drinking behavior, which may influence estimates of heritability and the influence of the common and unique environment.

METHODS

PARTICIPANTS

In the current study, we used data of a longitudinal questionnaire study of the Netherlands Twin Register. Every 2 to 3 years adolescent and young adult twins and their family members are asked to complete a questionnaire on their health, lifestyle and personality. Questionnaires have been sent out in 1991, 1993, 1995, 1997, 2000, 2002 and 2004. Some twins participated only once, while others participated several times. For more detailed information about sample and data collection we refer to Boomsma et al. (2006; 2002).

For the purpose of this study we used data of the 1993 and 1995 data collections, as in these waves twins were asked to indicate to what extent they had their friends in common. All data from twins in the age of 16-25 were selected for analyses. In the Netherlands it is legal to drink alcohol as of the age of 16. At this age, people mainly drink in company of their friends and their drinking behavior is more likely to be affected by friends than the behavior of younger Dutch adolescents who drink more often in company of their parents (Van Der Vorst et al., 2007).

We used the data of twin pairs from the 1993 wave of data collection, and complemented that with data from the 1995 wave. In case data for a complete twin pair were not available for 1993, but were available for 1995, we used the data from the 1995 wave. This resulted in a sample of 237 monozygotic male (MZM) twin pairs, 232 dizygotic male (DZM) twin pairs, 357 monozygotic female (MZF) twin pairs, 264 dizygotic female (DZF) twin pairs and 436 dizygotic opposite sex (DOS) twin pairs, all complete twin pairs. The mean age of these twin pairs was 19.4 years (SD = 2.7). Zygosity of the twins was based on DNA polymorphisms, or on survey questions regarding the physical similarity of the twins and confusion in identifying the twins by family members, friends and strangers in case DNA polymorphisms were not available. The agreement between zygosity based on DNA polymorphisms and zygosity based on questionnaires is 97% (Willemsen et al., 2005).

MEASURES

Frequency of drinking in twins was measured with the question: "How often do you drink alcohol?" This question had eight response categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week",

and (8) "daily" (Poelen et al., 2005). Category 8 was not present in all subgroups, therefore categories 7 and 8 were collapsed into one category, creating a 7-point frequency of drinking measure. To be able to compare our results with studies which used dichotomized drinking (e.g., Koopmans & Boomsma, 1996), we also transformed the original measure into the dichotomous regular drinking measure, consisting of non-regular drinking and regular drinking, which was defined as drinking a few times a month or more (Poelen et al., 2007).

In 1993 and 1995 the questionnaires contained the item: "Do you and your co-twin have the same friends?" The response categories were: (1) "all friends are shared", (2) "some of our friends are mutual", (3) "we both have our own friends", and (4) "I don't have friends". Less than 1% of the twins indicated that they did not have friends, therefore we excluded the data of these twins from our analyses.

Twins were also asked how many of their friends drink alcohol on a regular basis. Answer categories were: (1) "no one", (2) "a few", (3) "around half" (4) "most", and (5) "all". Based on the answers to these two questions, we created a new variable consisting of three categories: (1) "all friends in common", (2) "different friends who are similar in alcohol use" and (3) "different friends who differ in alcohol use". Only if both twins indicated to have all friends in common and if they reported similar alcohol use of friends, twins were classified in the first category. We refer to this category as the "concordant". Twins were classified as discordant when they both indicated to have only some of their friends in common, or to have their own friends, and reported differently on the alcohol use of their friends. When one twin reported to have all their friends in common while the other twin reported that they only had part or none of their friends in common twin pairs, and differed in their reports of their friends' alcohol use were also categorized as discordant.

STRATEGY OF ANALYSES

We first examined whether MZ twins more often had all friends in common and more often had friends with similar alcohol use than DZ twins. Frequency distributions were tested for statistical differences using Chi-square tests in SPSS 15.0. Next, polychoric correlations and genetic models were evaluated in Mplus (Muthén & Muthén, 1998-2006). We calculated polychoric correlations for all zygosity groups (MZM, DZM, MZF, DZF and DOS) separately for twin pairs who were concordant for the alcohol use of their friends and twin pairs who were discordant the alcohol use of their friends.

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Genetic model fitting was done conditional on concordant / discordant status of the pair. This approach to test for gene-environment (GE) interaction has been described by Eaves, (1982); Heath et al. (1998; see also Heath, 1987) and Boomsma et al. (1999). The analyses involves a multi-group analyses (five zygosity-by-zygosity groups by concordance / discordance status). The test for GE interaction is carried out by testing whether model parameter estimates (e.g. for heritability) are the same for concordant and discordant twins.

Because the alcohol variables were categorical, the weighted least square estimator with a mean- and variance-adjusted chi-square test statistic (WLSMV) was used. This is default for categorical data (Muthén & Muthén, 1998-2006; Prescott, 2004). An underlying liability, or vulnerability for alcohol used was assumed, which is normally distributed with unit variance and zero mean. One or more thresholds divide the liability into 2 or more categories. Thresholds are estimated based on the observed distribution of scores in the categories (Prescott, 2004).

The variance of the liability distribution for frequency of drinking and for regular drinking was modeled as a function of four influences: age, additive genetic effects (A), common environmental effects (C) and unique environmental effects (E). The estimates of unique environmental effects also include measurement error. A, C and E were standardized to have unit variance. The correlation between the latent A effects (r_A) for MZ twins was fixed to 1, while the correlation between the A factors for DZ twins was fixed to .5. The correlation between the common environmental latent factors (r_C) was fixed at 1. Unique environmental (E) latent factors were not correlated by definition (e.g., Boomsma et al., 2002). The effect of age was modeled on the thresholds.

Models were fit directly to the raw data. Frequency of drinking was assessed by seven categories and six thresholds to model this variable. Regular drinking was assessed by two categories, therefore there was one threshold. Because of sex differences in the distribution of regular drinking and frequency of drinking (Poelen et al., 2005; Poelen et al., 2007) separate thresholds for male and female twins were estimated. When the WLSMV estimator for categorical data is used, the comparison of different submodels cannot be based on subtracting the chi-squares and degrees of freedom, because the difference in chi-square values for two nested models is not distributed as chi-square. We therefore used the special option in Mplus for difference testing when the WLSMV estimator is used; as described in detail in the Mplus User's Guide (Muthén & Muthén, 1998-2006).

We first fitted the complete model in same-sex twin pairs and tested whether the effects of age and A, C, and E factors differed for males and females. We carried out a multi-group analysis with 8

groups (zygosity by sex by friends' status) and compared models with the same parameter estimates for males and females with models in which different parameter estimates for males and females were specified. Adding the data from opposite sex DZ (DOS) twins allowed us to examine qualitative sex differences in common environmental influences or, in other words, whether different environmental factors operate in males and females. We compared a model with a freely estimated common environmental correlation in DOS twins to a model in which this correlation was fixed to 1 and to a model in which common environment was not correlated to test whether a model in which the common environment is completely shared or not shared at all by males and females may provide a better fit.

With regard to age differences in the frequency distribution of alcohol use, we modeled the regression of age of twins on the thresholds of frequency of drinking and of regular drinking (Prescott, 2004).

RESULTS

SIMILARITY OF FRIENDS OF TWINS

We first examined whether MZ twins more often share their friends than DZ twins. Table 1 shows that MZ twins have significantly more often all their friends in common than DZ twins ($\chi^2(8, n = 1526) = 136.79, p < .001$). About 20% of the MZ twins (20.3% in the MZM and 18.2% in the MZF twins) share all their friends. In DZ same-sex twins these percentages were substantially lower (i.e., 4.7% in DZM and 3.4% in DZF) and it was particularly low in DZ opposite-sex twin pairs (1.1%).

Since only few DZ twin pairs shared all their friends, we combined the category "all friends in common" and "different friends, who are similar in alcohol use" into one category, i.e. concordant for alcohol use of friends. For MZM twin pairs, 61% had friends with similar alcohol use, compared to 49%, of the DZM twins ($\chi^2(1, n = 469) = 6.88, p < .01$). In MZF twins pairs, 58% had friends with similar alcohol use as compared to 44% in DZF twin pairs ($\chi^2(1, n = 621) = 13.14, p < .001$). The percentage of twins with friends with similar alcohol use, was lowest in the DOS twins (38%) and this percentage was significantly lower than in the DZM ($\chi^2(1, n = 668) = 7.35, p < .01$), but not significantly lower than in DZF twin pairs ($\chi^2(1, n = 700) = 2.24, p = .14$) (49% and 44% respectively).

Table 1

PREVALENCE OF SIMILARITY IN FRIENDS AND SIMILARITY IN ALCOHOL USE OF FRIENDS WITHIN TWIN PAIRS (%)

	MZM $n = 237$	DZM $n = 232$	MZF $n = 357$	DZF $n = 264$	DOS $n = 436$
All friends common	20.3	4.7	18.2	3.4	1.1
Separate friends; similar alcohol use	40.5	44.0	40.1	40.2	36.7
Separate friends; different alcohol use	39.2	51.3	41.7	56.4	62.2

Note. MZM, monozygotic males; DZM, dizygotic males; MZF, monozygotic females; DZF, dizygotic females; DOS, dizygotic opposite-sex twins.

Table 2 depicts polychoric twin correlations. For both frequency of drinking and regular drinking MZ correlations were higher than DZ correlations among discordant twins, indicating that genes influence alcohol use in this group. Differences in MZ and DZ correlations in concordant twin pairs were less evident, suggesting smaller genetic effects and increased common environmental influences in this group.

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Table 2

	MZM	DZM	MZF	DZF	DOS
Frequency of drinking					
Twins concordant friends' alcohol use	$n = 144$	$n = 113$	$n = 208$	$n = 115$	$n = 165$
	.75	.65	.78	.68	.47
Twins discordant friends' alcohol use	$n = 93$	$n = 119$	$n = 149$	$n = 149$	$n = 271$
	.77	.53	.65	.43	.32
Regular drinking					
Twins concordant friends' alcohol use	$n = 144$	$n = 113$	$n = 208$	$n = 115$	$n = 165$
	.83	.79	.85	.76	.48
Twins discordant friends' alcohol use	$n = 93$	$n = 119$	$n = 149$	$n = 149$	$n = 271$
	.79	.55	.68	.55	.45

Note. MZM, monozygotic males; DZM, dizygotic males; MZF, monozygotic females; DZF, dizygotic females; DOS, dizygotic opposite-sex twins.

THE MODERATING ROLE OF SIMILARITIES IN FRIENDS' DRINKING

Next, we examined whether concordance in friends' drinking moderated heritability estimates for alcohol use. Model fitting results for frequency of drinking and for regular drinking are given in Table 3. We first tested whether the age regression was equal for males and females in same-sex twins. For both frequency of drinking and regular drinking the model with the sex specific age effect (Table 3, model 1) fitted better to the data than the model without the sex specific age effect (Table 3, model 2). Therefore, sex specific age regressions were retained in all subsequent models.

We continued by examining whether the influence of A, C and E for males and females were equal. For both frequency of drinking and regular drinking results showed that the model with different parameters across sex (Table 3, model 3) did not fit the data better than the model with equal parameters across sex (Table 3, model 4). Therefore, all subsequent models were fitted with equal parameter estimates for males and females.

Next we tested for qualitative sex differences using data from same-sex and opposite-sex twins pairs. The common environmental correlation in DOS twins was estimated to be .55 and .59 for frequency of drinking and regular drinking, respectively. We compared this model

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(Table 3, model 5) to models with the common environmental correlations constrained at 0 (Table 3, model 6) and 1 (Table 3, model 7). As seen in Table 3, the model with the freely estimated correlation was the best-fitting model for both frequency of drinking and regular drinking.

Finally, we tested whether model parameters for concordant and discordant groups were the same. Both for frequency of drinking and regular drinking, models with different parameters across the two groups (Table 3, model 8) fitted the data better than models with equal parameter estimates across the two groups (Table 3, model 9).

In the final model, age and A, C and E factors loading on frequency of drinking and regular drinking were all significant at $p < .001$. The unstandardized parameter estimates for the effects of A, C and E were constrained to be equal for males and females, but the unstandardized age regression coefficient was different for males and females. Parameter estimates were standardized separately for males and females. As a result of the sex difference in age regression, some small differences in standardized parameters between males and females appeared.

Table 4 shows that percentage of the variance explained by each of the 4 factors. In male twins concordant for their friends' alcohol use, the variance in frequency of drinking was explained for 6% by age, and for 19% by additive genetic effects, 53% by common environmental effects and for 22% by unique environmental effects. For female twins in this group, a similar pattern was seen, with estimations for the effects of age, genes, common environment and unique environment at 0%, 21%, 56%, and 23% respectively. When twins were discordant for the alcohol use of their friends, a different pattern emerged. In male twins, the variance in liability to frequency of alcohol use was explained for 7% by age and for 47% by additive genetic effects, while common environment explained 18% and unique environment 28% of the variance. For female twins these estimates were 1%, 50%, 19% and 30%, respectively.

For regular drinking we observed a similar pattern as for frequency of drinking. In male twins concordant for friends' alcohol use, the variance in the liability to regular drinking was explained for 4% by age, and for 14% by additive genetic effects, 66% by common environmental effects and for 16% by unique environmental effects. We found a similar pattern for female twins, with estimations for the effects of age, genes, common environment and unique environment at 0%, 15%, 69%, and 16% respectively. When twins were discordant for the alcohol use of their friends, the variance in males was explained for 7% by age and for 33% by additive genetic effects, while common environment explained 34% and unique environment 26% of the variance. For female twins these estimates were 1%, 36%, 36% and 27%, respectively.

Table 3
MODEL FITTING RESULTS FOR FREQUENCY OF DRINKING AND REGULAR DRINKING

	vs	χ² (df)	p	Δχ² (df)	p
Frequency of drinking: same sex twins					
Step 1 sex differences in age regression					
1. Age-ACE sex specific age effect [a]		50.82 (44)	.223		
2. Age-ACE no sex specific age effect	1	56.62 (44)	.096	10.38 (1)	.001
Step 2 sex differences in a, c, e parameters					
3. Age-ACE sex differences		50.24 (43)	.208		
4. Age-ACE no sex differences [a]	3	50.82 (44)	.223	1.65 (2)	.438
Frequency of drinking: all twins					
Step 3 qualitative sex differences c parameter					
5. Age-ACE r_C estimated		71.80 (57)	.090		
6. Age-ACE r_C fixed at 0	5	78.14 (58)	.040	15.45 (1)	<.001
7. Age-ACE r_C fixed at 1	5	77.00 (58)	.048	12.22 (1)	<.001
Step 4 friends differences in a, c, e parameters					
8. Age-ACE differences friends		**59.32 (57)**	**.391**		
9. Age-ACE no differences friends	8	71.80 (57)	.090	17.12 (2)	<.001
Regular drinking: same sex twins					
Step 1 sex differences in age regression					
1. Age-ACE sex specific age effect		35.90 (35)	.426		
2. Age-ACE no sex specific age effect	1	42.44 (36)	.213	6.00 (1)	.014
Step 2 sex differences in a, c, e parameters					
3. Age-ACE sex differences		35.30 (32)	.315		
4. Age-ACE no sex differences	3	35.90 (35)	.426	.14 (3)	.987
Regular drinking: all twins					
Step 3 qualitative sex differences c parameter					
5. Age-ACE rC estimated		44.86 (45)	.478		
6. Age-ACE rC fixed at 0	5	54.64 (46)	.179	13.01 (1)	<.001
7. Age-ACE rC fixed at 1	5	50.42 (46)	.303	7.10 (1)	.008
Step 4 friends differences in a, c, e parameters					
8. Age-ACE differences friends		**35.65 (43)**	**.779**		
9. Age-ACE no differences friends	8	44.86 (45)	.478	11.94 (3)	.008

Note. A, additive genetic factor; C, common environmental factor; E, unique environmental factor. Vs, versus and indicates to which model the submodel is compared to. Models 1, 2, 3 and 4 are based on analyses using four groups of same-sex twins and models 5, 6, 7, 8 and 9 are based on analyses using all five groups of twins (MZM, DZM, MZF, DZF, DOS). r_C common environmental correlation in dizygotic opposite-sex twins. a model 1 is identical to model 4, both models contain sex specific age effects and no differences in a, c and e parameters between males and females. Best fitting model in bold.

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Nearly all participants (92%) indicated that they had initiated alcohol use. We repeated all analyses without the 8% of participants who indicated that they did not drink alcohol, because one could question whether the same genetic and environmental factors explain initiation and continuation of alcohol use. These analyses revealed similar results as in the analyses of the complete sample.

With regard to the group of twins who were similar in the behavior of their friends, a further distinction can be made between twins who both had many friends who were regular drinkers and twins who both indicated that half or less of their friends were regular drinkers. Among twins who were similar in the drinking behavior of their friends, 35% of the MZM, 31% of the DZM, 24% of the MZF, 21% of the DZF and 23% of the DOS twins indicated that the majority of their friends drink alcohol regularly. For both frequency of drinking and regular drinking, models were not significantly different for the group twins with the majority of their friends being a regular drinker and for twins with half or less of their friends being a regular drinker ($\Delta\chi^2(3) = 3.00$, $p = .392$ for frequency of drinking and $\Delta\chi^2(3) = .67$, $p = .880$ for regular drinking).

DISCUSSION

Our study tested to what extent estimates of heritability and common environment for alcohol use in adolescent and young adult twins (16-25 years) are moderated by the similarity of their friends' alcohol use. There is clear evidence for such moderation; being concordant for friends' alcohol use was associated with a decreased heritability and an increased influence of the common environment on variation in alcohol use compared to being discordant for the alcohol use of friends. In concordant twins, additive genetic effects explained 14% to 21% of the variance in alcohol use, and common environment explained 53% to 69% of the variance, depending on the phenotype (frequency or regular drinking). In contrast, in twins discordant for their friends' alcohol use the estimates for the effect of additive genetic factors were higher, ranging from 33% to 50% while the common environment explained 18% to 36% of the variance. The pattern of results was similar for men and women and for frequency of drinking and for regular drinking. Importantly, the contribution of the unique environment to the variance in alcohol use was similar in the groups of concordant and discordant twins. Heteroscedacity, that is differences between the groups in error variances associated with the mean differences in the groups, could have led to differences in the estimates for the proportion of the unique environment and thus lead to group differences in the heritability, without the presence of gene-environment interaction (Boomsma et al., 1999; Eaves et al., 1982). The fact that the contribution of the unique environment was similar in the two groups indicates that the differences in the groups as function of twin similarity in friends' alcohol use are due to gene-environment interaction.

Our results also showed that in adolescence MZ twins are more likely than DZ twins to have all of their friends in common and that MZ twins are also more likely than DZ twins to have similarly behaving friends, as was also shown in other studies (Horwitz et al., 2003; Rende et al., 2005; Rose, 2002; Walden et al., 2004). These findings can be explained by friendship selection processes. Friendship selection could stem from two sources as it could be socially or genetically mediated. According to the homophily theory people would like to become friends with others who are like themselves (Hogue & Steinberg, 1995; Lazarsfeld & Merton, 1954). This selection process is socially mediated, and thus MZ twins, who are more similar to each other than DZ twins, are more likely to have similar friends than DZ twins (Rose, 2007). Moreover, friendship selection is also likely to have a genetic basis, resulting from the fact that individuals seek out

Table 4

PARAMETER ESTIMATES AND PERCENTAGES EXPLAINED VARIANCE OF THE BEST-FITTING MODEL FOR FREQUENCY OF DRINKING AND REGULAR DRINKING IN TWIN PAIRS CONCORDANT FOR FRIENDS' ALCOHOL USE AND DISCORDANT FOR FRIENDS' ALCOHOL USE

	Age males	females	A males	females	C males	females	E males	females
Frequency of drinking								
Twins concordant friends' alcohol use	.24 (6%)	.05 (0%)	.44 (19%)	.46 (21%)	.73 (53%)	.75 (56%)	.47 (22%)	.48 (23%)
Twins discordant friends' alcohol use	.27 (7%)	.05 (0%)	.69 (47%)	.71 (50%)	.42 (18%)	.44 (19%)	.53 (28%)	.55 (30%)
Regular drinking								
Twins concordant friends' alcohol use	.20 (4%)	.07 (0%)	.38 (14%)	.38 (15%)	.81 (66%)	.83 (69%)	.40 (16%)	.40 (16%)
Twins discordant friends' alcohol use	.26 (7%)	.09 (1%)	.58 (33%)	.60 (36%)	.58 (34%)	.60 (36%)	.51 (26%)	.52 (27%)

Note. A, additive genetic influences; C, common environmental influences; E, unique environmental influences. The percentage explained variance is depicted between brackets and was obtained by squaring the standardized loadings. Frequency of drinking consisted of 7 categories: (1) "I do not drink alcohol", (2) "once a year or less", (3) "a few times a year", (4) "about once a month", (5) "a few times a month", (6) "once a week", (7) "a few times a week", and (8) "daily". Regular drinking was coded dichotomous and was defined as drinking a few times a month and more. Model fit frequency of drinking χ^2 (57) = 59.32; p = .391; Model fit regular drinking χ^2 (43) = 35.65; p = .779.

their friends on basis of their genetic makeup (Cleveland et al., 2005; Fowler et al., 2007b, Rose & Dick, 2005) and this too would cause MZ twins to have similar friends more often than DZ twins due to their larger genetic likeness.

Horwitz et al. (2003) argued that previous twins studies might have overestimated the strength of genetic influences and underestimated the strength of common environmental influences, because higher similarities in behavior among MZ compared to DZ twins do not only stem from genetic similarity but also from common environmental influences (i.e., common or behaviorally similar friends). Our results indeed show differences in strength of genetic and common environmental influences in twins with friends who were similar in alcohol use and in twins with friends who were different from each other in alcohol use. However, from the present study it is not clear what factors are related to over- or underestimation of results.

Several factors might be involved, such as friendship selection which could be environmentally or genetically induced. In fact, our study illustrates that both genes and friends are of importance in adolescent and young adult alcohol use, because the moderating effect of similarity in alcohol use of friends points to a gene by environment interaction. This underscores the importance of incorporating specific environmental factors in behavioral genetic research.

A few limitations of this study should be noted. It should be stressed that our study does not provide information about the causality in the relation between being concordant for their friends' alcohol use and the similarity in alcohol use within twin pairs. It is not clear whether having behaviorally similar friends causes similarity in alcohol use within twin pairs or whether similarity in alcohol use within twin pairs leads twins to get involved in similar social environments. For this study we constructed a cross-sectional dataset from two longitudinal measurement waves. Although analyses of longitudinal data may provide information regarding the direction of the association between friends' behavior and an individuals' alcohol use, the present information on the alcohol use in friends is limited in the sense that it is not known whether there may have been a change in friends over the time period. We therefore choose to analyze these data cross-sectionally. Previous studies on a similar topic (i.e., social contact within twin pairs, instead of similarity in friends, and similarity in alcohol use) with regard to causality showed mixed results. Two studies using a longitudinal design indicated that social contact within twin pairs leads to similarity in alcohol use in twins (Kaprio et al.,1990; Rose et al., 1990), while an other study, not using a longitudinal design, indicated that similarity in alcohol use within twins pairs leads to social contact (Lykken et al., 1990). In addition, we used self-reports of twins to assess frequency of drinking and regular drinking, while drinking of friends was assessed by twin reports on the number of regular drinking friends. It is possible that the twins' own alcohol use may have colored their perception of that of their friends. Future studies may benefit from obtaining self-report data in both twins and their friends and including them in longitudinal studies.

In conclusion, this study showed that concordance in friends' alcohol use has a moderating effect on the heritability estimates of alcohol use. Genetic factors were more important in the explanation of variation in alcohol use in twins discordant for friends' alcohol use, while common environmental effects were more important in the explanation of variation in alcohol use in concordant twins. These findings illustrate that both genes and friends are relevant in the variation of alcohol use of adolescent and young adult twins.

CHAPTER
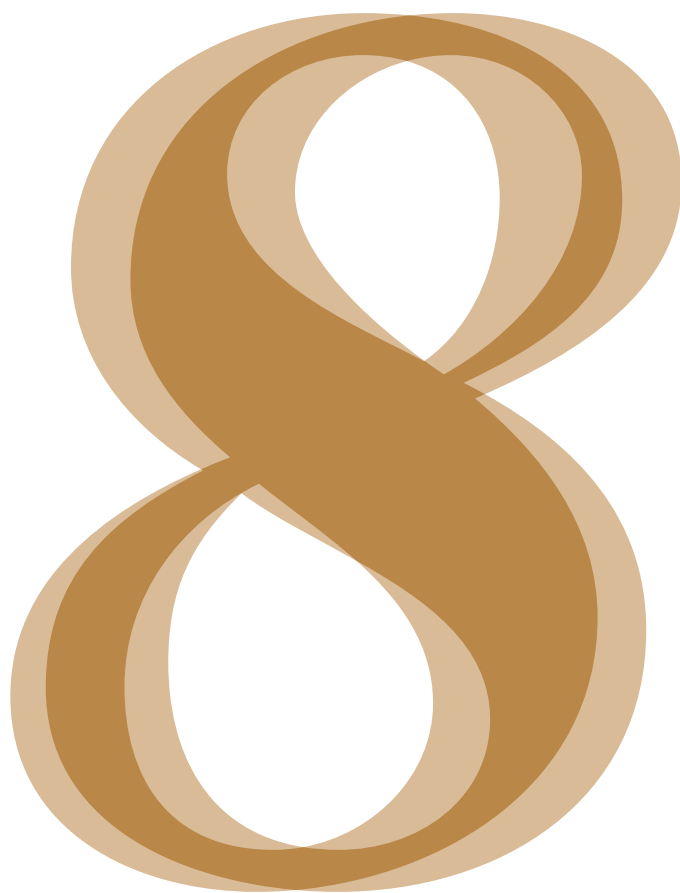
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PREDICTORS OF PROBLEM DRINKING IN ADOLESCENCE AND YOUNG ADULTHOOD: A LONGITUDINAL TWIN-FAMILY STUDY

ABSTRACT

We examined drinking behavior of parents, siblings, and friends of twins as predictors of adolescent and young adult problem drinking over a period of two and a period of seven years. Data of 12-30-year-old twins and their family members from the Netherlands Twin Register were analyzed. Problem drinking in twins was assessed in 1995 and 2000 and was defined based on the CAGE and amount of drinking. Data on alcohol use of parents, siblings and friends were collected in 1993. Logistic regression analyses were used to examine the short-term (1993-1995; n = 2994) and the long-term longitudinal predictors (1993-2000; n = 1796) of problem drinking. Age, sex and own alcohol use in 1993 explained a substantial part of the variance in adolescent and young adult problem drinking. Moreover, adolescents and young adults with fathers who drank frequently and with a large numbers of drinking friends, were at the highest risk for problem drinking two years later. Over a period of seven years the number of drinking friends was no longer a risk factor, but frequent alcohol use of fathers remained a risk factor for later problem drinking. Drinking behavior of mother and siblings did not substantially predict problem drinking. Sex and age did not moderate these effects.

INTRODUCTION

Recent figures on alcohol use in the Dutch population of 12 years and older show that 20% of the males and 5% of the females drink heavily, which is defined as drinking at least six drinks at one or more days a week (Statistics Netherlands, 2004). The prevalence is particularly high among young people in the age of 18 to 24 with 39% of the males and 9% of the females being heavy drinkers. Problem drinking refers to individuals who drink above a certain threshold and as a consequence experience problems related to their alcohol consumption. Prevalence rates of problem drinking peak at the same age as prevalence rates of heavy drinking; while the average among 16-70-year-olds is 17% for males and 4% for females (Van Dijck & Knibbe, 2005), during late adolescence and young adulthood (16-24 year of age), 34% of the males and 9% of the females is identified as a problem drinker. Heavy alcohol use and problem drinking in young people is associated with short-term consequences such as alcohol related violence, drunk driving, injuries, risky sexual behavior and school problems (Gruber et al., 1996; Hingson et al., 2003; Wechsler et al,, 1994), and is predictive of problematic alcohol use in adulthood (McCarty et al., 2004; O'Neill et al., 2001). These negative consequences call for extensive study of the predictors of adolescent and young adult heavy drinking and problem drinking. Research on young people's drinking generally focuses on more normative drinking patterns. It has provided evidence for the predictive value of drinking of family members and friends for adolescents' and young adult's alcohol use (e.g., Ary et al., 1993; Poelen et al., 2007; Reifman et al., 1998; Wood et al., 2004). However, only few studies examined the etiology of heavy drinking (e.g., Griffin et al., 2000; Reifman et al., 1998; Walden et al., 2007) and even less have focused on factors related to problem drinking in young people. The aim of this study is, therefore, to examine the role of the immediate social environment including parents, siblings and friends, on adolescent and young adult problem drinking.

Prior research on the effects of parental alcohol use on young people's drinking showed contradictory findings. Whereas some studies reported parental drinking to be related to problem drinking among adolescents (Ellickson et al., 2001), others found no significant associations (Ouellette et al., 1999). One limitation of these studies was that they did not examine the effects of maternal and paternal alcohol use separately, but combined mothers' and fathers' drinking into one overall measure of parental alcohol use. This overall mea-

sure might not capture the entire impact of parental drinking given that drinking of fathers and mothers may have a unique influence on their offspring's problem drinking. Those few studies that studied these differential influences again reported mixed findings. Walden et al. (2007) reported that both fathers' and mothers' drinking was related to adolescent heavy drinking, as did McGue et al. (1996a) who further showed this result to be stronger for biological than adoptive parents. In contrast, Reifman et al., (1998) reported that only mothers' drinking was related to heavy drinking among adolescents, while another study suggested that neither paternal nor maternal alcohol use was related to adolescent problem drinking (Windle, 2000).

Siblings and peers may also contribute to adolescent heavy drinking and problem drinking. Regarding the role of sibling drinking on problem drinking, only a small number of studies exist. Using data of adoptive siblings, McGue et al. (1996a) indicated that siblings' drinking is substantially related to adolescent alcohol misuse. In contrast, Windle (2000) did not find a longitudinal relation between siblings' frequency of drinking and adolescent problem drinking.

Friends' drinking is seen as a robust predictor of young people's alcohol use in general (Andrews et al., 2002; Ary et al., 1993, Bot et al., 2005a; Graham et al., 1991; Petraitis et al., 1995; Urberg et al., 1997; Wood et al., 2001). In line with these studies longitudinal research on adolescent heavy alcohol use (Griffin et al., 2000; Guilamo-Ramos et al., 2004; Ouellette et al., 1999; Reifman et al., 1998; Tucker et al., 2003) and problem drinking (Ellickson et al., 2001; Windle, 2000) also found support for the importance of drinking of friends.

Thus, previous studies point to the relevance of family members' and friends' drinking in predicting adolescent and young adult problem drinking. With regard to the relative importance, Windle (2000) reported that if parental, siblings', and friends' alcohol use were considered simultaneously in one longitudinal model, the effects of parental alcohol use were weakest. Other longitudinal studies simultaneously examining the roles of parents and friends (but not of siblings) found stronger effects for friends, with only significant effects of mother's drinking (Reifman et al., 1998) or no significant effects of parents' drinking (Ouellette et al., 1999). Ellickson et al. (2001) showed that friends' drinking but not parents' drinking was significantly associated with problem drinking over a period of two years. However, over a period of five years, parental drinking was significantly associated with problem drinking, but friends' drinking was not anymore.

In sum, existing studies suggest that parents', siblings' and friends' drinking may be important in adolescent and young adult problem drinking, although results are somewhat mixed. However,

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the impact of parents, siblings and friends has seldom been examined simultaneously in a long-term longitudinal study. In the current study we examined to what extent drinking of parents, siblings, and friends was related to adolescent and young adult problem drinking over a period of two years and seven years. We further explored whether these associations were moderated by sex and age.

METHODS

PROCEDURE AND PARTICIPANTS

Data reported in this study are part of a longitudinal survey study of the Netherlands Twin Register. Data collection was started in 1991 and 1993 by recruiting adolescent twins aged 13-22 years and their families. Their addresses were obtained from city councils in the Netherlands. In later years, additional volunteer twin families also participated. Since 1991 adolescent twins and their families received surveys about health, lifestyle and personality approximately every two years. Twins were asked to participate every two years (1991, 1993, 1995, 1997, 2000, 2002 and 2004), parents in 1991, 1993, 1995, 2002 and 2004, and siblings from 1995 onwards. Some individuals participated only once, others participated several times. Information about sample and data collection is described in detail in Boomsma et al. (2006; 2002).

In the present study we used data from the 1993, 1995, and 2000 surveys. At the first wave the mean age was 17.8 years (SD 3.1) with an age range from 12 to 25. Participants were grouped into three age groups. The youngest group consisted of 12-15-year olds and included all adolescents that were under the legal age to buy and drink alcohol. The second group contained middle and late adolescents aged 16-20. This age period is the period in which the adolescents are allowed to buy alcoholic beverages, and it is also the period during which regular drinking patterns develop. The oldest age group consisted of 21-25-year-old young adults and reflected the period in which individuals become more autonomous young adults who often leave home and are less guided by parental supervision and monitoring. The sample for the short-term (2 years) longitudinal analyses consisted of 1243 monozygotic (MZ) twins and 1751 dizygotic (DZ) twins, who participated in 1993 and 1995. For the long-term (7 years) longitudinal analyses the sample consisted of 839 MZ twins and 957 DZ twins, who participated in 1993 and 2000.

MEASURES

According to Van Dijck and Knibbe (2005) people are problem drinkers if they drink above a certain threshold and if they experience problems related to their alcohol use. We assessed drinking problems in the twins in 1995 and 2000 by using the CAGE questionnaire, a widely used screening instrument for problem drinking (Bisson et al., 1999; Smart et al., 1991). The CAGE questionnaire derives its name from the acronym of four questions: "Have you ever felt you ought to

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cut down on your drinking?", "Have people *annoyed* you by critici-
zing your drinking?", "Have you ever felt bad or *guilty* about your
drinking?", and "Have you ever had a drink first thing in the morning
to steady your nerves or get rid of a hangover?" (*eye opener*). The
questions were dichotomous: (1) "no" and (2) "yes". The score on
the CAGE scale was established by summing the answers of the four
questions (Ewing, 1984). Participants were also asked to report their
quantity of drinking with the question: "How many drinks do you
drink on average per week (including the weekend)?" This question
had seven response categories (1) "less than 1 drink a week", (2) "1-2
drinks a week", (3) "3-5 drinks a week", (4) "6-10 drinks a week", (5)
"11-20 drinks a week", (6) "21-40 drinks a week", and (7) "over 40
drinks a week" (Poelen et al., 2005).

We defined problem drinking as at least one reported problem
on the CAGE scale in combination with an alcohol consumption of at
least 11 drinks a week. This resulted in a dichotomous variable: (1) "no
problem drinker" and (2) "problem drinker". A cut-off point of one or
more positive answers on the CAGE was shown to be the most valid
cut-off point in adolescents (Chung et al., 2000). Problem drinking of
the adolescents and young adults was assessed in 1995 and 2000.

Frequency of drinking in twins was assessed in1993 with the
question: "How often do you drink alcohol?" This question had eight
response categories: (1) "I do not drink alcohol", (2) "once a year or
less", (3) "a few times a year", (4) "about once a month", (5) "a few
times a month", (6) "once a week", (7) "a few times a week", and (8)
"daily". This item was recoded into: (1) "never/seldom", (2) "less than
12 times a year", (3) "a few times a month". We combined this
measure with three zygosity categories: MZ, same sex DZ and dizy-
gotic opposite sex (DOS) twins, resulting in a measure with 9 catego-
ries. Missing data on frequency of drinking of co-twins could be com-
pleted by twins' reports on their co-twins' drinking, as these reports
were highly correlated ($r = .84$, $p < .001$).

Drinking of parents, siblings and friends was assessed in 1993
to predict problem drinking of adolescents and young adults respec-
tively two and seven years later. Frequency of drinking for fathers
and mothers was based on self-reports and was categorized as: (1)
"never/seldom", (2) "a few times a week", and (3) "daily". In case
data on alcohol use of father or mother were missing, data on alco-
hol use of 1995 were used, because these were highly stable over
time (for fathers $r = .75$, $p < .001$ and for mothers $r = .78$, $p < .001$).
If these data were also not available, we used twin reports on their
parents' alcohol use. Correlation analyses showed a sufficient resem-
blance between twin reports and parents reports of parental frequency

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of drinking ($r = .71$, $p < .001$ for fathers' drinking, and $r = .77$, $p < .001$ for mothers' drinking). In our sample 117 twins were from single parent (only mother) families, these families were excluded from further analyses as data on father's drinking was lacking.

In 1993, twins were asked about frequency of drinking of their brother(s) and sister(s) other than their co-twins. Based on these answers, drinking of non-twin siblings was categorized as: (1) "one or more brother(s) or sister(s) who seldom drink alcohol", (2) "one or more brother(s) or sister(s) who drink a few times a month alcohol", (3) "one or more brother(s) or sister(s) who drink a few times a week alcohol" and (4) "no additional brother(s) or sister(s)". There were 1501 participants with at least one brother and 1391 participants with at least one sister. When participants had more than one additional brother or sister, alcohol use of the most frequently drinking additional sibling was used to categorize the participants. In 1993, twins were also asked how many of their friends drank alcohol. Drinking of friends was categorized as: (1) "no drinking friend", (2) "a few friends drink", and (3) "more than half of the friends drink".

DATA ANALYSES

To determine whether drinking of family members and friends predicted problem drinking in adolescents and young adult twins we conducted multivariate logistic regression analyses for the short-term (1993-1995) and for the long-term (1993-2000) longitudinal data. In both analyses all predictor variables, including frequency of drinking of both twins, were assessed in 1993 while problem drinking of twins was assessed in 1995 and 2000. We used logistic regression analyses; age, sex, and respondents' own frequency of drinking in 1993 were entered in the model at the first step, thus in our analyses we controlled for these variables. Drinking of parents, co-twins, additional non-twin siblings and friends were entered in the model at the second step. Interaction terms between drinking of parents, co-twins, additional non-twin siblings and friends, and age and sex were entered in the model at the third and fourth step, respectively. These interaction terms were used to test whether the relations between family and friends' drinking and twins' alcohol use were different for 12-15-year olds, 16-20-year olds, for 21-25-year olds, and also for males and females.

RESULTS

DESCRIPTIVES

Table 1 shows the prevalence rates of problem drinking for males and females in each age group. As can be seen in Table 1, males were more often problem drinkers than females. In 1995, among the 16-20 year olds, 16% of the males as opposed to 5% of the females were problem drinkers (χ^2(1, n = 908) = 29.98, p < .001). Among the 21-25 year olds, these figures were 19% versus 7% for males and females, respectively (χ^2(1, n = 1387) = 49.78, p < .001). In the 2000 data, a similar pattern emerged. In each age group, about 30% of the males were problem drinkers, while these percentages were between 7% and 10% for females (χ^2(1, n = 268) = 22.68, p < .001 for 16-20-year olds; χ^2(1, n = 930) = 64.84, p < .001 for 21-25-year olds and χ^2(1, n = 556) = 49.15, p < .001 for 26-30-year olds).

Results also showed that in 1995 age differences existed for males (χ^2(3, n = 1156) = 16.12, p = .001) and females (χ^2(3, n = 1462) = 9.18, p = .027) but that age differences were not significant in 2000. These differences in 1995 were caused by the prevalence in 12-15-year olds and in 21-25-year olds, as the difference in prevalence between 16-20-year olds and 21-25-year olds was not significant. Not surprisingly, only a very small percentage of the 12-15-year olds were identified as problem drinkers. Because the 26-30 year olds only contained a very small number of participants (nine males and six females), the figures concerning the percentage of problem drinkers in these groups should be interpreted wit caution.

Table 1

THE NUMBER AND PERCENTAGE OF PARTICIPANTS REPORTING PROBLEM DRINKING BY AGE AND SEX

	Male				**Female**			
	12-15	**16-20**	**21-25**	**26-30**	**12-15**	**16-20**	**21-25**	**26-30**
Problem drinking								
1995, *n*	5	102	74	1	3	37	35	1
%	4.0	16.3	18.7	11.1	1.6	4.9	6.8	16.7
2000, *n*	—	32	111	52	—	17.0	59	25
%	—	33.3	31.3	28.6	—	9.9	10.3	6.7

Note. Prevalence rates differed significantly between males and females (Chi-square tests p < .05) except among 12-15-year olds and 26-30-year olds in 1995. Chi-square tests for sex differences ranged from χ^2(1, n = 908) = 29.98, p < .001 to χ^2(1, n = 930) = 64.84, p < .001.

AGE AND SEX EFFECTS

Table 2 presents the results of the logistic regression analyses. Age of the participants in 1993 was not predictive of problem drinking over a two year period (1993-1995) but did predict problem drinking over the seven-year period (1993-2000). The results indicated that the youngest participants in 1993 were two to five times more likely to be problem drinker in 2000 than were the 16-20 and 21-25 year-olds, respectively. Both on the short-term and long-term, males were more at risk for problem drinking than were females. Moreover, participants who drank at least a few times a month in 1993 were of higher risk for problem drinking in 1995 and 2000 than those who never or seldom drank.

DRINKING OF FATHERS, MOTHERS AND SIBLINGS

Paternal drinking was predictive for adolescent and young adult problem drinking, both over the two- and seven-year period. Adolescents and young adults whose fathers drank a few times a week in 1993 were about two times more likely to be a problem drinker in 1995 and 2000. Even more, when their fathers drank daily in 1993, they were also two times more likely to be problem drinker, but only over the two-year period.

The predictive value of maternal drinking turned out to be lower than that of fathers. The only significant association was found for drinking a few times a week in relation to problem drinking in 1995: when mothers drank a few times a week in 1993, the adolescents and young adults were less at risk for problem drinking than adolescents and young adults whose mothers never or seldom drank in 1993.

In general, alcohol use of the co-twin in 1993 was not predictive of problem drinking in 1995, nor in 2000. The only exception was for adolescents and young adults whose DOS co-twin never or seldom drank in 1993: they had a higher risk for problem drinking in 2000 compared to twins who had a MZ co-twin who never or seldom drank in 1993. The alcohol use of additional brothers or sisters also turned out to have a low predictive value in general. Only adolescents who had a sister who drank a few times a month in 1993 were more likely to be a problem drinker in 1995, compared to participants who had a sister who never or seldom drank in 1993.

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Table 2

LONGITUDINAL ASSOCIATIONS BETWEEN ALCOHOL CONSUMPTION OF PARENTS, SIBLINGS, AND FRIENDS AND PROBLEM DRINKING OF ADOLESCENTS AND YOUNG ADULTS

Variable	1993-1995		1993-2000	
	OR	95% CI	OR	95% CI
Step 1				
Age 1993				
12-15 year	1		1	
16-20 year	1.24	0.71-2.15	0.44***	0.28-0.67
21-25 year	0.75	0.40-1.42	0.18***	0.10-0.34
Sex				
Males	1		1	
Females	0.37***	0.27-0.50	0.25***	0.18-0.33
Alcohol use 1993				
Never/seldom	1		1	
A few times a year	0.58	0.23-1.47	1.01	0.60-1.71
A few times a month	2.49*	1.10-5.64	2.58**	1.47-4.52
Step 2				
Alcohol use father				
Never/seldom	1		1	
Few times a week	2.24**	1.37-3.65	1.78*	1.13-2.81
Daily	1.95*	1.16-3.26	1.46	0.90-2.36
Alcohol use mother				
Never/seldom	1		1	
Few times a week	0.67*	0.47-0.94	0.89	0.64-1.25
Daily	0.81	0.52-1.24	0.98	0.65-1.49
Alcohol use co-twin				
MZ never/seldom	1		1	
MZ a few times a year	0.74	0.20-2.71	0.83	0.41-1.69
MZ a few times a month	1.47	0.46-4.68	1.32	0.68-2.57
DZ never/seldom	0.55	0.12-2.67	0.86	0.42-1.77
DZ a few times a year	1.33	0.38-4.69	1.25	0.58-2.70
DZ a few times a month	1.48	0.46-4.77	0.90	0.44-1.84
DOS never/seldom	1.19	0.30-4.68	2.18*	1.14-4.15
DOS a few times a year	0.90	0.25-3.21	0.86	0.38-1.95
DOS a few times a month	1.48	0.46-4.75	1.15	0.56-2.36
Alcohol use brother(s)				
Seldom	1		1	
Few times a month	1.61	0.81-3.20	0.77	0.43-1.40
Few times a week	1.78	0.98-3.22	0.87	0.52-1.46
No additional brother(s)	1.50	0.87-2.58	0.98	0.65-1.47
Alcohol use sister(s)				
Seldom	1		1	
Few times a month	1.76*	1.03-3.02	1.44	0.84-2.45
Few times a week	1.44	0.79-2.62	1.74	0.93-3.24
No additional sister (s)	1.09	0.70-1.72	0.91	0.62-1.33
Alcohol use friends				
No one drinks	1		1	
A few drink	2.32	0.85-6.36	0.74	0.46-1.18
More than half drink	6.03***	2.24-16.23	1.26	0.75-2.10

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DRINKING OF FRIENDS

With regard to alcohol use of friends, our results showed that having a large number of drinking friends in 1993 was related to a substantial higher risk for problem drinking in 1995 compared to having no drinking friends in 1993. Having a few drinking friends in 1993 was not related to problem drinking.

Interactions between drinking of family members and friends, and age and sex were not significant. Thus the relation between family and friends' drinking and twins' alcohol use was not different for 12-15-year olds, 16-20-year olds and 21-25-year olds, nor for males and females.

In addition, our analyses showed that the short-term longitudinal model explained 30% of the variance in problem drinking, of which 25% was explained by age, sex and adolescents' and young adults' own alcohol use in 1993. The long-term longitudinal model with age, sex and own alcohol use in 1993 explained 21% of the variance in problem drinking. Adding family members' and friends' drinking to the model resulted in an additional 3% of the explained variance.

DISCUSSION

The main question we addressed in this study was to what extent adolescent and young adult problem drinking was predicted by drinking of family members (fathers, mothers, and siblings) and friends, over a period of two years or seven years, while accounting for the effect of age, sex, and own alcohol use.

Age, sex and own alcohol use were important predictors of problem drinking, but age and sex did not moderate the effects of family members and friends. This study showed that males were more often problem drinkers than females, which was comparable to other recent data of the national representative study on problem drinking in the Netherlands by Van Dijck and Knibbe (2005).With regard to age differences our study showed that people who were between 16 and 25 years of age in 1993 were at lower risk to be a problem drinker in 2000, when they were between 23 and 32, compared to participants who were 12 to 15 years old in 1993 and who were 19 to 22 in 2000. This finding is also in line with the finding by Van Dijck and Knibbe (2005) who reported that among 25-34-year olds problem drinking was less prevalent than among 16-24-year olds. This age effect might be explained by the fact that older adolescents and young adults were more likely to have finished their educational track and started working in 2000. Changes in social roles, such as the acquisition of a career, a spouse role and a parental role are to a large extent accountable for a drop in heavy and problem drinking (Hajema & Knibbe, 1998). As seen in other studies (Griffin et al., 2000; Guilamo-Ramos et al., 2004; Walden et al., 2007), our results showed that males were at higher risk for problem drinking than females.

An important conclusion of our study is that adolescents and young adults with relatively high levels of alcohol use are of higher risk for problem drinking after two and even seven years compared to adolescents and young adults with lower levels of alcohol use at baseline. This corroborates earlier studies showing that previous use is a strong predictor of current heavy and problematic drinking (Duncan et al., 1997; Ellickson et al., 2001; Griffin et al., 2000; Windle, 2000). Apparently, young people who drink at higher levels continue and accelerate their alcohol intake during adolescence and young adulthood resulting in subsequent problem drinking.

With regard to the impact of drinking of family members and friends, our findings indicated that adolescents and young adults who had fathers who frequently drank (i.e., a few times a week of daily) were twice as likely to be a problem drinking two or even seven

years later. This is in line with Ellickson et al. (2001) who found an effect of fathers' drinking over a five year interval. The association between father's drinking and problem drinking could be interpreted as a modeling effect of children of their father's behavior. But it may also be, as indicated by McGue et al. (1996a), that genetic factors are involved in the relationship between father's alcohol use and problem drinking in their offspring. McGue et al. (1996a) arrived at this conclusion because they only found an association between drinking of biologically related parents and their offspring and not between parents and their adoptive offspring.

In contrast to paternal drinking, drinking of mothers, co-twins or other siblings was not substantially related to adolescents' future problem drinking. We expected to find significant associations between twins' drinking, because twins are generally more alike than singletons and we previously found a significant association between co-twin's drinking and regular alcohol use (in particular over a two year period) (Poelen et al., 2007). However, as twins are likely to be similar in their alcohol use, the effect of the co-twins could have been captured in participants' own alcohol use, and there was little variance left to be explained by drinking of the co-twin. To test this possibility, we examined whether the association between cotwin's drinking and adolescent and young adult drinking was stronger if we did not control for participants' alcohol use at baseline. These analyses did not result in higher predictive values for co-twins' drinking. Still, the fact that other family members were included may cloud this issue, as the association between cotwin's drinking and adolescent and young adult drinking more prominent if drinking of other family members and friends were not included in the analyses and of we did not control for age, sex and participants' alcohol use at baseline.

Comparison of associations of alcohol use within MZ co-twins with associations of alcohol use within DZ co-twins could be used to disentangle genetic and environmental effects on behavior. The comparison in this study did not reveal a consistent pattern of associations within MZ and DZ twin pairs. This might be explained by the fact that we assessed associations between one twin's frequency of use in 1993 with the other twin's problem drinking in 1995 and 2000, while in classical twin studies drinking of twins is assessed with identical measures at the same point in time. The relative importance of genetic and environmental effects on problem drinking in young people has been rarely studied, only Young et al. (2006) showed that the variance in problem drinking in adolescents was for 53% explained by genetics and for 46% by environmental factors. All of these findings suggest that genes might play a role in problem drinking.

In line with studies on adolescent heavy alcohol use (Griffin et al., 2000; Guilamo-Ramos et al., 2004; Reifman et al, 1998; Tucker et al., 2003) and problem drinking (Ellickson et al., 2001; Ouellette et al., 1999; Windle, 2000) our study showed that drinking of friends can be considered to have a strong influence on problem drinking in adolescents and young adults over a short period of time, in our study two years. However, over a longer time period (i.e. seven years) drinking of friends did not add to the prediction of problem drinking. Possibly drinking of friends is not related to problem drinking later in life, but it is more likely that friendships changed during the assessment periods and that the adolescents and young adults made new friends with other drinking habits which outweighed the more distal effects of the former friends.

This study had a number of strengths, including a large sample, longitudinal data, and simultaneous examination of the impact of parents', siblings' and friends' drinking on adolescent and young adult problem drinking. However, while interpreting our results it should be noted that we used self-reports of parents and twins to assess their alcohol use, but that alcohol use of friends and additional siblings was reported by twins. This might have caused an overestimation of the effects of alcohol use of friends, since people tend to project their behavior to that of their friends, and perceived reports on drinking may therefore correlate more than actual reports (Bauman & Ennett, 1996). In 1995 examination of self-reports of additional siblings as well as twin-reports over their siblings showed that these reports highly correlated (correlations around .74, $p < .001$). This indicates that twins were very well capable of reporting on their siblings' alcohol use. We think that this also applies for twin reports on friends' drinking, thus our results are probably unbiased by overestimation of the effects of alcohol use of friends.

In conclusion, our study indicates that age, sex and own alcohol use explained a substantial part of the variance in adolescent and young adult problem drinking. Moreover, adolescents and young adults who had frequently drinking fathers and a large number of drinking friends, were at the highest risk for problem drinking two years later. Over a period of seven years frequent alcohol use of fathers remained a risk factor for later problem drinking but the number of drinking friends was no longer a predictor of problem drinking. However, these effects explained only a small part of the variance in problem drinking compared to age, sex and own alcohol use. Drinking of other family members did not add much to the prediction of problem drinking. Our findings did not show sex and age differences in effects of family and friends' drinking.

CHAPTER

9

GENERAL DISCUSSION

INTRODUCTION

The aim of the current thesis was to examine the etiology of individual differences in alcohol use in adolescents and young adults. In this chapter we discuss the main findings presented in this thesis. A summary of the main findings is presented on page 137. We first evaluate the findings on prevalence and development of alcohol consumption in adolescents and young adults. Next, we discuss the role of parents, siblings and friends in alcohol use and the relative contribution of genes and environment. Finally some suggestions for future research are given.

ASPECTS OF ALCOHOL CONSUMPTION IN ADOLESCENTS AND YOUNG ADULTS

Alcohol consumption in adolescents and young adults develops across several stages of use. Most adolescents enter the initiation stage and the subsequent regular drinking stage, but not all young people enter the more advanced stage of problem drinking. The current thesis confirms the presence of these stages in a sample of adolescents and young adults. It reveals that the majority of Dutch adolescents initiated alcohol use before the age of 16. Questionnaires filled out between 1993 and 2000 show that 68%-88% of the 12-15-year-old males and 60%-85% of the 12-15-year-old females indicated that they ever drank alcohol (Chapter 2). Thirty percent of these 12-15-year-old participants reported that they initiated before the age of 13 (Chapter 5). Time trends revealed that 12-15-year olds drank more frequently and consumed more drinks a week in 2000 than in 1993 (Chapter 2). Several factors such as lack of restrictive policy on underage drinking, lack of reinforcement of laws, and allowance of alcohol advertisements in the Netherlands might account for this increase in juvenile drinking. The increase in alcohol use in this age group could also be related to the introduction of so-called alcopops and bottled mixed drinks during the 1990s. These drinks have a sweat taste that conceals the taste of alcohol, and are therefore easy to drink. Other European studies already indicated that the introduction of alcopops accounts for an increase in drinking among 13-16-year olds (Roberts et al., 1999; Romanus, 2000). Dutch research shows that alcopops and bottled mixed are among the most popular alcoholic beverages among students in secondary education (De Zwart et al., 2000; Ter Bogt et al., 2002).

At the age of 12-15-years, regular drinking (16%-29% in males and 11%-24% in females) and problem drinking (4% in males and 2% in females) were not very prevalent, but this thesis shows that regular drinking and problem drinking become more widespread in late ado-

lescence and young adulthood. About 70% to almost 90% of the 16-20-year-old and 21-25-year-old males and between 52% and 71% of the 16-20-year-old and 21-25-year-old females were regular drinkers (Chapter 4). Problem drinking was less prevalent. About 16%-33% of the 16-20-year-old and 21-25-year-old males and 5%-10% of the 16-20-year-old and 21-25-year-old females were problem drinkers (Chapter 8). Although problem drinking was less prevalent than regular drinking, both percentages are rather high, particularly in males. These figures on late adolescent and young adult male alcohol use are in line with other studies showing that regular drinking and problem drinking are particularly high in this group (Karam et al., 2007; Van Dijck & Knibbe, 2005).

Prevalence rates for lifetime alcohol use, frequency of drinking, quantity of drinking, lifetime drunkenness, frequency of drunkenness and problem drinking increased with age from age 12 until the age of 25, after which these rates decreased (except for lifetime alcohol use) (Chapter 2). This decrease of alcohol use after the age of 25 might be explained by a change in social role as in general the majority of the people over 25 start working, acquire a partner or become a parent, which has been shown to be associated with a decrease in drinking (Hajema & Knibbe, 1998).

In addition to the age effects on alcohol use, our study confirmed other studies on sex differences in alcohol use by showing that, except in the youngest age group (12-15) and on lifetime alcohol use, males exceed females on all aspects of drinking (e.g., De Zwart et al., 2000; Sutherland & Shepherd, 2001; Van Laar et al., 2002; Young et al., 2002). Sex differences in alcohol consumption might be partly caused by physiological differences in sensitivity to alcohol, as females are in general more sensitive to alcohol than males and, therefore, females need to drink less to obtain the same physical effects from alcohol as males (Ely et al., 1999; Frezza et al., 1990; Wilsnack et al., 2000). Nonetheless, physiological differences in sensitivity to alcohol do not explain sex differences in drunkenness. Sex differences in alcohol use might also be explained by socio-cultural factors. In western cultures a greater tolerance exists towards male drinking than towards female drinking. Drinking is often seen as a demonstration of masculinity, while drinking generally does not fit with expectations of females' public behavior and feminine roles (e.g., Wilsnack et al., 2000).

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SUMMARY OF RESULTS

	Chapter
Drinking of fathers and mothers is cross-sectionally related to regular drinking;	**3, 4**
Fathers' drinking consistently predicts problem drinking in their offspring.	**8**
Drinking of siblings other than the co-twin hardly contributes to regular drinking and problem drinking.	**3, 4, 6, 8**
Drinking of the co-twin is a strong risk factor for regular drinking, in particular cross-sectionally and over a short period of time;	**3, 4**
Drinking of the co-twin does not predict problem drinking.	**8**
Drinking of friends is cross-sectionally strongly associated with regular drinking;	**3, 4, 6**
Drinking of friends is a risk for regular drinking and problem drinking over a period of two years but not over a period of seven years.	**8**
Friends' drinking is cross-sectionally and over a short period in time more relevant than parental drinking, while over a longer period of time parents remain important and friends' drinking is no longer relevant.	**4, 8**
Genes are most important in explaining the variation of initiation of alcohol use in early adolescents (12-15-years old) (83% in males and 70% in females).	**5**
Common environment explains most of the variation of frequency of drinking in early adolescents (12-15-years old) (82% in both males and females).	**5**
Both genes and friends' drinking explain the variation in frequency of drinking and regular drinking in adolescents and young adults (16-25 years).	**7**
Similarity in drinking between friends of twins moderated the estimates of heritability and common environment.	**7**

THE ROLE OF FAMILY AND FRIENDS

In the current thesis genetic and environmental contributions to different stages of alcohol use in adolescents and young adults were examined. We will first discuss the role of alcohol use of family and friends from the viewpoint of social interaction and environmental mediation. Family members, unlike friends, share both genes and environment and thus there is no simple interpretation for an association between for example parental drinking and drinking behavior in their offspring. In the next sections we get back to genetic influences on alcohol use in adolescents and young adults, when analyzing the data from monozygotic (MZ) and dizygotic (DZ) twins.

PARENTAL ALCOHOL USE

Cross-sectional examination of associations between drinking of fathers and mothers and drinking in their offspring showed relative small associations for regular drinking (Chapter 3 and 4). This is in line with other studies on the role of parental alcohol use in young people's drinking (e.g., Duncan et al., 1996; Li et al., 2002; Wood et al., 2004). These associations were persistent over two years and for mothers even over seven years of time (Chapter 4). Moreover, associations with problem drinking of adolescents and young adults were examined in a longitudinal design. In line with Ellickson et al. (2001) and Walden et al. (2007), results showed that fathers' drinking was consistently related to problem drinking in their offspring (Chapter 8). Relatively frequent drinking of fathers at baseline predicted problem drinking in their children after two and even after seven years. This thesis indicates that drinking of both fathers and mothers contributes to alcohol use in their offspring, and it appears that mother's drinking plays a larger role in regular drinking and that father's drinking plays a larger role in problem drinking. However, it should be noted that both parents might be equally relevant to their offspring's alcohol use, but due to the relatively strong similarities in parental drinking, this might not become visible in multivariate analyses. This is supported by the fact that our cross-sectional univariate analyses on regular drinking did not indicate significant differences between relative risks regarding drinking of fathers and drinking of mothers.

Chapters 3, 4 and 8 did not reveal sex differences in the associations between alcohol use of fathers and mothers and regular drinking and problem drinking in their offspring. We did not found

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support for the assumption that alcohol use of the same-sex parent has a larger impact (Harburg et al., 1982; Newcomb et al., 1983). Fathers' and mothers' drinking has the same role in male and female regular drinking and problem drinking, as was also shown in other studies (Björkqvist et al., 2004; Seljamo et al., 2006).

ALCOHOL USE OF SIBLINGS

We found small or non-significant associations between drinking of siblings other than the co-twin and regular drinking and problem drinking of adolescents and young adults in both cross-sectional and longitudinal analyses (Chapter 3, 4 and 8). In contrast, drinking of the MZ and DZ co-twin was a strong risk factor for adolescent and young adult regular drinking, in particular cross-sectionally and over a short period of time (Chapter 3 and 4), but drinking of the MZ and DZ co-twin was not related to problem drinking over time (Chapter 8). Conclusions on the relative importance of twin siblings versus non-twin siblings in alcohol use of adolescents and young adults can only be drawn from relative risk analyses in Chapter 3. This chapter shows that, in particular in 12-15-year olds, regular drinking of MZ co-twins posed the highest risk for regular drinking, followed by same sex DZ co-twins, opposite sex DZ co-twins and non-twin siblings. One of the most important explanations for differences in the impact of MZ co-twins and DZ- co-twins and non-twin siblings are genetic differences. MZ twin siblings are likely to be more similar in alcohol use than non-twin siblings because they share all of their genes, while DZ twin siblings and non-twin siblings share about half of their genes. Twin siblings are also likely to be more similar in alcohol use than non-twin siblings as twins are of the same age. In adolescents and young adults variations in alcohol use are strongly age dependent and twin siblings may therefore be more similar in alcohol use. In addition, MZ and DZ twin siblings could be more important role models for each other than non-twin siblings and thus more strongly affect each other's behavior. The Social Learning Theory (Bandura, 1977) indicates that modeling of behavior is likely to occur if a person is similar to the role model, for example in age or sex. However, such social interaction models in twins lead to strong predictions of differences in variances (for continuous traits; Boomsma, 2005) or differences in prevalence (for categorical traits; Carey, 1992). We did not obtain evidence that such mechanisms play an important role. Finally, siblings who are close in age (or of the same age in case of twins) are likely to spent time together at home or outside home throughout adolescence. This might result in more shared experiences within the family environment, at school and with friends Boyle et al. (2001), and might lead to similarities in drinking.

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Not only alcohol use of parents and siblings might play a role in the development of alcohol use in adolescents and young adults, but also factors outside the family might be relevant. During adolescence young people try to develop an identity independent from their families and spent an increasing time with their friends. Friends might be important role models for alcohol use, because adolescents tend to conform to peer norms during this period.

Cross-sectional analyses in our studies showed that friends' drinking was strongly associated with adolescent and young adult regular drinking (Chapter 3, 4 and 6). In line with other studies on predictors of adolescents' regular drinking over a short period of time (Andrews et al., 2002; Ary et al., 1993; Beal et al., 2001; Bot et al., 2005a, Engels et al., 1999; Graham et al. 1991; Reifman et al., 1998; Urberg et al., 1997; Webster et al., 1994; Windle, 2000; Wood et al., 2001), we found that friends' drinking was a risk for adolescent and young adult regular drinking prospectively, over a period of two years (Chapter 4 and 6). Problem drinking was only examined longitudinally, and these analyses showed, in line with longitudinal analyses on adolescent heavy alcohol use (Griffin et al., 2000; Guilamo-Ramos et al., 2004; Ouellette et al., 1999; Reifman et al., 1998; Tucker et al., 2003) and problem drinking (Ellickson et al., 2001; Windle, 2000) that friends' drinking was a risk for adolescent and young adult problem drinking over a period of two years. Over a period of seven years, drinking of friends at baseline was no longer a risk factor for regular drinking and problem drinking in young people. It is striking that cross-sectionally and over a short period in time drinking of friends is more relevant to adolescent and young adult drinking than drinking of parents, while over a longer period of time parents remain important and friends' drinking is no longer relevant (Chapter 4 and 8).

Cross-sectionally and over a short period of time friends might function as role models for young people's drinking and in that way they actually have an impact on alcohol consumption. However, it should be noted that similarity between friends' drinking and young people's alcohol consumption not only results from influence of friends but might also stem from peer selection. Peer selection is the process in which friendships are formed on the basis of common behavior, such as, for example, alcohol use. Several studies argue that the influence of friends in the development of alcohol use in young people might be less significant than is often assumed, because friendships could be formed on basis of common alcohol use (peer selection) (Andrews et al., 2002; Bauman & Ennett, 1996; Engels et al., 1997; Fisher & Bauman, 1988; Sieving et al., 2000). Jaccard et

al. (2005) showed that peer influence was limited if peer selection effects were controlled for. According to the authors, peer influences are often overestimated and are probably not more important than parental influences.

Moreover, not all adolescents are affected in similar ways by alcohol use of their friends, and some adolescents might be more susceptible to peer influence than others. Adolescents who indicate to have a high quality friendship (Jaccard et al., 2005) and adolescents who indicate to have few conflicts in their friendships (Urberg et al., 2003) are more likely to be susceptible to peer influence. Moreover, several personality characteristics have been found to be related to susceptibility to peer influence (Engels et al., 2005; Vitaro et al., 2000). In Chapter 6 of this thesis we examined whether relationship quality with the best friend and individual's personality characteristics, such as extraversion and agreeableness, moderated the association between alcohol use of best friend's and alcohol use of adolescents. These findings did not reveal differences in susceptibility to peer influence according to relationship characteristics and individual's personality. They also illustrate the robustness of lack of strong longitudinal effects of friends' drinking on adolescent alcohol use, as we did not find significant effects of friends' drinking in subgroups which might be more susceptible to peer influence.

GENETIC AND ENVIRON-MENTAL INFLUENCES ON ALCOHOL USE

Variation in alcohol use in adolescents and young adults can be explained by both genetic and environmental factors. In this thesis (Chapter 5 and 7) we used the genetically informative twin design to examine the relative contribution of genes and environment to individual differences alcohol use in adolescents and young adults. Twin studies have shown that estimates of genetic and environmental influences strongly depend upon age and upon the phenotype that is analyzed. Different indicators of alcohol use may lead to different conclusions regarding heritability. It is important, when analyzing drinking behavior, to take into account the developmental stage of young people (e.g., Hopfer et al., 2003; Viken et al., 1999). In the current thesis, the etiology of variation in initiation of alcohol use and frequency of drinking in early adolescents (12-15-years old) and regular drinking in middle and late adolescents and young adults (16-25-years old) was examined in two separate studies.

GENES AND ENVIRONMENT IN EARLY ADOLESCENTS

This thesis shows that genetic factors were most important in explaining the variance of early initiation of alcohol use in early adolescents (12-15-years old), as they explained 83% of the variance in males and 70% of the variance in females. A much smaller part of the variance in early initiation of alcohol use in this group was explained by common environmental factors (2% in males and 19% in females) (Chapter 5). Previous studies showed that initiation of alcohol use was moderately heritable and largely explained by common environmental influences (Fowler et al., 2007a; Koopmans & Boomsma, 1996; Maes et al., 1999; Pagan et al., 2006; Rhee et al., 2003; Rose et al., 2001; Viken et al., 1999). Differences in findings between previous studies and our findings are likely to be explained by differences in phenotype and differences in age between samples. Most other studies mainly examined older adolescents or adolescent samples that were less homogeneous in age (i.e. samples with an age range of 11-19-years). In this thesis we focused on early adolescence as this is the period in which alcohol initiation usually takes place. In contrast to previous study we focused on early adolescent initiation. We made a distinction between adolescents who never initiated, adolescents who

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initiated at age 13 or after and adolescents who initiated before the age of 13. Early adolescent initiation has been shown to be related to negative consequences in later life, such as heavy alcohol use, problem drinking and alcohol dependence (Grant et al., 2001; Hawkins et al., 1997; Kuntsche et al., 2008; Pitkänen et al., 2005). Unlike other studies our assessment of initiation of alcohol use perhaps discriminated between more problematic (and genetically induced) early adolescent initiation and later adolescent initiation or abstinence until the age of at least 16.

In addition, common environmental factors explained most of the variance of frequency of drinking in 12-15-year olds (82% of the variance in both males and females), while genetic factors were not involved in the explanation of the variance of frequency of drinking (Chapter 5). Common environmental factors are those influences from the environment that twins who grow up in the same family have in common and that differ between families. These influences tend to make twins from the same family similar to each other, regardless of zygosity. In early adolescence, twins have the tendency to spend a lot of time together and therefore they have shared experiences at home and outside home such as at school and with friends. Variation between families of early adolescents might be caused by parental attitudes and norms towards alcohol use and some parents might set more strict rules towards their children's alcohol use than others (Van Der Vorst et al., 2008b). Also availability of alcohol and access to alcohol might differ between early adolescents of different families.

We were the first to test whether and to what degree the same factors were related to individual differences in initiation of alcohol use and frequency of drinking in a young group of adolescents that were relatively homogeneous in age. We found that genetic and unique environmental factors were specific for variation in initiation and frequency of drinking, thus variation in initiation and frequency of drinking were explained by different genetic and unique environmental factors. In females, common environmental factors were also specific for variation in initiation of use and frequency of drinking, while in males mostly the same common environmental factors explained the variances in initiation of alcohol use and frequency of drinking (Chapter 5).

These findings indicate that different prevention strategies need to be designed for adolescents who have not yet started to use alcohol and who already have initiated alcohol use, as different factors explained initiation of alcohol use and frequency of drinking. This thesis shows that there is a genetic predisposition for starting

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to use alcohol at an early age. Consequently prevention of alcohol initiation should ideally include identification of genetically predisposed adolescents. However, identification and screening based on a person's genetic makeup is yet technically not well developed and it is still not widely accepted by society. It certainly is possible to pay attention to offspring of parents who misuse alcohol, as these children probably have a hereditary higher risk for early alcohol initiation. Alternatively, the roles of parents in preventing adolescents to start drinking alcohol or to start drinking frequently could be stressed. Most Dutch adolescents start drinking alcohol at home in the presence of their parents (Engels, 1998). Van Der Vorst et al. (2008b) indicated that parents can control alcohol use of their children effectively. Prevention programs may be used, as indicated by Van Der Vorst and colleagues (2008b), to enhance parents' awareness of their powers to postpone the age of alcohol initiation of their children and to encourage parents to provide and maintain strict rules about their adolescent's drinking.

Once early adolescents have initiated alcohol use, common environmental effects predominate as influences on variation in frequency of drinking. These common environmental effects might incorporate factors from inside the family, such as drinking of parents and rules and norms of parents about alcohol use. Many Dutch parents allow adolescents to drink alcohol at home (e.g., Van Der Vorst et al., 2005) and about half of the Dutch early adolescents report to drink with their parents (NIGZ, 2006). In addition to intra-familial influences the common environment might include extra-familial influences such as shared peer effects. Adolescent siblings are likely to spent time together outside home, which results in shared experiences with friends (Boyle et al., 2001).

In addition, Chapter 5 implies that for a part the variance of frequency of drinking in males is explained by different common environmental factors than frequency of drinking in females. This sex difference might have its origin in differences in pubertal development in early adolescence as girls mature earlier than boys (Dick et al., 2000). Adolescents tend to form an identity independent from their parents and foster tighter bonds with their peers during adolescence. Girls do this earlier than boys because they mature earlier, which might imply that girls are more influenced by their peers than boys in early adolescence. Studies on this topic showed that early maturing girls are likely to affiliate with older and deviant peers (Caspi et al., 1993). Associations presented in Chapter 3 of this thesis indeed showed a trend being indicative that friends' drinking was a greater risk factor for drinking in females compared to males (Chapter 3).

GENES AND ENVIRONMENT IN LATE ADOLESCENTS AND YOUNG ADULTS

With regard to alcohol use in adolescents and young adults (16-25 years) this thesis shows that both genes and friends' drinking are relevant in explaining the variation in frequency of drinking and regular drinking. Our study was the first to examine the moderating effect of similarity in drinking between friends of twin 1 and friends of twin 2 on estimates of heritability and common environment. Findings indicate that genetic factors were more important in the explanation of variation in alcohol use in twins with behaviorally different friends (47%-50% explained variance for frequency of drinking and 33%-36% explained variance for regular drinking in males and females respectively) than in twins with behaviorally similar friends (19%-21% explained variance for frequency of drinking and 14%-15% explained variance for regular drinking in males and females respectively). In contrast, common environmental effects were less important in the explanation of variation in alcohol use in twins with behaviorally different friends (18%-19% explained variance for frequency of drinking and 34%-36% explained variance for regular drinking in males and females respectively) than in twins with behaviorally similar friends (53%-56% explained variance for frequency of drinking and 66%-69% explained variance for regular drinking in males and females respectively) (Chapter 7).

The estimates of explained variance detected in other twin studies were more or less in line with our results for twins with friends with different alcohol use. Other twin studies assessing alcohol use in adolescents aged 16 years and older indicated that genetic factors accounted for about 40% and common environmental factors for about 30% of the variance in frequency of drinking in 16-17-year olds (Pagan et al., 2006; Viken et al., 1999). In young adults aged 25 the variance of frequency of drinking in males was mainly explained by genes (48%) and for 8% by common environment. In females heritability was19% and common environment explained 31% (Pagan et al., 2006). The genetic components detected in these studies were higher than the genetic component in twins with friends with similar alcohol use. The estimates of the common environmental factors in previous twin studies were lower than the common environmental factors in twins with friends with similar alcohol use in our study.

This thesis seems to provide contrary findings with regard to the importance of friends in young people's alcohol use. In Chapter 7 the role of friends in alcohol use appeared to be evident, but according to findings described in Chapters 3, 4, 6 and 8 the role of friends' drinking in young people's alcohol use is less prominent. We suspect

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that differences in findings are caused by differences in cross-sectional or short-term longitudinal investigation versus long-term longitudinal investigation. We think that longitudinal examination of influences of friends over a longer period of time might lead to underestimation of the role of friends in young people's alcohol use. As friendships change rapidly during adolescence (Ennett & Bauman, 1994), influences of friends on adolescent alcohol use can only be detected in longitudinal designs with short-term follow-up assessments. This reasoning is in line with observational, correlational and experimental studies showing that strong direct imitation effects of peers in drinking contexts such as bars (Bot et al., 2007; Larsen, Engels, Granic & Overbeek, 2008; Quigley & Collins, 1999).

SUGGESTIONS FOR FUTURE RESEARCH

INCORPORATION OF EXPLICIT ENVIRONMENTAL MEASURES IN THE TWIN DESIGN

We examined relations between drinking of parents, siblings and friends and alcohol use of adolescents and young adults. We also looked at the resemblance for drinking in MZ and DZ twins. However, in the twin studies, we did not we did not incorporate the measures of parental drinking. As a next step, it would be informative to extend the twin design with explicit environmental measures such as parental alcohol use (Caspi et al., 2000; Dick et al., 2007a; Koopmans & Boomsma, 1996). This type of extension of the twin model will take us a step further in unraveling genetic and environmental effects. It provides insight into how the common and unique environmental effect is constituted. Some previous twin studies extended a twin design with explicit measures to examine main effects and moderator of these measures. For instance, Koopmans and Boomsma (1996) tested whether resemblance in alcohol use between parents and their offspring was genetically or culturally transmitted. They showed that in 15-16-year-old adolescents common environmental influences mainly accounted for the variance in alcohol use. However, cultural transmission explained only a small part of the common environmental influences. Dick et al. (2007a) included parenting characteristics, parental alcohol problems, parental smoking and friends' alcohol use in twin models on adolescent drinking and smoking at age 14 and age 17. These measures had a small main effect on adolescent drinking and smoking. This type of extended twin models helps us to gain a more comprehensive understanding of environmental factors affecting young people's alcohol use. Future studies should focus on including measures such as parental and friends' norms about alcohol use and indicators of alcohol specific socialization such as parental rules about alcohol use (Van Der Vorst et al., 2008b) to have a more complete understanding of specific behaviors of parents and friends that contribute to environmental effects on young people's alcohol use.

It is generally recognized that behavior is affected by a complex interplay between genes and environmental influences. Twin studies could use explicit environmental measures to examine whether these measures moderate genetic and environmental influences on drinking. In this thesis we examined drinking of friends and the extent to which twins share their friends. We found that similarities in drin-

king of friends of twins moderated genetic and shared environmental effects (Chapter 7); genetic effects on variation in alcohol use were higher and common environmental effects on alcohol use were lower in twins with behaviorally different friends than in twins with behaviorally similar friends. Other twins studies examining the moderation effects of explicit environmental measure on the relation between genetic and environmental effects on young people's alcohol use focused on parental monitoring and peer characteristics (Dick et al., 2007a; Dick et al., 2007b), specific measures of the family environment, such as parental closeness, family discipline and religious upbringing (Dick et al., 2001; Koopmans et al., 1999; Miles et al., 2005; Rose & Dick, 2005), and rural or urban residency and other socio-regional factors such as proportion of young adults in a regional area and the relative amount of money spent on alcohol in an area (Dick et al., 2001).

Twin studies indicating that genetic effects on individual differences in alcohol use were moderated by explicit environmental measures appear to provide evidence for gene-environment interactions. However, examination of gene-environment interactions are rather complex and according to Rutter and Silberg (2002) correct conclusions could only be drawn if the environmental effects are truly environmental, if genetic effects are measured and if the statistical power is sufficient to detect the interaction. Many previous twin studies on gene-environment interactions in young people's alcohol use do not fulfill these criteria. Although the relevance of well developed studies on gene-environment interactions in alcohol use in young people is acknowledged, these types of studies are relatively scarce. Only a few studies examined interactions of candidate genes (mainly related to dopamine and serotonin systems) with environmental risk factors such as family adversity and stress (see review by Van Der Zwaluw & Engels, 2008). These studies predominantly examined alcohol dependence (e.g., Heath & Nelson, 2002) and problem drinking (Nilsson et al., 2008), while less attention was paid to other stages of alcohol use relevant in adolescents and young adults, such as initiation of alcohol use and regular drinking. Moreover, according to a review by Van Der Zwaluw and Engels (2008), studies on interactions of candidate genes with environmental factors suffer from a strong diversity in terms of candidate genes, environmental factors, measures of alcohol use, sample characteristics and study designs, which makes it difficult to draw firm conclusions from these studies. In addition, the authors stress that these studies lack a developmental perspective. Studies do not apply longitudinal research designs to examine various stages of alcohol use, while gene-environment interactions might differ across various stages of alcohol use. These lacunas

in existing studies provide several opportunities for future research on gene-environment interactions in young people's alcohol use.

Main effects of explicit environmental measures on variation in alcohol use and moderation effects of explicit environmental measures on the relation between genetic and environmental factors and alcohol use have been discussed. However, the relations between alcohol use of parents, siblings and friends or other environmental factors and alcohol use in young people might be mediated by either underlying environmental processes or underlying genetic processes. A relevant issue for future research in this respect is whether friendship selection is either socially or genetically mediated. Several studies indicate that friendship selection has a genetic origin (Cleveland et al., 2005; Fowler et al., 2007b; Rose & Dick, 2005), these studies show that individuals seek out their friends partly on the basis of their genetic makeup. In contrast, other studies argue that peer selection is primarily mediated by underlying environmental processes and not by genetic processes (Walden et al., 2004). In addition to including explicit environmental measures in twin designs to explore direct effects and moderation effects on alcohol use in adolescents and young adults, the mediational effects in this respect should also be taken into account in future research on this topic.

DEVELOPMENTAL PATTERNS IN ALCOHOL USE

We applied cross-sectional and longitudinal analytic techniques to gain insight into determinants of (change in) adolescents' and young adults' alcohol use. For future research it would be interesting to further improve our knowledge on the etiology of young people's alcohol use by applying longitudinal research approaches to identify determinants of trajectories of change in individual drinking patterns. Studies on the relative contribution of genetic and environmental influences on variation in alcohol use in adolescents and young adults have not yet applied this type of techniques. Previous studies examining change in drinking patters paid attention to for example parental drinking and parental attitudes toward adolescent alcohol use (Power et al., 2005), the role of parental substance use disorders in trajectories of adolescent substance use (Walden et al., 2007), but these studies did not aim at unraveling genetic from environmental effects. We assume that extreme trajectories, such as strong increasing drinking patterns or consistently heavy drinking, might be more influenced by genes than more normative trajectories, while in contrast more normative trajectories of use might be more influenced by parental and peer factors. It would be interesting to test these hypotheses in future studies.

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ROMANTIC PARTNERS

Associations between drinking of parents, siblings and friends and alcohol use of adolescents and young adults were explored, However, there is one group of relevant persons we did not take into consideration: romantic partners. During adolescence young people start to get interested in dating and sexual experiences and they get involved with their first romantic partners (Furman, 2002). Young people tend to spend a lot of time with their romantic partners and romantic partners take important positions in young people's lives. It seems likely that romantic partners play a role in alcohol use of adolescents and young adults, but studies on the effects of romantic partners in young people's drinking behavior are scarce. Future studies should explore to role of romantic partners in this respect. In the same vein as research of effects of friends' drinking, these studies could focus on both actual influence of romantic partners and on selection effects and assortative mating. Engels and Knibbe (2000) revealed the involvement in a steady romantic relationship resulted in a decrease of male alcohol use. However, it seems also plausible that romantic partners select each other on basis of common drinking patterns or norms with regard to alcohol use.

DEFINITION OF ALCOHOL PHENOTYPES

An important finding is that results of longitudinal and genetic analyses were highly dependent of the definition of the phenotype under examination. For example previous studies showed that variation in initiation of alcohol use was mainly explained by common environment and hardly by genes (e.g., Fowler et al. 2007a; Pagan et al., 2006; Rose et al., 2001), while in contrast, we found that variation in early initiation (before age 13) was almost completely accounted for by genetics. This difference in findings is likely to be due to difference in definition of the phenotype, with the phenotype examined in this thesis reflecting early adolescent initiation. We found that drinking of co-twins did not play a role in adolescent and young adult problem drinking, while it predicted adolescent and young adult regular drinking. These findings implicate that future studies on the determinants of adolescent and young adult alcohol use should use clear definitions of phenotype or indicators of alcohol use.

The relative importance of genetic and environmental effects on variation in more advanced drinking behaviors, such as heavy drinking and problem drinking, in adolescents and young adults has rarely been studied. The few twin studies on the variance in problem drinking show that problem drinking in adolescents and young adults is for a relatively large part explained by genetic factors (Pagan et al.,

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2006; Rhee et al., 2003; Young et al., 2006). Future studies should more into depth map the etiology of several alcohol phenotypes or indicators of drinking in young people.

A TWIN DESIGN OF DRINKING IN A NATURALISTIC SETTING

The results presented in this thesis were based on data previously collected by mailed surveys. Alcohol consumption in young people usually takes place in social settings and one might argue that assessment of drinking behavior in a naturalistic social settings provides a closer view of the reality of young people's alcohol consumption. Only a few studies conducted observational research in a naturalistic setting to examine the etiology of alcohol use in adolescents and young adults (e.g., Bot et al., 2007; Van De Goor, 1990). These studies indicate that in social settings imitation effects of drinking occur.

In addition, it has been shown that genetics also predict alcohol use in social settings. For example, Van Den Wildenberg et al. (2007) showed that in male heavy drinkers genes were involved in craving for alcohol if they were exposed to alcohol. However, the contribution of genetic and environmental factors to variation young people's drinking in naturalistic settings is relatively unexplored. As far as we know no study applied a twin design to examine young people's alcohol use in a naturalistic social setting. A twin design would be very helpful to disentangle genetic and environmental factors that affect variation in alcohol use in naturalistic settings. Relevant to study could be whether MZ twin pairs react in a more similar manner to environmental cues, such as drinking of peers, in a naturalistic setting than DZ twins pairs. Moreover, it would also be interesting to examine whether imitation of behavior in a naturalistic setting occurs in a similar way in MZ and DZ twins.

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SAMENVATTING

      Ondanks dat het in Nederland niet is toegestaan om alcohol te verkopen aan jongeren onder de 16 jaar, drinkt een groot deel van deze jongeren alcohol. Dit proefschrift laat zien dat de meerderheid van de Nederlandse adolescenten met alcoholgebruik begint voordat ze 16 jaar oud zijn. Uit de vragenlijstgegevens blijkt dat 68% tot 88% van de 12 tot 15 jarige jongens en 60% tot 85% van de 12 tot 15 jarige meisjes ooit alcohol heeft gedronken (Hoofdstuk 2). Dertig procent gaf zelfs aan te zijn begonnen met drinken voor de leeftijd van 13 jaar (Hoofdstuk 5). Op deze leeftijd (12 tot 15 jaar) drinkt 16% tot 29% van de jongens en 11% tot 24% van de meisjes regelmatig alcohol (waarbij regelmatig drinken gedefinieerd is als een aantal keer per maand of vaker drinken). Bij 16 tot 25 jarigen zijn deze percentages gestegen naar 70% tot 90% bij mannen en 52% tot 71% bij vrouwen (Hoofdstuk 4). Bij een klein deel van de adolescenten en jongvolwassenen ontwikkelt regelmatig alcoholgebruik zich tot probleemdrinken. Probleemdrinkers ervaren problemen als gevolg van zwaar drinken. Prevalentie cijfers in dit proefschrift laten zien dat 16% tot 33% van de 16 tot 25 jarige mannen en 5% tot 10% van de vrouwen in deze leeftijdscategorie probleemdrinkers zijn (Hoofdstuk 8). Deze percentages zijn relatief hoog in vergelijking met andere westerse landen. Zwaar alcoholgebruik en probleemdrinken door jonge mensen kunnen op korte termijn negatieve gevolgen met zich meebrengen, zoals: dronkenschap in het verkeer, betrokkenheid bij geweld en riskant seksueel gedrag. Op langere termijn kunnen hersen- en leverschade en diverse vormen van kanker optreden (onder andere kanker in het hoofd- halsgebied, maag-, lever- en darmkanker en borstkanker). Het spreekt voor zich dat zwaar alcoholgebruik en probleemdrinken voorkomen moeten worden. Jongeren in Nederland beginnen op een jonge leeftijd met drinken en regelmatig drinken. Daarnaast is het percentage probleemdrinkers onder Nederlandse adolescenten en jongvolwassenen relatief hoog. Om deze redenen is het relevant om de determinanten van deze verschillende stadia van alcoholgebruik in kaart te brengen. Wetenschappelijk onderzoek naar determinanten van stadia van alcoholgebruik laat zien dat zowel omgevingsfactoren als genen een rol spelen in alcoholgebruik van jonge mensen. In dit proefschrift zijn daarom de rol van familie en vrienden bij het alcoholgebruik van adolescenten en jongvolwassenen in kaart gebracht. Daarbij is de relatieve rol van genen en omgeving onderzocht. Voor de meerderheid van de studies in dit proefschrift is gebruik gemaakt van tweeling-familiedata van het Nederlands Tweelingen Register, voor één studie (Hoofdstuk 6) is gebruik gemaakt van het longitudinale project "Gezin en Gezondheid" waaraan families met adolescenten (geen tweelingen) deelnamen.

DE ROL VAN FAMILIE EN VRIENDEN

De rol van familie en vrienden bij het alcoholgebruik van adolescenten en jongvolwassenen kan onder andere verklaard worden aan de hand van de Sociale Leer Theorie (Bandura, 1977). Volgens deze theorie leren mensen door het observeren en imiteren van rolmodellen. Als deze theorie wordt toegepast op het alcoholgebruik van jongeren dan wordt aangenomen dat drinken door jongeren verklaard wordt door attitudes ten aanzien van alcohol en alcoholgebruik van rolmodellen zoals ouders, broers en zussen en vrienden. Jongeren zullen alcoholgebruik voortzetten als zij in hun gedrag worden aangemoedigd en gesteund door rolmodellen, hierdoor ontstaan positieve verwachtingen ten aanzien van alcoholgebruik. Daarnaast kan de rol van familieleden en vrienden bij alcoholgebruik van jongeren ook verklaard worden door genetische factoren. Familieleden zijn meer gelijk in hun alcoholgebruik omdat ze genen delen die alcoholgebruik beïnvloeden. Ondanks dat vrienden niet biologisch aan elkaar verwant zijn, kunnen genen ook een rol spelen in de relatie tussen alcoholgebruik van jongeren en hun vrienden. De keuze voor bepaalde vrienden lijkt namelijk een genetische basis te hebben.

Uit studies in dit proefschrift blijkt dat alcoholgebruik van vaders en moeders samenhangt met regelmatig drinken van hun kinderen. Adolescenten en jongvolwassenen met vaders en moeders die frequent drinken hebben een grotere kans om regelmatig te drinken dan adolescenten en jongvolwassenen van vaders en moeders die minder frequent drinken (Hoofdstuk 3 en 4). Dit resultaat werd gevonden in cross-sectionele analyses, in analyses over een periode van twee jaar, en alleen voor moeders ook over een periode van zeven jaar. Met betrekking tot probleemdrinken laat de longitudinale studie beschreven in Hoofdstuk 8 zien dat het alcoholgebruik van vader probleemdrinken van adolescenten en jongvolwassenen twee en zelfs zeven jaar later voorspelt. Het alcoholgebruik van moeder lijkt geen rol te spelen in probleemdrinken van adolescenten en jongvolwassenen. Er werd geen verschil gevonden tussen mannelijke en vrouwelijke adolescenten en jongvolwassenen in de samenhang tussen alcoholgebruik van vaders en moeders en regelmatig drinken en probleemdrinken onder jongeren.

De rol van alcoholgebruik van broers en zussen naast de tweelingbroer of -zus in regelmatig drinken en probleemdrinken bleek slechts zeer beperkt te zijn. Daarentegen was het alcoholgebruik van de monozygote (MZ) en dizygote (DZ) co-twin een sterke risicofactor voor regelmatig drinken, vooral cross-sectioneel en over een korte periode (Hoofdstuk 3, 4 en 6). Alcoholgebruik van de MZ en DZ co-twin was niet gerelateerd aan probleemdrinken. Een van de meest voor de hand liggende verklaringen voor verschillen in impact tussen alcohol-

gebruik van MZ co-twins en DZ co-twins en boers en zussen naast de co-twin zijn genetische verschillen. Omdat MZ tweelingen al hun genen delen is de kans groot dat zij op elkaar lijken in hun alcoholgebruik, DZ tweelingen en broers en zussen naast de co-twin delen gemiddeld genomen de helft van hun genen. Zowel MZ als DZ tweelingbroers en -zussen hebben daarnaast een grotere kans om op elkaar te lijken in hun alcoholgebruik dan broers en zussen naast de co-twin, omdat ze dezelfde leeftijd hebben. De variatie in alcoholgebruik in adolescenten en jongvolwassenen hangt namelijk voor een groot deel af van leeftijd. Daarnaast zouden MZ en DZ tweelingbroers of -zussen belangrijkere rolmodellen voor elkaar zijn dan broers of zussen naast de co-twin, waardoor ze een sterkere impact hebben op elkaars gedrag. De Sociale Leer Theorie van Bandura (1977) geeft namelijk aan dat modelling van gedrag vaker voorkomt als een persoon meer gelijk is aan het rolmodel, bijvoorbeeld in leeftijd of geslacht. Ook zijn broers en zussen met weinig leeftijdsverschil (of geen leeftijdsverschil in geval van tweelingen) geneigd thuis of buitenshuis samen tijd door te brengen. Hierdoor hebben zij wellicht meer gedeelde ervaringen in het gezin, op school en met vrienden, dit kan leiden tot grotere gelijkheid in alcoholgebruik.

Naast ouders en broers en zussen spelen vrienden een rol in de ontwikkeling van alcoholgebruik van adolescenten en jongvolwassenen. De rol van vrienden valt te verklaren vanuit het feit dat tijdens de adolescentie jongeren een identiteit onafhankelijk van hun ouders proberen te ontwikkelen en steeds meer tijd met hun vrienden gaan doorbrengen. Vrienden kunnen rolmodellen zijn voor adolescenten. Ook hebben adolescenten de neiging om zich te conformeren aan normen van hun vrienden tijdens deze periode. Dit proefschrift laat zien dat alcoholgebruik van vrienden gerelateerd is aan regelmatig alcoholgebruik, zowel cross-sectioneel als over een periode van twee jaar (Hoofdstuk 3, 4, 6). Probleemdrinken is alleen longitudinaal onderzocht; resultaten laten zien dat alcoholgebruik van vrienden een voorspeller was van probleemdrinken twee jaar later, maar niet zeven jaar later (Hoofdstuk 8). Het is opvallend dat het alcoholgebruik van vrienden cross-sectioneel en over een periode van twee jaar een grotere rol speelt in alcoholgebruik van adolescenten en jongvolwassenen dan alcoholgebruik van ouders, terwijl over een langere periode het alcoholgebruik van ouders juist een belangrijkere rol speelt en het gedrag van vrienden minder relevant is.

DE RELATIEVE INVLOED VAN GEN- EN OMGEVINGSINVLOEDEN

Om de relatieve invloed van genen en omgeving op alcoholgebruik bij adolescenten en jongvolwassenen te onderzoeken is in dit proefschrift gebruik gemaakt van het tweeling design. Het tweeling design berust op het verschil in genetische relatie tussen monozygote

(MZ of eeneiige) tweelingparen en dizygote (DZ of twee-eiige) twee-lingparen. MZ tweelingparen zijn genetisch identiek, omdat zij uit één bevruchte eicel zijn ontstaan. DZ tweelingparen delen gemiddeld genomen de helft van hun genen, zoals eerstegraads familieleden waaronder boers en zussen en ouders en hun kinderen. In tweeling-onderzoek wordt de gelijkenis in gedrag, zoals alcoholgebruik, binnen MZ paren vergeleken met de gelijkenis in gedrag binnen DZ paren. Als de gelijkenis binnen MZ paren groter is dan binnen DZ paren betekend dit dat genetische factoren een bijdrage leveren aan dit gedrag. In structurele vergelijkingsmodellen gebaseerd op gegevens van tweelingparen wordt de variantie in gedrag opgedeeld in drie componenten: (1) additieve genetische invloeden, (2) gedeelde om-gevingsinvloeden en (3) unieke omgevingsinvloeden. Onder gedeelde omgevingsinvloeden worden alle omgevingsfactoren verstaan die familieleden delen en gelijk aan elkaar maken. Unieke omgevings-factoren zijn omgevingsfactoren die familieleden niet delen en deze maken familieleden verschillend van elkaar. Per definitie zijn gene-tische invloeden volledig gelijk in MZ tweelingparen en 50% gelijk in DZ tweelingparen. Gedeelde omgevingsinvloeden zijn volledig gelijk in MZ en DZ tweelingenparen en unieke omgevingsinvloeden zijn vol-ledig ongelijk in beide paren.

GEN- EN OMGEVINGSINVLOEDEN IN DE VROEGE ADOLESCENTIE

Dit proefschrift is het eerste onderzoek dat aantoont dat genen een grotere rol spelen dan omgevingsfactoren in het verklaren van verschillen in het vroeg initiëren van alcoholgebruik. Vanuit eerder onderzoek werd aangenomen dat omgevingsfactoren de belangrijkste rol zouden spelen in het beginnen met drinken. Uit Hoofdstuk 5 blijkt echter dat genen 83% van de variatie in initiatie van alcoholgebruik bij jongens en 70% van de variatie bij meisjes verklaren. Een veel kleiner deel van de variatie wordt verklaard door de gedeelde omge-ving (2% bij jongens en 19% bij meisjes).

De individuele verschillen in de frequentie van alcoholgebruik van 12 tot 15 jarigen blijkt daarentegen voor een groot deel door gedeelde omgevingsinvloeden te worden bepaald (82% van de vari-antie voor zowel jongens als meisjes). De overige 18% van de vari-antie wordt verklaard door unieke omgevingsinvloeden, dus genen spelen geen rol in de verklaring van de variantie van frequentie van alcoholgebruik in vroeg adolescenten die eenmaal begonnen zijn met drinken. Gedeelde omgevingsinvloeden zorgen voor overeenkomsten binnen tweelingparen ongeacht de zygositeit. In de vroege adolescen-tie brengen tweelingen vaak veel tijd met elkaar door en daardoor

delen ze veel ervaringen thuis en buitenshuis, zoals op school en met vrienden. Dit maakt dat ze blootgesteld worden aan dezelfde factoren die effect hebben op alcoholgebruik, zoals beschikbaarheid van alcohol in huis, regels van hun ouders ten aanzien van alcoholgebruik, en het drinken van vrienden.

Met betrekking tot de relatieve verhouding tussen genen en omgeving als verklaring voor individuele verschillen in alcoholgebruik laat deze studie daarnaast zien dat er geen overlap is genen en unieke omgevingsfactoren die initiatie van alcoholgebruik en frequentie van drinken voorspellen. Met andere woorden, de variatie in initiatie en frequentie van drinken worden verklaard door andere genen en factoren uit de unieke omgeving. Voor meisjes zijn ook de gedeelde omgevingsinvloeden specifiek voor de variatie in initiatie en frequentie van drinken, terwijl voor jongens grotendeels dezelfde factoren uit de gedeelde omgeving individuele verschillen in initiatie en frequentie van alcoholgebruik voorspellen.

GEN- EN OMGEVINGSINVLOEDEN IN DE LATE ADOLESCENTIE EN JONGVOLWASSENHEID

Dit proefschrift laat zien dat zowel genen als omgeving een aandeel hebben in de verklaring van individuele verschillen in frequentie van alcoholgebruik en regelmatig drinken van adolescenten en jongvolwassenen in de leeftijd van 16 tot 25 jaar.

In Hoofdstuk 7 hebben we aangetoond dat genetische en omgevingsinvloeden veranderen onder invloed van overeenkomsten in alcoholgebruik van vrienden van tweelingen. Voor deze studie deelden we de tweelingen in in concordante paren, dat wil zeggen paren waarbij vrienden van beide individuen vergelijkbaar alcoholgebruik vertonen en discordante paren. Discordante paren zijn de paren waarbij de vrienden van beide individuen verschillen in hun alcoholgebruik. Resultaten laten zien dat genetische factoren een grotere rol spelen in de verklaring van de variantie van alcoholgebruik van discordante paren, terwijl gedeelde omgevingsinvloeden een sterkere invloed hebben als tweelingen concordant zijn voor het alcoholgebruik van hun vrienden. Afhankelijk van het fenotype (frequentie of regelmatig drinken) verklaren genetische effecten 14% tot 21% van de variantie in alcoholgebruik van concordante paren en gedeelde omgevingfactoren 53% tot 69%. In discordante paren, daarentegen, wordt 33% tot 50% van de variantie verklaard door genetische factoren en 18% tot 36% door gedeelde omgevingsfactoren. Deze bevindingen duiden op een gen-omgevings-interactie, die er op wijst dat de invloed van genen afhangt van de omgevingsfactoren (het alcoholgebruik van vrienden).

PUBLICATIONS

Poelen, E. A. P., Derks, E. M., Engels, R. C. M. E., Van Leeuwe, J. F. J., Scholte, R. H. J., Willemsen, G., & Boomsma, D. I. (2008). The relative contribution of genes and environment to alcohol use in early adolescents: Are similar factors related to initiation of alcohol use and frequency of drinking? *Alcoholism: Clinical and Experimental Research, 32*, 975-982.

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Evelien

CURRICULUM VITAE

Evelien Poelen was born on March 10 1979 in Groesbeek, the Netherlands. After completing secondary education, she went to Maastricht to study Health Sciences at Maastricht University in 1998. She specialized in Health Education and Health Promotion. After a five month research internship at the University of Toronto in Canada she received her Master degree in Health Sciences in 2002. In the beginning of 2003 she started as a PhD-student at the Radboud University in Nijmegen, resulting in this dissertation. The project was a collaboration with prof. dr. Dorret Boomsma and dr. Gonneke Willemsen from the VU University. In 2006 she received The 2006 Kettil Bruun Society Early Career Scientist Award. In addition to her research she has been teaching several courses at the Department of Family and Childcare Studies. In 2007 she completed a training trajectory in teaching and received a certificate for her teaching qualifications (Basiskwalificatie Onderwijs). Currently she is a teacher at the Faculty of Social Sciences of the Radboud University and she studies at the Obstetrics Academy Rotterdam to become a midwife.