

ABSTRACT

This study uses data from the Ontario Health Survey to examine within-family influences (sibship number, age and sex composition; family structure and parental substance use) on the use of tobacco, alcohol and marijuana in households (N=4,643) among offspring aged 12 to 24 years. Using a modification of the kappa statistic, concordance among siblings is modest generally and undifferentiated across substance type. Concordance is stronger among sibships that are either all male or older (19-24 years) and is particularly strong for siblings $\leq$ two years apart in age. The dominant influence of substance use behaviour appears to be from older siblings to younger siblings and not from parents to offspring. Sibling concordance for substance use suggests that the treatment and prevention of substance use (and abuse) among adolescents and young adults might be enhanced by including a family focus, especially where there are two or more siblings at home.

ABRÉGÉ

L'étude, fondée sur les données de l'Enquête sur la santé en Ontario, porte sur les influences intrafamiliales (nombre, âge et sexe des membres de la fratrie, structure familiale et consommation de drogues par les parents) sur la consommation de tabac, d'alcool et de marijuana dans des familles (n = 4 643) d'au moins un parent et un enfant de 12 à 24 ans. Une analyse Kappa modifiée révèle une concordance fraternelle modeste dans l'ensemble, peu tranchée selon le type de drogue. La concordance est plus prononcée lorsque la fratrie se compose uniquement de garçons ou comporte un membre plus âgé (19 à 24 ans), particulièrement lorsque l'écart entre les membres est de deux ans ou moins. L'influence dominante, en matière de consommation de drogues, semble s'exercer des aînés aux cadets et non des parents aux enfants. La concordance constatée entre les membres de fratries porte à croire que l'on pourrait améliorer le traitement et la prévention de la consommation (et de l'abus) de drogues chez les adolescents et les jeunes adultes en y intégrant une composante familiale, surtout lorsqu'il y a plus d'un enfant à la maison.

Familial Influences on Substance Use by Adolescents and Young Adults

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Substance use by adolescents and young adults is increasing after a decade-long decline in use during the 1980s.¹⁻⁴ Efforts to understand factors leading to drug use in this age group have focused on genetic, individual and environmental influences (especially family, peer and school environmental factors).⁵ Evidence suggests that genetic factors account for a large share of observed familial aggregation of use and abuse of alcohol and illicit drugs, and that both general and drug-specific genetic influences are at play.⁶ However, the relative importance of environmental and genetic factors is unclear. For example, a recent population-based twins study found little evidence of family environmental factors causing alcohol-related disorders in contrast to earlier clinic- and court-based studies.⁷ In contrast, in a U.S. adoption cohort, substantial environmental effects were reported for sibling aggregation (but not for parent-child aggregation) of alcohol use and problem drinking ($r = 0.24$ in non-biological siblings, $r = 0.45$ in same sex/same age siblings vs. $r = 0.01$ ($p > 0.05$) for opposite sex/dissimilar age siblings).⁸

A criticism of the literature in this area is that very few studies have used representative community-based samples to evaluate these issues free from the referral biases

inherent in clinic samples.⁹ Two such studies report on sibling effects. In the U.S. National Survey on Drug Abuse, drug use by teenagers correlated with drug use by fathers (from $r = 0.17$ for current cigarette use to $r = 0.31$ current marijuana use), by mothers (from $r = 0.04$ ($p > 0.05$) for current alcohol use to $r = 0.30$ for lifetime marijuana use), and by older siblings ($r = -0.07$ ($p > 0.05$) for lifetime cocaine use to $r = 0.30$ for lifetime marijuana use).¹⁰ In a second study, alcohol use was highly concordant among spouses ($r = 0.67$) but less so among parents and offspring and siblings (from $r = 0.25$ to $r = 0.44$).¹¹

The objective of this study is to examine family influences on tobacco, alcohol, and marijuana use by 12-24 year olds in a representative general population sample living at home. The following questions are addressed: 1) what is the prevalence of substance use among family members?; 2) does sibship structure influence aggregation or clustering of substance use in families?; 3) does gender or age influence within-family correlations of substance use?; and 4) is substance use among younger siblings associated more strongly with parental substance use or substance use by older siblings? Answers to these questions will provide insight into the relative importance of parental and sibling effects and whether observed sibling aggregation is likely to be due to shared genetic or environmental effects.

METHODS

Survey design

Information for this research comes from the Ontario Health Survey (OHS: ref. 12). The sample was obtained using a stratified multi-stage cluster design: there were 35,479 dwellings selected and 87.5% of these yielded a person knowledgeable

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Dr. Michael Boyle is supported by a Canadian Institutes of Health Research Scientist Award and Dr. Peter Szatmari is supported by a Senior Fellowship Award from the Ontario Mental Health Foundation.

about the household who agreed to provide information on sociodemographic and general health variables of all residents in a personal interview. Self-administered questionnaires on more personal health issues (including substance use) were left for completion by all household members aged 12 years and older.

Sample for analysis

The sample consisted of families with at least one offspring aged 12 to 24 years and at least one natural parent in the home. All household members other than offspring and their natural parent(s) were excluded. Applying these criteria yielded a potential sample of 23,915 individuals living in 6,976 families. Failure of individuals to return self-administered questionnaires reduced the sample by 24.5% (5,861/23,915). Missing data on one or more of the variables needed for the analyses reduced the sample by another 14.9% (3,564/23,915). A comparison of respondents and nonrespondents based on interview data is presented in Table I. Most differences are less than 5% and none are larger than 10%. The following groups (>5% differences) may be over-represented: one-parent households; parents born in Canada who were younger and better educated; and siblings who were older and female.

Variables and measures

The substance use variables were measured independently for respondents based on their answers to self-administered questionnaires. Use of cigarettes refers to daily consumption; use of alcohol refers to average weekly consumption of 2 or more drinks in the previous 12 months; use of marijuana refers to lifetime use of marijuana, cannabis or hash at least 5 times. Sociodemographic variables were derived from responses provided by the knowledgeable household member to the interviewer-administered questionnaire.

Analysis

Prevalences are estimated by the number of users per 100 for each category of substance use. A modification of the kappa statistic proposed by Fleiss¹³ is used to estimate familial aggregation. In this method,

TABLE I
Distribution of Selected Characteristics of Respondents and Nonrespondents

Characteristics	Respondents	Nonrespondents
Households (6976)	(4643)	(2333)
Urban residence	74.5	70.2
<6 members in household	93.4	91.8
Income below the poverty line	14.4	11.0
One parent in home	18.3	13.0
Parents (12,919)	(7749)	(5170)
Female	54.1	49.7
Age in years <50	78.4	71.2
Birthplace Canada	75.5	66.6
Secondary school complete	64.1	58.2
Working	79.1	79.1
Siblings (10,996)	(6741)	(4255)
Female	49.2	42.2
Age in years 18-24	61.1	54.6
In school	83.0	78.2

TABLE II
Substance Use Prevalence per 100 Among Parents and Siblings by Gender and Age in Years

	Tobacco (current)	Alcohol (one year)	Marijuana (lifetime)
Parents			
Mothers (4194)	25.9	18.9	7.5
Fathers (3555)	27.8	42.3	9.5
Siblings			
Sex			
Females (3423)	11.6	7.8	10.6
Males (3318)	16.3	16.8	15.7
Age in years			
12-14 (2073)	2.1	1.6	1.3
15-17 (2048)	12.2	4.9	8.9
18-20 (1580)	20.8	22.1	19.3
21-24 (1040)	25.0	29.3	28.0

TABLE III
Family Composition and Aggregation of Substance Use Among Siblings Estimated by Kappa (Standard Error)

Feature Category (n)	Tobacco	Alcohol	Marijuana
Overall (1727)	0.19 (0.02)	0.15 (0.02)	0.20 (0.02)
Number of siblings			
2 (1405)	0.20 (0.03)	0.14 (0.03)	0.20 (0.03)
≥3 (322)	0.15 (0.03)	0.18 (0.03)	0.18 (0.03)
Sex composition			
All female (368)	0.09 (0.05)	0.09 (0.05)	0.17 (0.05)
All male (415)	0.24 (0.04)	0.17 (0.04)	0.28 (0.04)
Mixed (994)	0.20 (0.03)	0.14 (0.03)	0.17 (0.03)
Age composition			
All 12-18 (971)	0.20 (0.03)	0.16 (0.03)	0.16 (0.03)
All 19-24 (182)	0.30 (0.06)	0.25 (0.06)	0.29 (0.06)
Mixed (574)	0.11 (0.03)	0.03 (0.03)*	0.13 (0.03)

* not significant at $p < 0.05$

an analysis of variance approach is taken to adjust for variations in the number of siblings per family. Absolute differences between kappas in excess of 0.10 are defined arbitrarily as 'important' effects. Considered in this analysis are the effects of sibship structure (sibship size, sex composition and age composition) on familial aggregation. Kappa is used also to examine the effects of gender and age on within-

family correlations by estimating levels of concordance on substance use between pairs of family members, including spouses, spouses and siblings and siblings subdivided by sex and age. Households with four or more siblings [43/4,643 (0.9%)] are excluded from this analysis to prevent large sibships from exerting undue weight on the analysis. Finally, logistic regression analysis is used to estimate the strength of

TABLE IV
Kappa Estimates of Agreement Between Family Members on Substance Use
(Standard Error)

Members (n)	Tobacco	Alcohol	Marijuana
Spouses (3106)	0.30 (0.02)	0.32 (0.02)	0.44 (0.03)
Father-Son (2728)	0.14 (0.02)	0.09 (0.02)	0.05 (0.02)
Father-Daughter (2492)	0.04 (0.02)	0.06 (0.01)	0.05 (0.02)
Mother-Son (3106)	0.06 (0.02)	0.07 (0.02)	0.01 (0.02)*
Mother-Daughter (3017)	0.16 (0.02)	0.12 (0.02)	0.08 (0.02)
Brothers ≤ 2 yrs (290)	0.45 (0.08)	0.44 (0.07)	0.33 (0.08)
Brothers > 2 yrs (333)	0.02 (0.05)*	0.07 (0.04)*	0.06 (0.07)*
Sisters ≤ 2 yrs (240)	0.27 (0.09)	0.34 (0.11)	0.23 (0.09)
Sisters > 2 yrs (284)	0.06 (0.07)*	0.05 (0.06)*	0.14 (0.07)
Brothers-Sisters ≤ 2 yrs (516)	0.23 (0.06)	0.22 (0.06)	0.28 (0.06)
Brothers-Sisters > 2 yrs (579)	0.11 (0.04)	0.11 (0.04)	0.10 (0.04)

* not significant at $p < 0.05$

TABLE V
Strength of Association Estimated by Relative Odds and 95% Confidence Intervals in Logistic Regression Between Substance Use in Youngest Sibling and Substance Use Reported by Parents and Older Siblings

Characteristic	Tobacco	Alcohol	Marijuana
Youngest sibling			
Male gender	1.46 (0.99-2.14)	2.47† (1.53-3.97)	1.42 (0.93-2.17)
Age in years	1.37† (1.28-1.47)	1.59† (1.46-1.75)	1.46† (1.35-1.59)
Parents			
Lone parent	1.36 (0.91-2.04)	0.91 (0.53-1.56)	1.24 (0.79-1.96)
Substance used	1.37 (0.93-2.03)	1.09 (0.68-1.74)	1.91 (0.96-3.80)
Siblings			
>2 in home	0.63 (0.36-1.11)	0.65 (0.32-1.30)	0.78 (0.43-1.42)
Substance used	4.08† (2.75-6.05)	3.77† (2.37-5.99)	5.34† (3.48-8.18)

† $p < 0.001$

association between substance use by the youngest sibling in the family (dependent variable) and use of the same substance by parent(s) and older sibling(s).

RESULTS

Prevalences and sibship structure

Prevalences for all substances used are higher among fathers than among mothers and among male siblings than among female siblings (Table II). Among siblings, there is a gradient of increasing substance use by age that begins to taper off among 21-24 year olds.

Table III shows that overall levels of aggregation are modest for use of tobacco, alcohol and marijuana ($\kappa=0.19, 0.15, 0.20$). Estimates of aggregation exhibit small variation by sibship size. Sibships composed entirely of males versus females exhibit higher levels of aggregation for use of tobacco ($\kappa=0.24$ versus 0.09) and marijuana ($\kappa=0.28$ versus 0.17). Age composition exerts the most potent effect on estimates of aggregation: sibships composed

entirely of young adults aged 19 to 24 years show the highest levels of aggregation for all categories of substance use.

Within family correlations

Concordance for the same categories of substance use are much higher between parents ($\kappa=0.30$ to 0.44) than between parents and their children ($\kappa=0.05$ to 0.16) (Table IV). There appears to be a small gender-specific effect for tobacco use. Concordance between father-son and mother-daughter are 0.14 and 0.16, respectively; between father-daughter and mother-son, they are 0.04 and 0.06, respectively.

Concordance on substance use between siblings are influenced by both closeness in age and sex. Siblings more than two years apart in age exhibit low concordance on substance use for all pairings ($\kappa=0.02$ to 0.14). Siblings within two years of each other exhibit higher levels of concordance: these estimates are higher for brother ($\kappa=0.33$ to 0.45) than for sister ($\kappa=0.23$ to 0.34) and brother-sister pairings ($\kappa=0.23$ to 0.28) (Table IV).

Parent and older sibling substance use

Table V presents relative odds (RO) between substance use reported by parents and older siblings and substance use reported by the youngest member of the sibship. Covariates are included to control for family status (one vs. two parents); sibship size (3 or more vs. 2); and the age and gender of the youngest sibling. The strength of association between parental substance use and use of the same substance by the youngest sibling is small and nonsignificant (RO=1.09 to 1.91). These contrast with substance use by older siblings which is associated strongly and significantly with substance use by younger siblings (RO=3.77 to 5.34).

DISCUSSION

This study provides evidence for the aggregation of substance use among siblings in families. Overall, the effect is modest, appears to be undifferentiated across substance type and is stronger among sibships that are either all male or older (19-24 years). Within-family concordance is particularly strong for spouses and for siblings ≤ two years apart in age. Furthermore, the dominant influence of substance use behaviour appears to be from older siblings to younger siblings and not from parents to offspring.

There are a number of possible explanations for the strong between-sibling associations in substance use observed in this study. First of all, access to tobacco, alcohol and drugs such as marijuana is determined very much by age. The presence of older siblings already engaging in substance use provides the means for younger siblings to obtain these substances. Second, older siblings constitute important role models, and in some instances the initiation of younger siblings into substance use may arise from imitative behaviour. Third, closeness in age will have important influences on socialization processes. Siblings close in age can be expected to spend more time together through childhood and adolescence. This will lead to more shared experiences in the family, neighbourhood, at school and with adolescent peer groups. An older sibling engaging in substance use will likely have peers engaged in the same

activity who, in turn, could serve as important role models for engaging in substance use and provide additional opportunities to access tobacco, alcohol and marijuana.

The relatively weak associations between parental substance use and substance use by younger siblings should not be interpreted to mean that parental behaviour has no impact on substance use in the family. In addition to substance use behaviour, there are other within-family processes such as affectional ties, management practices and the resolution of conflict that may have important implications for substance use among siblings.¹⁴

Study limitations

There are a number of study limitations that the reader should bear in mind when considering the findings. One, all information was collected by self-administered questionnaire completed at home, without opportunity to corroborate responses. Although studies exist in support of the reliability and validity of this method,¹⁵ it is arguable that random error and under-reporting have led to an attenuation of associations. Two, the statistic used to measure concordance on substance use – kappa – is compressed downward by low base rates.¹⁶ Three, although respondents and nonrespondents are comparable on sociodemographic characteristics, net data loss at 39.4% is high, and could include sample loss selective for substance use. Four, it is not possible to establish the chronology of substance use within families because the study design is cross-sectional. Five, data are not available on intensity of contact between siblings or peer substance use, variables that would

help to clarify the modifying effects of age on between-sibling agreement in substance use. And six, the study is restricted to the effects of family composition on substance use. There is no attempt to determine whether or not the socioeconomic circumstances of families act as effect moderators or to model the impact of other important influences on substance use such as family processes and peers.

Identification of risk factors associated with substance use by adolescents and young adults is important from both preventive and therapeutic viewpoints. Sibling concordance for substance use points to the importance of environmental effects and suggests that the treatment and prevention of substance use (and abuse) among adolescents and young adults might be enhanced by including a family focus, especially where there are two or more siblings at home. Empirical support exists for family-based treatments for substance abuse and family-based preventive interventions are under development.¹⁷ Evaluation of the effectiveness of these preventive programs should be a priority for research on interventions.

REFERENCES

1. Adlaf EM, Ivis EJ, Smart RG, Walsh GW. *The Ontario Student Drug Use Survey: 1977-1995*. Toronto: Addiction Research Foundation of Ontario, 1995.
2. Adlaf EM, Ivis FJ, Smart RG, Walsh GW. Enduring resurgence or statistical blip? Recent trends from the Ontario student drug use survey. *Can J Public Health* 1996;87:189-92.
3. Johnston LD, O'Malley PM, Bachman JG. *National Survey Results on Drug Use from Monitoring the Future Study, 1975-1995, Vol. 2, Secondary School Students* [NIH Publication No. 96-4139]. Washington, DC: US Government Printing Office, 1996.
4. Poulin C, Elliott D. Alcohol, tobacco and cannabis use among Nova Scotia residents: Implications for prevention and harm reduction. *Can Med Assoc J* 1997;156:1387-93.
5. Weinberg NZ, Rahdert E, Collier JD, Glantz MD. Adolescent substance abuse: A review of the past 10 years. *J Am Acad Child Adolesc Psychiatry* 1998;37:252-61.
6. Merikangas KR, Stolar M, Stevens DE, et al. Familial transmission of substance use disorders. *Arch Gen Psychiatry* 1998;55:973-79.
7. Prescott CA, Kendler KS. Genetic and environmental contributions to alcohol abuse and dependence in a population-based sample of male twins. *Am J Psychiatry* 1999;156:34-40.
8. McGue M, Sharma A, Benson P. Parent and sibling influences on adolescent alcohol use and misuse: Evidence from a U.S. adoption cohort. *J Stud Alcohol* 1996;57:8-18.
9. Light JM, Irvine KM, Kjerulf L. Estimating genetic and environmental effects of alcohol use and dependence from a national survey: A "quasi-adoption" study. *J Stud Alcohol* 1996;57:507-20.
10. Gfoerer J. Correlation between drug use by teenagers and drug use by older family members. *Am J Drug Alcohol Abuse* 1987;13:95-108.
11. Tambs K, Vaglum P. Alcohol consumption in parents and offspring: A study of the family correlation in a general population. *Acta Psychiatr Scand* 1990;82:145-51.
12. Ontario Ministry of Health. *Ontario Health Survey 1990: User's Guide Vol. 1 Documentation*. Toronto, Ontario Ministry of Health, 1992.
13. Fleiss JL. *Statistical Methods for Rates and Proportions* 2nd ed. New York: John Wiley & Sons, 1981.
14. Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance use prevention. *Psychol Bull* 1992;112:64-105.
15. Needle R, McCubbin H, Lorence J, Hochhauser M. Reliability and validity of adolescent self-reported drug use in a family-based study: A methodological report. *Int J Addictions* 1983;18:901-12.
16. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. *J Clin Epidemiol* 1990;43:543-49.
17. Hogue A, Liddle HA. Family-based preventive intervention: An approach to preventing substance use and antisocial behaviour. *Am J Orthopsychiatry* 1999;69:278-93.

Received: August 22, 2000

Accepted: January 18, 2001