

ASSOCIATION BETWEEN SMOKING AND THE RISK OF HEAVY DRINKING
AMONG YOUNG WOMEN: A PROSPECTIVE STUDYCAMILLA SCHMIDT MORGEN¹, KIRA BANG BOVÉ¹, KATRINE STRANDBERG LARSEN¹,
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Abstract — Aim: To address the association between smoking habits and the risk of later heavy drinking among young women. **Methods:** Repeated assessments of alcohol and smoking habits were obtained in 1991–93 and 1999–2000 in a Danish representative cohort in Copenhagen. A total of 6369 non- to moderate-drinking Danish women, aged 20–29 years at baseline, attended a follow-up examination and were included in the study. The risk of becoming a heavy drinker (more than 14 drinks per week) 8 years after enrolment was analyzed by means of logistic regression. **Results:** A total of 177 women became heavy drinkers during follow-up. Daily smoking at baseline was associated with an increased risk of becoming a heavy drinker 8 years later. Relative to nonsmokers, the adjusted odds ratios (OR) for becoming a heavy drinker associated with smoking 1–14, 15–24, or more than 24 cigarettes per day were 1.6 (95% confidence intervals (CI) 1.1–2.4), 1.7 (CI 1.1–2.6), and 2.3 (CI 0.9–5.9), respectively. Age at sexual debut modified the effect of smoking, and women with a debut before the age of 15 years had an adjusted OR of 2.9 (CI 1.1–3.9) compared to never-smokers while there seemed to be no effect among women with a sexual debut after the age of 18. In addition, relative to nondrinkers, all of the moderate (1–5 units per week), medium (6–10 units), and large (10–14 units) alcohol consumption at baseline were associated independently with becoming a heavy drinker 8 years later. **Conclusions:** This study suggests that smoking is an important predictor of later heavy drinking among young women and that this relatively elevated risk is most pronounced among women with an early sexual debut.

INTRODUCTION

The association of tobacco and alcohol consumption has been examined in several cross sectional studies (Bien and Burge, 1990; Daepfen *et al.*, 2000; De Leon *et al.*, 2007; DiFranza and Guerreria, 1990; Gulliver *et al.*, 2000; Jackson *et al.*, 2002; John *et al.*, 2003). Most of these studies demonstrate a close relationship between the uses of these two substances together. Hence the prevalence of alcohol dependence was shown to be four times higher among people with nicotine dependence in a recent study by Gruzca *et al.* (Gruzca and Bierut, 2006) and in the general population smokers are more likely to drink than nonsmokers (Bien and Burge, 1990). The combined rather than single use of alcohol and tobacco may produce a multiplicative or synergistic increase in, for instance, cancer rates and thereby add an extra dimension to the risk of negative health outcomes (De Leon *et al.*, 2007). The theories of cooccurrence of the use of tobacco and alcohol suggested the following pathways: genetic factors (True *et al.*, 1999), interpersonal linkage, where personality factors are described in the context of addictive personality pattern (Bien and Burge, 1990), through a sensation-seeking personality pattern (Castilla *et al.*, 1999; Kraft and Rise, 1994) or by being a function of a third variable (Wetzels *et al.*, 2003; Ritchey *et al.*, 2001; Jackson *et al.*, 2003). Most of the studies on the tobacco–alcohol relation are cross-sectional (Daepfen *et al.*, 2000; De Leon *et al.*, 2007; John *et al.*, 2003; McKee *et al.*, 2007; Ritchey *et al.*, 2001), based on adolescents (Fleming *et al.*, 1989; Jackson *et al.*, 2002; Sher *et al.*, 1996; Wetzels *et al.*, 2003) or based on substance use in alcoholics seeking treatment (DiFranza and Guerreria, 1990;

Myers *et al.*, 2007) and few studies have explored the prospective association in the general population (Jackson *et al.*, 2003; Jensen *et al.*, 2003) with one study finding a positive long-term effect of smoking on later alcohol consumption and one study only finding a short-term effect (Jackson *et al.*, 2003). Consequently, it remains unclear whether smoking predicts later heavy alcohol drinking in the general population, which could be valuable in future preventive strategies.

The aim of the present study was to investigate the relation between smoking and subsequent heavy drinking among young non- and moderate-drinking women.

METHODS

Study population

The study is based on a prospective cohort comprising 11,088 women. The selection was a random sample selected within age strata 20–29 years of the female population in Copenhagen, Denmark by means of the computerized Central Population Register. The participants were all born in Denmark and were invited to participate in the study by letter. Information on the participants was collected through an interview carried out by trained nurses and a self-administered dietary questionnaire, including drinking habits, which had to be returned by mail. The cohort was established by Department of Virus, Hormones and Cancer (Danish Cancer Society) from May 1991 to January 1993 and continued to 2000 with a mean follow-up time of 8.1 years (range 7.2–9.3 years). The cohort was established with the purpose of studying the natural history of papillomavirus infection and cervical intraepithelial neoplasia. The Ethical Committee of Copenhagen and Frederiksberg Municipalities approved the study. Procedures for enrolment and data collection are described in details elsewhere (Kjaer *et al.*, 1996).

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A total of 16,345 women were invited, of which 11,088 (68%) were included in the first part of the study. The present study is based on all the 6747 women who returned the dietary questionnaire at the baseline and who participated in the follow-up in 2000. In order to investigate the risk of becoming heavy drinker, only those women who were non- to moderate drinkers at the baseline were included (6519). A total of 150 women had not answered the relevant questions regarding the covariates used and thus 6369 (57%) were eligible for analyses in this study.

Outcome

The participants were dichotomized into heavy drinkers and non- to moderate drinkers at the follow-up based on self-reports in a dietary questionnaire. The outcome heavy drinking was defined as an intake of more than 14 units of alcohol per week. This definition was based on the recommendations from the Danish National Board of Health (Gronbaek *et al.*, 1997). The alcohol consumption was calculated as the total weekly intake of beer (bottles), wine (glasses), and spirits (units). A bottle of beer contains 12 g alcohol and is similar to 1/6 bottle of wine or 1 serving of spirits (4 cl).

Exposure

Information on smoking habits was obtained from the dietary questionnaire at baseline. The participants reported if they were current smokers, never smokers, or former smokers. The definition of being a current smoker was a person who smoked one or more cigarettes per day during the month prior to the interview. The women were categorized as never smokers, former smokers, 1–14 cigarettes per day, 15–24 cigarettes per day, and more than 24 cigarettes per day.

Covariates

The following covariates, based on self-reports from the interview and the dietary questionnaire, were assumed to potentially confound the analyses: Average weekly consumption of alcohol at baseline (nondrinkers, <1 unit of alcohol/week, 1–5 units/week, >5–10 units/week, and >10–14 units/week). The alcohol intake at baseline was included as both a continuous and categorical measure. Furthermore, age (20–21, 22–23, 23–24, 26–27, and 28–29 years old) and cohabitation (cohabitant or living alone) were included as covariates. Cohabitants referred to married women and women who lived with a partner. Living alone included divorced, widowed or not married women who were living alone. We further included education (1–10 years and >10 years), parity (0 births, 1 birth and more than 1 birth), number of spontaneous abortions (0, 1–2, and more than 2), number of induced abortions (0, 1–2, and more than 2), number of sexual partners (0, 1–5, 6–10, 10–15, and >15), history of sexually transmitted diseases (yes or no to have had at least one of the following diseases: Chlamydia, gonorrhoea, syphilis, genital warts, herpes or any other kind of sexually transmitted disease), using contraceptives at the first intercourse (yes, no), and age at first sexual intercourse (12–14 years, 15–18 years, and >18 years).

STATISTICS

The odds ratios and 95% confidence intervals (CI) for becoming a heavy drinker were estimated by means of logistic regression (SAS/STAT version 9.1). Age of the women and alcohol intake at baseline examination were entered into all the analyses. Selection of confounders was based on the change-in-estimate method described by Greenland and Rothman (Greenland and Rothman, 1998). A change in the estimates, of the association between smoking and risk of becoming a heavy drinker, of minimum 10% was used as the criterion to select confounders. Cohabitation, education, parity, spontaneous abortions, induced abortions, number of sexual partners, history of sexually transmitted diseases did not fulfill this criterion, and these variables were therefore not included in the final multivariate model. The adjusted estimates of smoking habits as a risk factor for becoming a heavy drinker among the non- to moderate-drinkers were obtained by entering age, baseline alcohol consumption, and age at first sexual intercourse in a multivariate logistic regression analysis. Alcohol use at baseline was included as a continuous measure in the analysis and age plus age at first intercourse were included as categorical measures. Possible modifications between age and smoking and between smoking and age at sexual debut were examined by stratification. The criterion for a significant interaction was set to 5%.

RESULTS

A total of 177 women became heavy drinkers during follow-up. Based on the percentwise distributions presented in Table 1 it seemed that women who smoked had a greater consumption of alcohol, a higher mean age, a greater proportion of women living alone, a greater proportion of low educated, a higher mean number of sexual partners, a higher mean number of induced abortions, a greater proportion of women with a history of sexually transmitted diseases, a greater proportion who had not used protection at first intercourse, and a lower mean age at sexual debut than never smokers. Smokers did not differ from nonsmokers with regard to mean number of births, and number of spontaneous abortions.

Daily smoking at baseline was associated with an increased risk of becoming a heavy drinker at follow-up, even after adjusting for alcohol consumption at baseline as a continuous measure (Table 2). Women who smoked more than 24 cigarettes per day had an adjusted odds ratio of 2.3 (CI 0.9–5.9) of becoming heavy drinkers at follow-up compared to participants who had never smoked. Women who smoked between 14 and 24 cigarettes per day had adjusted odds ratio of 1.7 (CI 1.1–2.6) and women who smoked between 1 and 14 cigarettes a day had adjusted odds ratio of 1.6 (CI 1.1–2.4) of becoming a heavy drinker at follow-up compared to women who had never smoked.

Alcohol consumption at baseline, but also age at first intercourse, were additionally shown to be predictors for heavy alcohol consumption at follow up. For women with a baseline alcohol consumption at 1–5 units per week, the adjusted OR for becoming a heavy drinker 8 years later was 2.2 (CI 1.0–4.7) and for women with an alcohol consumption at 10–14 units per week at baseline, the adjusted OR for becoming a heavy drinker was 27.0 (CI 12.3–59.2) compared to a weekly intake

Table 1. Distribution of baseline characteristics according to smoking status, $n = 6369$

Smoking status	Never smoker	Former smoker	1–14 Cigarettes/day	15–24 Cigarettes/day	>24 Cigarettes/day
n (%)	2978 (46.9)	666 (10.5)	1479 (23.1)	1164 (18.3)	82 (1.3)
Alcohol consumption (monthly intake) ^a	14.7 (0–61)	15.7 (0–61)	17.4 (0–61)	17.2 (0–61)	18.1 (0–61)
Mean age	24.8 (20–29)	25.4 (20–29)	24.7 (20–29)	24.9 (20–29)	25.3 (20–29)
Age at sexual debut, mean	17.2 (12–27)	16.1 (12–27)	16.3 (12–27)	15.8 (12–27)	15.3 (12–20)
Education, low%	20	25	32	43	52
Civil status, living alone, %	44	33	49	51	52
Number of births, mean	0.2 (0–3)	0.3 (0–3)	0.2 (0–3)	0.2 (0–3)	0.3 (0–2)
Number of spontaneous abortions, mean	0.0 (0–3)	0.1 (0–3)	0.1 (0–5)	0.1 (0–5)	0.1 (0–2)
Number of provoked abortions, mean	0.2 (0–4)	0.3 (0–4)	0.3 (0–5)	0.4 (0–4)	0.8 (0–4)
Number of sexual partners, mean	5.4 (1–13)	6.5 (2–13)	6.4 (2–13)	7.0 (2–13)	7.9 (4–13)
Ever sexually transmitted disease, yes%	27	37	34	43	60
Used protection at first intercourse, no%	20	30	25	29	39

^aWomen with an alcohol consumption above 61 units per month were excluded from the analysis, since these were heavy drinkers at baseline (above 14 units per week, calculated as 61/4.3).

Table 2. Odds Ratios and CI, of becoming a heavy drinker according to smoking status, alcohol consumption, and age at sexual debut; $n = 6369$

Measures at baseline	OR crude	95% CI	OR adjusted ^a	95% CI
Smoking status				
Never smoker	1		1	
Former smoker	1.9	(1.1–3.1)	1.5	(0.9–2.6)
>0–14 cigarettes/day	2.1	(1.4–3.1)	1.6	(1.1–2.4)
14–24 cigarettes/day	2.4	(1.6–3.6)	1.7	(1.1–2.6)
>24 cigarettes/day	4.5	(1.9–10.9)	2.3	(0.9–5.9)
Alcohol consumption				
<1 units/week	1		1	
1–5 units/week	2.1	(1.0–4.5)	2.2	(1.0–4.7)
>5–10 units/week	7.5	(3.6–15.5)	7.4	(3.5–15.3)
>10–14 units/week	30.3	(13.9–66.2)	27.0	(12.3–59.2)
Age at sexual debut				
12–14	2.9	(1.6–5.2)	2.1	(1.1–3.9)
15–18	1.3	(0.8–2.2)	1.1	(0.6–1.9)
>18	1		1	

^aMutually adjusted for alcohol consumption as continuous measure, smoking, age at sexual debut, and age.

of less than 1 unit. For women with a sexual debut before the age of 15, the adjusted OR for becoming a heavy drinker was 2.1 (CI 1.1–3.9) compared to women with a sexual debut after the age of 18 years (Table 2).

A significant interaction was found between age at sexual debut and smoking status. Hence, as shown in Table 3, the risk of being a heavy drinker at follow-up was restricted to women with a lower age at first intercourse. In the group of women with a sexual debut before the age of 15 years, the odds ratio for becoming a heavy drinker was 2.2 (CI 0.9–5.4) for ex-smokers, 2.2 (CI 1.0–4.7) for current smokers smoking ≤ 14 cigarettes per day, and 2.9 (CI 1.5–5.9) for current smokers smoking more than 14 cigarettes. For the women with sexual debut after the age of 18, the corresponding odds ratios were respectively 1.0 (CI 0.3–3.2) for ex-smokers, 1.0 (CI 0.4–2.3) for current smokers (CI ≤ 14 cigarettes per day), and 0.5 (CI 0.1–1.8) for current smokers with a daily consumption of more than 14 cigarettes. These analyses were adjusted for alcohol consumption as a categorical measure (instead of a continuous measure) because of the small sizes of the strata.

DISCUSSION

The present study demonstrates that smoking among non- to moderate-drinking young women increases their risk of later becoming heavy drinkers compared to never-smoking women. The greater relative risk was more pronounced among women with an early sexual debut. In addition, the study demonstrates that light to large alcohol consumption is an important predictor of later heavy drinking among young women, when compared to abstainers.

The findings of this study are supported by a study (Jensen *et al.*, 2003) on the elderly Danish population with a mean age of 50 and a follow-up time between 5 and 10 years, where the authors found a prospective association between smoking and later alcohol consumption. In a study by Jackson *et al.* (Jackson *et al.*, 2003) the positive association between smoking and later alcohol consumption in a general population with mean age 44 years was only present on a short-term basis (1 year) and not on a long-term basis (16 years) (Jackson *et al.*, 2003) which could be due to a different population sample and different alcohol and smoking measures. The population sample Jackson *et al.* studied had 79% men, the outcome was defined as alcohol use disorder (pathological alcohol use), and the exposure was nicotine dependence (10 cigarettes a day for the past year).

The findings of a moderate alcohol consumption as an independent predictor of later heavy drinking is almost equivalent with the OR for smoking and later heavy drinking and is supported by a study where drinking alcohol more than once a month was shown to be associated with later heavy drinking (more than 14 units per week for women) (Andersen *et al.*, 2003) which indicates that even a moderate alcohol intake in early adulthood may be a beginning of a large-scale alcohol consumption in adulthood. Furthermore, a recent study found that for women the risk of developing alcoholism after 25 years increases even with low levels of alcohol consumption at baseline (Flensburg-Madsen *et al.*, 2007). From a health promotion point of view it is important to know if drinking behavior in young adulthood tracks into adulthood. The very high, adjusted OR for becoming a heavy drinker for women with a large alcohol consumption at baseline is interesting though not surprising since only a slight increase in alcohol consumption during the 8 years of follow-up would place these women in the heavy-drinking category. The result could also be due to an

Table 3. Unadjusted Odds Ratios of becoming a heavy drinker according to smoking status, stratified by age at first intercourse; $n = 6369$

Age at first at first intercourse	OR <15 years	(CI)	OR 15–18 years	(CI)	OR >18 years	(CI)
<i>n</i> (%)	762 (12.0)		4783 (75.1)		824 (12.9)	
Never smoker	1		1		1	
Former smoker	2.2	(0.9–5.4)	1.5	(0.6–3.6)	1.0	(0.3–3.2)
1–14 cigarettes/day	2.2	(1.0–4.7)	1.9	(1.0–3.6)	1.0	(0.4–2.3)
> 14 cigarettes/day	2.9	(1.5–5.9)	1.9	(0.9–3.8)	0.5	(0.1–1.8)

underreporting at baseline, such that some of the women who reported to consume between 10 and 14 units per week were actually heavy drinkers already at baseline and have continued to drink above the recommended 14 units per week during the 8 years of follow-up.

This study has the advantage of repeated assessments of drinking and smoking habits among the same participants and a large sample size. Since information regarding health behaviors was obtained prospectively, differential recall bias was eliminated.

One limitation of the current study is that the results could be subject to selection bias, since participants who did not participate in both examinations and did not return the dietary questionnaire in phase 1 were excluded from the analysis. Participants who did not attend follow-up were more often drinking, smoking, and low educated and this contributes to the risk of selection bias. We do not expect nonresponse to have affected the internal validity but it can reduce the generalizability of the study.

The information on smoking and alcohol consumption were self-reported measurements, therefore underreporting by the participants is not impossible. The analyses were made with different definitions of heavy drinkers, and according to this, the number of women in each category differed considerably as a high percentage of the women drank close to 14 units of alcohol per week. However, the association was present independently of which definition was used. The results would be biased if underreported alcohol consumption were associated with smoking at baseline. A false association would appear if many smoking moderate drinkers from the first examination were in fact heavy drinkers, thereby having a greater risk of also being a heavy drinker at follow-up. The reliability of self-reported alcohol intake has been investigated in a Danish cohort, showing no important differences between self-reported questionnaires and dietary interviews, but some underestimation is not impossible (Gronbaek and Heitmann, 1996).

Underreporting of smoking could also bias the results and create a stronger relation between smoking and drinking but the authors of a previous study have validated data on self-reported smoking and found small differences based on serum cotinine (Patrick *et al.*, 1994). The number of cigarettes smoked per day in this study could be overestimated since the variable is a combination of two questions, regarding current smoking status and cigarettes smoked per day when the subjects were smoking the most. An overestimation could result in bias towards the null. The group of ex-smokers is likely to be nonhomogeneous, since women categorizing themselves as ex smokers could relapse into smoking during follow-up. Results from this group should be interpreted with caution and need further in-

vestigation with, for instance, information about time since quitting.

Since the association between smoking and later heavy drinking was most pronounced among women with an early sexual debut, sexual habits could have influenced the results by being a function of common third variables, risky behavior or special personality traits such as sensation-seeking regarding smoking, alcohol, and sexual behaviors. In a previous studies, sensation seeking was found to be associated with alcohol and smoking behavior (Kraft and Rise, 1994); another study (Graves and Leigh, 1995) concluded that sexual activity was associated with alcohol consumption and smoking. Furthermore, individuals who report symptoms of anxiety and depression are highly represented amongst those who smoke tobacco and consume alcohol at harmful levels (Alati *et al.*, 2004), which could have influenced the association found between smoking and later alcohol consumption.

Previous studies have found that the use of either tobacco or alcohol predicts a future dependence of the other (Jackson *et al.*, 2003; Simon *et al.*, 1995) and results from twin and family studies have pointed at a shared genetic predisposition as an biological explanation (Gruza and Bierut, 2006; True *et al.*, 1999). The effect of nicotine on alcohol consumption has been documented in several animal studies showing an increased self-administered use of alcohol among rats exposed to nicotine (Rose *et al.*, 2004; Le *et al.*, 2003). A study by Ritchey *et al.* found that adolescents had a greater pleasure caused by a synergistic effect of the use of both substances together, which could explain the cooccurrence of the two substances (Ritchey *et al.*, 2001a). Furthermore, smoking and alcohol consumption can be seen as complementary behaviors (Room, 2004) and influenced by a social context since tobacco and alcohol are often used in the same situations (Johnson and Jennison, 1992).

It cannot be clarified whether smoking influences later alcohol consumption directly or through a common third variable such as a general risk behavior. However, the prospective relationship between smoking and alcohol consumption especially among women with an early sexual debut, and between alcohol consumption and later heavy drinking, is important to recognize when identifying risk groups and designing preventive strategies. Young women with a high alcohol consumption is a particular public health concern since they might become pregnant and expose the fetus to alcohol with the attendant risk of fetal alcohol syndrome.

In conclusion, smoking was shown to increase the risk of becoming a heavy drinker 8 years later among light to moderate drinking women. This was most pronounced for women with an early sexual debut. Alcohol consumption and age at sexual debut were likewise predictors of later heavy drinking.

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