EPIDEMIOLOGY

Association of Average Daily Alcohol Consumption, Binge Drinking and Alcohol-Related Social Problems: Results from the German Epidemiological Surveys of Substance Abuse

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Abstract — Aims: The present study investigates the combined effect of average volume and binge drinking in predicting alcohol-related social problems and estimates the proportion of alcohol-related harms related to specific drinking patterns that could be prevented if transferred to a low-risk drinking group. Methods: Data came from the 1997 and 2000 German Epidemiological Survey of Substance Abuse (ESA) (age: 18–59 years; response rate: 65% and 51%, respectively). The pooled sample consisted of 12,668 current drinkers. By using nine categories of average daily intake and three groups of binge drinking, individuals were grouped into 22 mutual exclusive groups. Social problems were defined as the occurrence of ‘repeated family quarrels’, ‘concern of family members or friends’, ‘loss of partner or friend’ or ‘physical fight or injury’ in relation to alcohol. Results: The effect of average daily intake is modified by binge drinking frequency such that the association was strongest in those with four or more binge drinking occasions during the last 30 days. Within each binge drinking group, adjusted relative risks (aRR) increased with alcohol intake up to a certain threshold and decreased thereafter. Overall, compared to the reference group (≤7 g ethanol/day—no binge), the population-attributable fraction (PAF) related to the other drinking groups was 71.4% (95% CI 64.4–77.1%). Conclusions: The frequency of binge drinking occasions seems to be a better predictor of alcohol-related social problems than volume. Alcohol-related social harms especially among drinkers with moderate volume per day may be reduced by targeting prevention strategies towards episodic heavy drinkers.

INTRODUCTION

Risk curves and dose–response analyses have a long tradition of studying the relations between alcohol consumption and harmful health and social consequences. Positive relations between overall intake and adverse consequences such as morbidity, mortality, social problems, abuse and dependence are well established (Babor et al., 2003). While a few medical conditions, such as cardiovascular disease, show a protective effect of moderate consumption, most conditions revealed a positive linear or exponential relationship with the volume of alcohol consumption (Lazarus et al., 1991; Corrao et al., 2004).

Recent studies also provide evidence that not only volume of consumption but also patterns of drinking, especially irregular heavy drinking, are related to the burden of disease and non-medical consequences of drinking (Rehm et al., 1996, 2003). Drinking patterns such as intoxication are considered to be more related to acute consequences such as various types of accidental injuries, aggression, violence, legal problems, suicide or interpersonal conflicts rather than total volume (Bondy, 1996; Room, 2001; Kuntsche et al., 2008). For example, Miller et al. (2007) investigated the links between current drinking, binge drinking and other health risk behaviours in a sample of high school students and found that binge drinking was related to poor school performance, being a victim of dating violence, attempting suicide, smoking and using illegal drugs. Among adults, and controlling for overall volume, Midanik et al. (1996) found significantly higher risks for the experience of work-related problems, drunk driving as well as alcohol dependence among individuals who reported having had five or more drinks on at least 1 day in the last year. Examining the relative importance of volume of consumption and the frequency of binge drinking, two studies (Single et al., 1996; Rehm and Gmel, 1999) reported that binge drinking was more predictive for experiencing social problems than was overall volume.

While studies consistently showed that at any level of average volume, binge drinking increases the risk of experiencing acute negative social consequences, studies estimating the contribution of different drinking patterns to the total burden of alcohol-related harm in the population suggest that a major part is contributed by moderate drinkers. This is referred to as the ‘prevention paradox’ that states that the bigger part of alcohol-related harm may originate among moderate drinkers, even though the risk of negative consequences is by far the highest among subjects with high-risk drinking. This is simply due to the higher number of moderate drinkers in the population (Kreitman, 1986; Skog, 1999; Gmel et al., 2001). Most recently, Rossow and Romelsjö (2006) summarized the available evidence for the prevention paradox, which indicates that the prevention paradox applies best to drinking cultures where drinking often leads to intoxication among the majority of drinkers. In their cross-sectional population-based study of Norwegian adults and in a sample of Swedish armed forces conscripts, the authors applied two alternative definitions of high-risk drinking: the upper 10% of drinkers by annual volume of consumption and the upper 10% of the drinkers by annual frequency of intoxication (Rossow and Romelsjö, 2006). In their study, the bigger part of alcohol-related quarrelling and physical violence was found among drinkers with low or moderate risk drinking, providing empirical support for the prevention paradox. In addition, by applying frequency of intoxications rather than annual volume of drinking to determine the high-risk group, a
Drinking Patters and Alcohol-Related Social Problems

Although several studies (Midanik et al., 1996; Gmel et al., 2001; Rossow and Romelsjö, 2006; Kuntsche et al., 2008) compared the relative importance of intoxications and average volume of drinking with regard to alcohol-related harm, few studies investigated whether these two drinking characteristics act interactively upon the likelihood to exhibit alcohol-related problems. In addition, to our knowledge only one study estimated the proportion of alcohol-related harm related to specific drinking patterns that could be prevented if transferred to a low-risk drinking group. In a Swiss general population sample, Gmel et al. (2001) found that moderate drinkers defined in terms of volume reported more problems than at-risk drinkers and binge drinkers reported more problems than non-binge drinkers. However, the authors could not establish an interaction effect between mean consumption and binge drinking on alcohol-related social consequences, which might be due to the small cell sizes of the cross-classification of the mean consumption and frequency of binge drinking in their dataset. Gruenewald and colleagues (2003) studied dose–response relationships among college students based on a graduated frequency measure of drinking various quantities. Estimating population risks distributed over a large number of drinkers and estimated the proportion of alcohol-related harm related to alcohol consumption within the last 30 days (n = 13,404) as abstainers did not receive questions on alcohol consumption and alcohol-related problems. Subjects with missing values on alcohol volume (n = 130), frequency of binge drinking (five or more drinks containing on average 70 g ethanol per occasion) (n = 386) or the indicator of alcohol-related social problems (n = 102) were excluded. Another 220 subjects were excluded because their responses on average volume per drinking day were contradictory to their responses on binge drinking: 51 reported an intake of ≥70 g ethanol per day but indicated no occasion of binge drinking and 169 subjects reported at least one occasion of binge drinking but had altogether only consumed <70 g ethanol in the last month. Altogether, 838 respondents or 6.3% of the sample of drinkers within the last 30 days had missing values on at least one of the variables used for the analysis. The analytical sample consisted of 12,566 subjects.

Methods

Data from the 1997 and 2000 Epidemiological Survey of Substance Abuse (ESA) covering the adult German general population were used. The study design of the mail survey has previously been described in more detail (Kraus and Bauerfeind, 1998; Kraus and Augustin, 2001). In short, two independent cross-sectional multistage random samples from the adult population aged 18–59 years were drawn. In 1997, sampling was based on a random route approach; in 2000, subjects were randomly selected from the residents’ registration offices. Out of all eligible subjects, 8020 (1997) and 8139 subjects (2000) participated, corresponding to response proportions of 65% and 51%, respectively.

The two independent cross-sectional samples were pooled to increase the sample size (n = 16,159). For the present analysis, the sample was restricted to respondents reporting alcohol consumption within the last 30 days (n = 13,404) as abstainers did not receive questions on alcohol consumption and alcohol-related problems. Subjects with missing values on alcohol volume (n = 130), frequency of binge drinking (five or more drinks containing on average 70 g ethanol per occasion) (n = 386) or the indicator of alcohol-related social problems (n = 102) were excluded. Another 220 subjects were excluded because their responses on average volume per drinking day were contradictory to their responses on binge drinking: 51 reported an intake of ≥70 g ethanol per day but indicated no occasion of binge drinking and 169 subjects reported at least one occasion of binge drinking but had altogether only consumed <70 g ethanol in the last month. Altogether, 838 respondents or 6.3% of the sample of drinkers within the last 30 days had missing values on at least one of the variables used for the analysis. The analytical sample consisted of 12,566 subjects.

Measurements

Data on the use of psychotropic substances and substance-related problems were collected via self-completion questionnaires covering questions on alcohol consumption patterns, alcohol-related chronic and social consequences as well as socio-demographic characteristics.

Alcohol volume. Alcohol consumption was assessed using a beverage-specific quantity–frequency measure based on the past 30 days: (i) ‘During the last 30 days, on how many days did you drink beer (wine, spirits)?’ (ii) ‘On average, on a day when you drank beer (wine, spirits), how many glasses of beer (wine, spirits) did you drink?’ The average daily consumption (in grams ethanol per day) was calculated by multiplying frequency and quantity using beverage-specific standard ethanol contents of 40 g, 92 g and 320 g ethanol for beer, wine and spirits, respectively.

Binge drinking. Binge drinking was specified as the intake of five or more drinks of any alcohol at a single occasion and the frequency was assessed by asking ‘On the last 30 days, on how many days have you drunk five or more drinks containing any alcohol on a single occasion?’ The average ethanol content for a standard drink was estimated to 14 g resulting in an average amount of 70 g ethanol for a binge occasion. Binge drinking
within the last 30 days was categorized into ‘no binge occasion’, ‘1–3 binge occasions’ and ‘4 or more binge occasions’. Since our main research question relates to the interactive effects of average alcohol intake and binge drinking, our analysis followed the approach recommended by Rehm and Gmel (2000) to create suitable dummy variables that reflect average intake as well as binge drinking frequency. Accordingly, alcohol intake was categorized in nine groups based on the number of standard drinks: up to 7 g, 8–14 g, 15–28 g, 29–42 g, 43–56 g, 57–69 g, 70–98 g, 99–126 g, 127 g or more per day. Individuals were then grouped according to the number of standard drinks and frequency of binge drinking within the last 30 days (‘no binge occasion’, ‘1–3 binge occasions’ and ‘4 or more binge occasions’). The latter two volume categories among drinkers who binged 1–3 times a month resulted in sparsely populated cells and were collapsed into the category ‘70 g or more per day’. And, since among non-binge drinkers an average daily amount of ≥70 g per day may not be reached without binging, individuals were grouped into 22 mutual exclusive alcohol intake groups.

**Social problems.** Alcohol-related social problems in the last 12 months were assessed using responses on the questions whether due to their alcohol consumption respondents had experienced (1) repeated quarrels with partner or family member(s), (2) reproach or concern of family member(s) or friend(s), (3) loss of partner or friend(s) and (4) physical fight(s) or injury(ies). A variable was constructed by using any positive responses on the problems (1)–(4) indicating the presence of alcohol-related social problems.

While the wordings of the questions on alcohol consumption and binge drinking were identical in both surveys, the wordings regarding social problems differed slightly. By face validity, the questions were regarded as measuring the concepts of alcohol-related ‘repeated family quarrels’, ‘concern of family members or friends’, ‘loss of partner or friend’ and ‘physical fight or injury’.

**Statistical analyses**

Data on quantitative variables were expressed as mean and standard deviation. Qualitative variables were expressed as percentages and absolute numbers. Unadjusted differences were tested using the chi-squared and Wilcoxon statistics. Cuzick’s (1985) nonparametric test for trend across ordered groups was used to investigate whether the likelihood of alcohol-related social problems increases with age and binge drinking frequency. Associations between average daily alcohol intake expressed in grams ethanol (nine groups) and alcohol-related social problems were expressed as relative risks (RR). Adjusted RR (aRR) were derived from Poisson regression models with Huber/White standard errors (Greenland, 2004). Each regression model also included age, gender and survey year. In addition, a model including an interaction term of the binge drinking group and average daily intake was performed. PAFs were calculated for alcohol intake groups related to alcohol-related social problems. We computed adjusted PAFs for each alcohol intake group using average daily volume of consumption of ≤7 g and no binge drinking during the last 30 days as the reference group. PAF is a function of both RR and the prevalence of the exposure, and increases as one or both of these quantities increase. Adjusted PAFs were derived using the AFLOGIT procedure of Stata, which calculates PAF and corresponding 95% confidence intervals (CI) on the basis of the previously fitted regression model (Greenland and Drescher, 1993).

**RESULTS**

Table 1 displays characteristics of study participants in the pooled analytical sample as well as by survey year. It also shows bivariable associations between socio-demographic, drinking variables, and alcohol-related social problems. Among all participants, 5.2% (1997: 5.3%; 2000: 5.2%) revealed alcohol-related social problems. Older individuals were less likely than younger individuals to show alcohol-related social problems ($P < 0.01$ for linear trend) and males were more likely than females to reveal alcohol-related social problems. The average volume of alcohol intake (in grams ethanol per day) was higher in individuals with alcohol-related social problems compared to those without.
to those without these problems. They were also more likely to report several binge drinking occasions during the last 30 days than those without these problems ($P < 0.01$ for linear trend).

Next, we performed a model that included average daily intake as a continuous variable, binge drinking groups (two binary indicators) and the product term of average daily intake and binge drinking groups. The findings indicated that the effect of average daily intake is modified by binge drinking frequency, such that the association was strongest in those with four or more binge drinking occasions versus no binge occasion ($\beta_{4+}$ binge occasions versus no binge occasion $\times$ alcohol intake $= -0.020$, $P < 0.01$; $\beta_{4+}$ binge occasions versus no binge occasion $\times$ alcohol intake $= -0.017$, Wald $P < 0.01$). Figure 1 shows the effect modification of binge drinking and average daily intake on the likelihood of social problems.

Table 2 shows the aRR to reveal alcohol-related social problems of the 22 alcohol intake groups with the reference group of subjects with a maximum of 7 g of pure alcohol per day (i.e. half a standard drink) and no drinking occasion during the last 30 days. Within each binge drinking group, aRR increased with alcohol intake up to a certain threshold and decreased thereafter. For example, in those with no binge occasion during the last 30 days, the aRR for social problems increases from 1.07 (8–14 g/day) to 6.10 (43–56 g/day), and then decreases to 3.89 (57–69 g/day). Similar patterns were found in those with one to three binge drinking occasions during the last month. In the last group of individuals with four and more binge occasions, the aRR increased from 1.47 ($\leq 7$ g/day) to 29.51 (99–126 g/day) and decreased thereafter.

In addition, we calculated fractions attributable to the 22 alcohol intake groups based on the estimates of the Poisson regression model (Table 2). Overall, the PAF related to combinations of average daily volume of consumption and binge drinking frequency was 71.4% (95% CI: 64.4–77.1%). In men (Fig. 2), the PAF was 63.3% (95% CI: 50.7–72.7%) and in women (Fig. 3), the PAF was 82.0% (95% CI: 72.1–88.4%).

Figure 2 suggests that the highest proportions of risks are attributable to binge drinking among men. However, among the three binge drinking groups, the PAF of social problems sharply increased with average amount of alcohol consumed and decreased after a certain threshold was reached.

Figure 3, which displays the PAF for alcohol-related social problems among the female sub-sample, indicates the dose–response relation differed somewhat from the findings in the male sub-sample. In females with no binge drinking occasion or those with one to three binge occasions, the PAF increased with volume of drinking up to 28 g per day and decreased

Table 2. Adjusted relative risks and population-attributable fractions for alcohol-related social problems by binge drinking groups

<table>
<thead>
<tr>
<th>Gram ethanol per day by the binge drinking group</th>
<th>N (%)</th>
<th>aRR (95% CI)</th>
<th>PAF (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No binge occasion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\leq 7$ (reference group)</td>
<td>4,952 (39.4%)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>8–14</td>
<td>1,707 (13.6%)</td>
<td>1.07 (0.68, 1.67)</td>
<td>0.003 (-0.147, 0.0194)</td>
</tr>
<tr>
<td>15–28</td>
<td>1,212 (9.7%)</td>
<td>1.98** (1.31, 2.98)</td>
<td>0.026 (0.008, 0.044)</td>
</tr>
<tr>
<td>29–42</td>
<td>397 (3.2%)</td>
<td>2.37 (1.34, 4.21)</td>
<td>0.012 (0.002, 0.023)</td>
</tr>
<tr>
<td>43–56</td>
<td>100 (0.8%)</td>
<td>6.10** (3.12, 11.93)</td>
<td>0.011 (0.004, 0.019)</td>
</tr>
<tr>
<td>57–69</td>
<td>47 (0.4%)</td>
<td>3.89 (1.27, 11.97)</td>
<td>0.003 (-0.01, 0.008)</td>
</tr>
<tr>
<td>1–3 binge occasions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\leq 7$</td>
<td>442 (3.5%)</td>
<td>1.87 (1.04, 3.36)</td>
<td>0.009 (-0.001, 0.020)</td>
</tr>
<tr>
<td>8–14</td>
<td>617 (4.9%)</td>
<td>3.35** (2.25, 5.00)</td>
<td>0.037 (0.021, 0.053)</td>
</tr>
<tr>
<td>15–28</td>
<td>719 (5.7%)</td>
<td>3.99** (2.75, 5.78)</td>
<td>0.055 (0.036, 0.073)</td>
</tr>
<tr>
<td>29–42</td>
<td>315 (2.5%)</td>
<td>6.27** (4.12, 9.53)</td>
<td>0.042 (0.028, 0.056)</td>
</tr>
<tr>
<td>43–56</td>
<td>101 (0.8%)</td>
<td>5.93** (3.12, 11.25)</td>
<td>0.013 (0.005, 0.021)</td>
</tr>
<tr>
<td>57–69</td>
<td>59 (0.5%)</td>
<td>6.90** (3.29, 14.47)</td>
<td>0.009 (0.003, 0.015)</td>
</tr>
<tr>
<td>$\geq 70$</td>
<td>62 (0.2%)</td>
<td>6.41** (2.25, 18.25)</td>
<td>0.004 (-0.0002, 0.008)</td>
</tr>
<tr>
<td>4+ binge occasions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\leq 7$</td>
<td>87 (0.7%)</td>
<td>1.47 (0.37, 5.80)</td>
<td>0.001 (-0.003, 0.005)</td>
</tr>
<tr>
<td>8–14</td>
<td>220 (1.8%)</td>
<td>3.41** (1.86, 6.23)</td>
<td>0.013 (0.003, 0.022)</td>
</tr>
<tr>
<td>15–28</td>
<td>485 (3.9%)</td>
<td>7.80** (5.50, 11.05)</td>
<td>0.083 (0.065, 0.102)</td>
</tr>
<tr>
<td>29–42</td>
<td>390 (3.1%)</td>
<td>9.23** (6.55, 13.02)</td>
<td>0.085 (0.068, 0.102)</td>
</tr>
<tr>
<td>43–56</td>
<td>229 (1.8%)</td>
<td>13.93** (9.81, 19.78)</td>
<td>0.075 (0.061, 0.089)</td>
</tr>
<tr>
<td>57–69</td>
<td>171 (1.4%)</td>
<td>15.19** (10.52, 21.95)</td>
<td>0.062 (0.050, 0.075)</td>
</tr>
<tr>
<td>70–98</td>
<td>161 (1.3%)</td>
<td>20.16** (14.30, 28.44)</td>
<td>0.079 (0.068, 0.091)</td>
</tr>
<tr>
<td>99–126</td>
<td>79 (0.6%)</td>
<td>29.51** (20.81, 41.85)</td>
<td>0.059 (0.052, 0.066)</td>
</tr>
<tr>
<td>$\geq 126$</td>
<td>50 (0.4%)</td>
<td>25.75** (16.95, 39.13)</td>
<td>0.032 (0.026, 0.038)</td>
</tr>
</tbody>
</table>

*aThe Poisson regression model also included age, gender and survey year. aRR, adjusted relative risk; CI, confidence interval; PAF, population-attributable fraction. *P < 0.05, **P < 0.01.*
thereafter. However, in females with four and more binge drinking occasions, the PAF of those with 99 g per day and more kept rising with amounts of consumed alcohol.

**DISCUSSION**

Using data from two nationally representative cross-sectional samples, this study adds to the growing body of research demonstrating that binge drinking in combination with average volume of alcohol consumption is associated with the risk of alcohol-related social consequences. The present study revealed that 5.2% of the individuals in our sub-sample of current drinkers recorded alcohol-related social problems during the previous year. This yields to an estimated proportion of 4.3% (2.05 million people) of the 18- to 59-year-old German population that reported alcohol-related social problems during the past year. Alcohol-related social problems decreased with age and were reported more often by men than by women. Alcohol-related social problems were also related to binge drinking frequency during the last month and average alcohol intake was higher in those with alcohol-related social problems compared with those that showed no alcohol-related social problems.

Findings of our multivariable models revealed that the risk of alcohol-related social problems curvilinearly increased by average amount of alcohol intake, after adjusting for sociodemographic factors. However, the results also demonstrate that the risk of alcohol-related social problems was most pronounced among subjects with four and more binge drinking occasions during the last month. This suggests that binge drinking episodes are more strongly related to alcohol-related social problems than to average volume. In addition, we found that the effect of average consumption is modified by the frequency of binge drinking, with those that reported four and more binge occasions during the last month showing the strongest relation between the average volume of consumption and the risk of alcohol-related social problems. In the total sample, we also showed that the PAF related to drinking groups was highest among individuals with four and more binge drinking occasions during the last month and the average volume of consumption between 29 and 42 g ethanol per day. Gender-specific analyses indicated that the dose–response relation of alcohol intake and social problems is almost identical for men and the total sample, while it differed somewhat in the female sub-sample. Females with four and more binge occasions and intake of 99–126 g or more ethanol per day had higher PAFs than males. This could either be related to true differences or to sparsely populated cells among women with four and more binge occasions and intake of ≥70 g ethanol per day, which might have resulted in biased estimates.

The prevalence of alcohol-related social problems observed in the present study was within the range of those observed in a Swiss general population survey (7.7%, Rehm and Gmel, 1999), a Spanish general population sample (6.5%, Alvarez et al., 2006) and in the US National Household Survey on Drug Abuse (5.3%, Harford et al., 2005). However, depending on the definitions of alcohol-related social problems applied, these figures might not be directly comparable.

In line with previous research (Room et al., 1995; Midanik et al., 1996; Gmel et al., 2001), our findings indicate that alcohol-related social problems are associated with the volume of alcohol consumed and the frequency of binge drinking. Another conclusion that is consistent with earlier research (Room et al., 1995; Gmel et al., 2001) is that bingeing is a better predictor of alcohol-related social consequences than average volume of consumption. Results of our regression models with average volume and binge drinking frequency as main effects and an interaction term of these two variables indicate that the effect of average volume of alcohol consumed on the likelihood of social problems was modified by the frequency of binge drinking. Conversely, Gmel et al. (2001) found that for binge drinkers the problem severity did not differ significantly with average consumption from non-binge drinkers. However, this might be related to the small sample size in the latter study.

The findings of our study in the adult population are not directly comparable to the results reported for the same
population by Mäkelä and Mustonen (2007) and those reported for college students by Gruenewald et al. (2003). On the population level, social problems reported by respondents most often occurred in the groups with an average intake level of 15–28 g and 29–42 g of ethanol per day independent of the frequency of binge drinking. Using an ethanol content of 14 g as standard drink, this would amount to an average intake of 1–3 drinks a day. Gruenewald et al. (2003) found the maximum number of problems reported at moderate drinking levels of 2–3 drinks (equivalent to 24–42 g for a US standard glass containing 12–14 g ethanol; Greenfield and Kerr, 2008). However, since frequency was taken as a measure of exposure of various quantities, the number of drinks (dose) in their analysis is not equivalent to average volume. Thus, their results show that a pattern of 2–3 drinks per occasion is most prevalent in the population of college students in terms of the frequency of exposure and that this pattern accounts for a large proportion of alcohol-related problems. Our results, however, refer to average alcohol intake per day gained by non-binge drinking, less than weekly or weekly binge drinking. The simultaneous assessment of dose and frequency comparing the population risks of harm associated to various patterns of use to a reference group as studied by Mäkelä and Mustonen (2007) found much higher doses of drinking accounting for a large proportion of alcohol-related problems. These differences may be partly due to cultural differences but as argued by the authors their method of comparing the risks for negative consequences related to different drinking patterns to different reference groups may have biased the results.

Our study also contributes to the discussion of the prevention paradox (Kreitman, 1986; Skog, 1999; Gmel et al., 2001; for an overview see Rossow and Romelsjö, 2006). Due to our large sample size (n = 12,668 drinkers) and the classification of drinkers into 22 categories combining average volume and frequency of heavy occasional drinking, our results revealed that (1) the majority of harm was attributable to binge drinking behaviour and (2) although the highest risk for alcohol-related harm was found among heavy drinkers (in terms of average intake), the majority of population-attributable harm (PAF) could be avoided by moderate drinkers, whose drinking was characterized by frequent occasions of heavy drinking (bingeing).

Our study also has a number of limitations. First, a major limitation of this study has been its low response rate in one of the study samples (51%, ESA 2000). Despite the low response proportions of the 2000 ESA survey, distributions of socio-demographic characteristics differed only marginally between the weighted sample and population census data (Kraus and Augustin, 2001), indicating that the 2000 ESA is unlikely to have been unacceptably biased due to non-response related to socio-demographic data. However, if those with high levels of average volume of consumption or with current binge drinking are less likely to take part in the study, which is commonly assumed, then the present study would overestimate problems in those individuals with moderate volume and no binge occasion during the last month. Second, average quantity of alcohol per drinking day tends not to be the arithmetic mean of a person’s varying consumption pattern and under-represents heavy drinking occasions (Greenfield and Kerr, 2008). Therefore, the quantity–frequency measure calculated by multiplying frequency and average quantity per drinking day may lead to underestimation of volume. Third, in line with Rehm and Gmel (2000), we have created suitable dummy variables to combine information on aggregate volume and frequency of binge drinking occasions. While this approach allows modelling of curvilinear dose–response relations and easily interpretable results, it also has some drawbacks. The categorization of the continuous volume variable may have resulted in a loss of power or misclassification error (Greenland, 1995). Future research might consider using more flexible techniques for dose–response analyses that avoids categorization of continuous predictors (such as generalized additive models, spline models or fractional polynomials). Fourth, the associations between drinking patterns and social problems rely on the subjective causal attribution of the reported problems to alcohol. Thus, exposure (alcohol consumption) and outcome (social harm) were not independently measured, which may have resulted in an overestimation of the association between alcohol consumption and harm (Gmel et al., 2000). Furthermore, since we only used a binary indicator to measure social problems, no information on the severity or frequency of alcohol-related social problems was provided. Thus, if heavy drinkers/frequent binge drinkers experience more problems or more severe harms, their share of the burden of total harm may be underestimated (Rossow and Romelsjö, 2006). Future work should address whether our differences in predictors exist among severity and dimensions of alcohol-related social problems. Fifth, although we conducted gender-specific analyses, our database might be too small to provide reliable estimates in the female subgroup. Moreover, using 5+ as a proxy of binge drinking in females may be inappropriate as it may underestimate high-risk drinking in this sub-sample. A ‘cut-off’ of four drinks in a row may provide a more suitable indicator of intoxication in females (Herring et al., 2008). Future research might also use prospective data to disentangle age from cohort effects. Last, as pointed out by others (Steenland and Armstrong, 2006), calculating PAFs for non-causal or surrogate factors can artificially inflate our perception of how much of the risk of alcohol-related social problems is explained. In this regard, it is worthwhile noting that our alcohol-intake groups may be surrogates for other processes not considered in our regression models. Although we calculated adjusted PAFs taking covariables such as age, gender and survey year into account, there might be other unmeasured risk factors that were not considered and might have caused selection on unobservables. Thus, the issue of causality is not completely settled. Accordingly, the PAF is not meant to reflect the proportion of cases that are explained by the risk factor or attributable to the risk factor in a causal manner. Rather, the PAF is much more useful in prioritizing public health interventions or estimating societal impact of risk factor control policies, than for characterizing aetiological factors.

In conclusion, frequency of binge drinking occasions seems to be a better predictor of alcohol-related social problems than volume. Alcohol-related social harms especially among drinkers with moderate average intake per day may be reduced by targeting prevention strategies towards episodic heavy drinkers. In turn, reducing incidences of episodic heavy drinking may reduce overall alcohol consumption.
REFERENCES


