Is the population level link between drinking and harm similar for women and men?—a time series analysis with focus on gender-specific drinking and alcohol-related hospitalizations in Sweden

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Background: A question that has not been addressed in the literature is whether the population level association between alcohol and harm differs between men and women. The main aim of this article is to fill this gap by analysing recently collected time series data of male and female self-reported drinking in relation to gender-specific harm indicators in Sweden. Methods: Male and female per capita and risk consumption was estimated on the basis of self-reported data from monthly alcohol surveys for the period 2002–07. Overall per capita consumption including recorded sales and estimates of unrecorded consumption were also collected for the same period. Alcohol-related hospitalizations were used as indicators of alcohol-related harm. Data were aggregated into quarterly observations and analysed by means of time series analyses (ARIMA-modelling). Results: Overall per capita consumption was significantly related to both male and female alcohol-related hospitalizations. Male per capita consumption and risk consumption were also significantly related to alcohol-related hospitalizations among men. Female per capita consumption and risk consumption had also a positive association with alcohol-related hospitalizations but statistical significance was only reached for alcohol poisonings where the association was even stronger than for men. Conclusions: Changes in alcohol consumption in Sweden was associated with changes in male and female alcohol-related hospitalizations also in analyses based on gender-specific consumption measures. There was no clear evidence that the population level association between alcohol and harm differed between men and women.

Keywords: alcohol-related hospitalizations, gender-specific drinking, population drinking, time series analysis

Introduction

The implication of changes in per capita alcohol consumption is an issue of great interest in most countries, not least to what extent alcohol-related harms are affected. Numerous studies have also shown that many different forms of alcohol-related harm tend to rise as per capita consumption increase. These findings have important implications for alcohol policies, e.g. as evidence for measures aiming at reducing per capita consumption.

A question that has not been addressed in the literature is whether the population level association between alcohol and harm differs between men and women, most likely since gender-specific consumption data allowing for such studies have not been available. The main aim of this article is to fill this gap by analysing time series data of male and female self-reported drinking habits in relation to alcohol-related hospitalizations in Sweden for the period 2002–07. More specifically, we will estimate to what extent changes in male and female per capita consumption and risk drinking are associated with changes in alcohol-related hospitalizations by means of ARIMA-times series analysis.

Earlier Swedish studies that have analysed overall per capita consumption in relation to harm among men and women separately, have revealed a mixed pattern. A 11 increase in per capita consumption tended to have a weaker effect for women regarding liver cirrhosis, suicide and homicide whereas the link was stronger for fatal accidents. A weaker association for women may be the result of a poorer reflection of changes in female per capita consumption in overall per capita consumption (than changes in male per capita consumption). Thus, as women drink less than men and also have experienced a different development over time, overall per capita consumption and female per capita consumption may not have a temporal match. A weaker population level association for women is also expected as women in general have a less detrimental drinking pattern and fewer risk drinkers than men.

On the other hand, for some forms of alcohol-related harm this effect may be partly offset by the fact that women are more vulnerable than men to several adverse consequences from a given amount of drinking. For instance, studies have shown that although women are less likely to be involved in alcohol-related traffic crashes, they tend to have a higher relative risk given the same level of drinking. This idea accords with the previously mentioned finding of a stronger aggregate level link between per capita consumption and female fatal accidents. However, a weaker aggregate level link
for women with respect to cirrhosis does support this idea as several studies have suggested that women have a higher risk of cirrhosis than men.12,13

All in all, it is thus not apparent what to expect from an aggregate level analysis that uses a gender-specific per capita measure instead of an overall per capita measure and the main purpose with this article is to shed light on this question.

Methods

Data on alcohol consumption were obtained from a monthly telephone survey with 1500 Swedes commissioned by SoRAD, Stockholm university.14 Two distinct measures of alcohol consumption are estimated in the survey. One is an estimate of unrecorded consumption, which is added to monthly figures on recorded sales to obtain monthly estimates of actual per capita alcohol consumption. The second measure is only based on self-reported drinking behaviour during the last 30 days according to the quantity and frequency scale. Thirty contact attempts are made before a contact attempt is recorded as a non-response, and the monthly non-response rates varied between 40% and 55% during the study period. The sample is representative for the Swedish-speaking population aged 16–80 years with respect to age, gender and indicators of socio-economic status such as educational level.

The following measures of alcohol consumption are constructed on the basis of the data collected in this survey for the period January 2002 to December 2007:

- Estimates of per capita alcohol consumption based on registered consumption in Sweden (Sales at Systembolaget, restaurants and grocery stores) plus estimates of unrecorded consumption (e.g. travellers’ imports and smuggling). The respondents are asked of how much of different types of unrecorded alcohol they have purchased during the last 30 days and these data are then added to recorded sales and next aggregated into quarterly estimates of per capita consumption.

- Estimates of male and female per capita alcohol consumption based only on data from the Monitoring survey and questions on how often spirits, wine and beer have been consumed during the last 30 days and the typical amount consumed in one occasion (the quantity and frequency scale). These answers are then aggregated into quarterly average amounts of alcohol consumption in pure ethanol per respondent including abstainers (~25% during the last 30 days).

- Estimates of male and female risk consumption are calculated on the basis of this data. There is no golden standard in definition of risk consumption and we apply the definition proposed by the Swedish National Institute of Public Health and the Swedish Council on Health Technology (SBU). This is the most commonly applied definition in Sweden and sets the limits to approximately >24 g/day for men and 15 g/day for women. This measure is then expressed as the proportion of risk drinkers by each quarter.

Alcohol-related hospitalizations were retrieved from the Swedish Hospital Discharge Register which covers all public, inpatient care in Sweden. Although there is some evidence that alcohol-related diagnoses are underreported in these statistics, the underreporting is found to be relatively stable over time.15 Furthermore, although changes in alcohol-related hospitalizations also have other causes than the need for treatment several studies have revealed a significant relationship with changes in per capita alcohol consumption.16,17

Three different groups of alcohol-related hospitalizations were analysed in relation to alcohol consumption: (i) An index consisting of all hospitalizations with an alcohol-related diagnosis as main or contributory cause, (ii) a measure restricted to acute diagnoses like acute intoxication (ICD-10: F10.0) and toxic effect of alcohol (T51) (hereafter, alcohol poisonings) and (iii) a measure basically restricted to more chronic diagnoses (harm resulting from long term heavy drinking) including (F10.1–F10.9), Mental and behavioural disorders due to alcohol, alcoholic liver disease (K70), pancreatitis (K86.0), alcoholic polyneuropathy (G62.1), alcoholic cardiomyopathy (I42.6), alcoholic gastritis (K29.2), alcoholic myopathy (G72.1), degeneration of nervous system due to alcohol (G31.2) (hereafter chronic hospitalizations).

The analysis starts with showing and discussing recent trends in alcohol-related hospitalizations and the various drinking measures. In order to estimate the association between consumption and harm, we apply the technique for time series analyses suggested by Box and Jenkins,18 so called ARIMA modelling. Although there exists different approaches to time series analysis, ARIMA is the most commonly applied method in alcohol epidemiology and it takes efficiently into account some of the complications associated with analyses of time series data.19

Since some seasonal variation was found in the consumption data according to the autocorrelation function (ACF) one option would have been to estimate models based on seasonally differenced data \(\nabla V = Y - Y_{t-p}\). This modelling was however not selected here as it would imply a reduction in the already relatively few numbers of observations and would increase the risk of not detecting an association that actually exists (type 2 error). For most analyses, seasonally differenced models gave similar parameter estimates as models using regular differencing but with larger standard errors implying that statistical significance was not reached (results not shown). For analyses of chronic diagnoses, however, seasonal models produced very unrealistic results (non-significant negative estimates) not in accordance with previous research using longer time series.

We thus estimated models based on regularly differenced data, i.e. the raw data were transformed into differences between adjacent quarterly estimates. With this operation, the trend was eliminated and remaining autocorrelation in the error term was easily modelled with the error term parameters (to obtain white noise).

The following basic model specification was thus used in the present analysis:

\[
\nabla \ln H_t = \nabla b A_t + \nabla N_t
\]

\(H_t\) is the indicator of alcohol-related harm (different forms of hospitalization) at quarter \(t\), \(A\) is the alcohol consumption variables and \(N\) is the noise term that includes other factors related to \(H\) not included in the model. The operator \(\nabla\) denotes that the data is differenced. \(\ln\) signifies that the harm series are logarithmized, which takes into account the fact that the risk function between alcohol and many harms tends to be non-linear, i.e. the risk increases more than linearly with higher consumption. The noise structure is estimated by autoregressive- and moving average-parameters. The Box–Ljung Q-test is applied to control that there is no significant autocorrelation between the error terms (i.e. the residuals are white noise). This diagnostic test for the residual correlation was satisfactory in all our models, indicating that they were adequately fitted.

Results

Descriptives

Women report consuming on average 0.661 of 100% alcohol per quarter compared with 1.541 for men. Corresponding figures for risk consumption are 9.6 and 15.7%, respectively.
With respect to alcohol-related hospitalizations, men have on average about three times higher number of alcohol-related hospitalizations than women—188 000 compared with 64 000.

**The development of consumption and alcohol-related hospitalizations 2002–07**

Figure 1 illustrates that there is a positive relationship between estimated per capita consumption on the one hand and the self-reported consumption for men and women on the other. The magnitude of the association (according to \( r_{xy} \)) is 0.69 for women and 0.71 for men. The corresponding correlation between the share of risk consumers and per capita consumption is 0.78 for women 0.74 for men. There is a seasonal variation in per capita consumption, so that consumption is higher in the second and the third quarter. Risk consumption follows a similar pattern with the share of male risk consumers being highest in the third quarter, see figure 1.

Seasonal variation is not found for the various measures of alcohol-related hospitalizations (figure 2). Another difference is that a weak increase over time is found for women whereas no clear change is found among men.

**Estimation of time series models**

Per capita consumption is significantly associated with all alcohol-related hospitalizations among both men and women, with significant parameter estimates of 0.11 and 0.13, respectively (table 1, Model 1). This means that a 1 l increase in per capita consumption within one-quarter is associated with an increase in the number of visits in the same quarter with 12% for men and with 14% for women (these estimated changes consider that the natural logarithm of the harm indicator was used in the estimation and are thus not identical with parameter estimates in the table 1).

When a gender-specific consumption measure is used, the effect becomes somewhat larger and is in the range of 18% for both men and women (table 1, Model 2). However, only the estimate for men is statistically significant \((P = 0.01)\). The association between risk consumption and hospitalizations is also positive (Model 3). The results imply that

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**Figure 1** Per capita alcohol consumption and self-reported alcohol consumption, litres of 100% alcohol per person 15+ (right axis), and risk consumption in per cent (left axis). Quarterly data for the period 2002–07

**Figure 2** Inpatient treatment with alcohol-related diagnoses per 100 000 inhabitants: all inpatient treatments, alcohol poisonings and all except alcohol poisonings (chronic harm). Quarterly data for the period 2002–07
when the share of male risk consumers increases by one percentage unit, this is associated with a significant ($P < 0.001$) increase in hospitalizations with 1.6%. The estimate for women is somewhat lower, 1.3%, and reaches borderline significance ($P = 0.06$).

Corresponding analyses using alcohol poisoning as an outcome are presented in table 2.

Per capita consumption is significantly related to alcohol poisonings among both men and women with estimates suggesting a 16% increase in alcohol poisonings for women and a 17% increase for men as per capita consumption rise with 11 within a quarter. Also an estimation of models applying the gender-specific per capita consumption measure reveal a positive and significant association for both men and women, with a larger estimate for women (0.53) than for men (0.23). This means that a 1 l increase in self-reported consumption in one-quarter on average has been associated with an increase in alcohol poisonings with 70% for women and 60% for men (considering that the natural logarithm of the harm indicator was used). According to a $t$-test, this difference between men and women was statistically significant ($P < 0.05$). The effect of changes in risk consumption on alcohol poisonings was statistically significant for both men and women with an estimated increase for women and men of 2.3 and 2.1%, respectively (Model 3).

Restricting the analysis to alcohol-related hospitalizations excluded from alcohol poisonings yields a somewhat weaker effect of changes in per capita consumption (table 2). For women the estimate is 0.08 and not significant ($P = 0.15$), whereas the male effect of 0.08 reaches statistical significance ($P < 0.05$). The impact of gender-specific consumption is stronger with estimates of 0.25 for women and 0.14 for men but only the male estimate is statistically significant. A similar finding is obtained when risk consumption is used as a predictor, and again statistical significance is only reached for men.

Discussion

This article has analysed the temporal relationship between alcohol consumption and alcohol-related hospitalizations in Sweden during the period 2002–07. In contrast to earlier studies, the impact of alcohol was not only measured by per capita consumption but also by male and female measures of per capita consumption and risk consumption estimated in a survey.

The traditional approach based on per capita consumption, showed that a 11 increase in per capita consumption was followed by a significant increase in both male and female alcohol-related hospitalizations with 12 and 14%, respectively. Thus, additional support for the idea that changes in per capita consumption have a significant impact on alcohol-related harm was gained. The impact was somewhat larger for acute harms (17 and 16% increase) measured by hospitalizations due to alcohol poisonings, than more chronic outcomes including diagnoses like cirrhosis and alcohol dependence (9 and 8%, respectively). This difference seems reasonable given that only short-term effects (co-variation between quarters) were estimated in these models and that the relatively short data series did not allow for incorporation of any lag structure in the alcohol measure. The findings also verifies that an increase in per capita consumption have a short-term effect also on long-term harm as recently has been noted in many studies recently for liver cirrhosis deaths in Finland. It should also be noted that the estimated effect on alcohol poisonings are in line with previous findings by Norström and Ramstedt who conducted a similar analysis of the same data but for a shorter time period, namely for 2001–05, and only for the whole population.

Could a similar analysis based on gender-specific self-reported drinking verify the results based on the overall per capita consumption and to what extent did the population level association between alcohol and harm differ between men and women? All in all, analyses based on gender-specific consumption measures of average and risk drinking

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Semi-logarithmic models estimated on differenced quarterly data for 2002–07
a: Box–Ljung test for residual autocorrelation, lag 4
b: $P$-values of the Box–Ljung test
c: Proportion consuming at a risk level: women >15 g/day (6.841 of 100% alcohol per year) men >24 g/day (10.951 of 100% alcohol per year)

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All alcohol-related diagnoses except alcohol poisonings
Model 1
| Model/Input | Estimate | SE | $P$-value | $Q^a$ | $P^b$ |
| Model 2 | | | | | |
| Self-reported per capita consumption | | | | | |
| Women | 0.081 | 0.057 | 0.154 | 6.267 | 0.180 |
| Men | 0.078 | 0.039 | 0.046 | 1.764 | 0.779 |
| Model 3 | | | | | |
| Risk consumption | | | | | |
| Women >15 g/day | 0.009 | 0.008 | 0.255 | 2.814 | 0.589 |
| Men >24 g/day | 0.013 | 0.005 | 0.005 | 0.424 | 0.981 |

Semi-logarithmic models estimated on differenced quarterly data for 2002–07
a: Box–Ljung test for residual autocorrelation, lag 4
b: $P$-values of the Box–Ljung test
c: Proportion consuming at a risk level: Women >15 g/day (6.841 of 100% alcohol per year) men >24 g/day (10.951 of 100% alcohol per year)
confirmed results based on overall per capita consumption. This similarity was most apparent for men where a significant impact of both male per capita consumption and male risk consumption was found in relation to all three measures of alcohol-related hospitalizations included in the analysis. For women on the other hand, the overall pattern was similar as well, but with several estimates not reaching statistical significance.

There was no clear evidence that the population level association differed between men and women. In favour of the idea that the association is stronger for men was that all male analyses were statistically significant whereas for women the estimates became non-significant in some models. The less clear-cut results for women may be related to less statistical power in the female analyses (lower base as women have more abstainers) or that hospitalization data are less reliable as an indicator of harm for women since women are found in other forms of treatment. Furthermore, variations in the risk of an alcohol poisoning should be higher between female drinking and female acute harm such as hospitalizations. This result gives support to Skogs’ idea of a collective drinking cultures where changes in per capita consumption is assumed to be reflected in all different drinking categories, from low to heavy drinkers. Such conformist changes in a population could be the result of both social factors (influence through social networks) and/or cultural factors i.e. common traditions and practices that predicts drinking in society across the year (e.g. holidays and vacations). Clearly, both men and women are included in these variations.

In sum, this study found no clear evidence that the population level association between alcohol and harm differed between men and women. However, the strong link between female drinking and female acute harm such as alcohol poisonings is worth replicating in further studies. As this study was limited to alcohol-related hospitalizations and to a fairly short time period, we believe that further studies should look at other harm indicators and also include a longer time frame if possible.

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Conflicts of interest: None declared.

Key points
- Changes in overall per capita consumption was significantly related both male and female alcohol-related hospitalizations in Sweden during the period 2002–07.
- Analyses based on gender-specific consumption measures of average and risk drinking confirmed results based on overall per capita consumption.
- There was no clear evidence that the population level association differed between men and women.
- There were signs of a stronger effect among women with respect to hospitalizations due to alcohol poisonings.
- The result gives support to the idea of a collective drinking cultures where changes in per capita consumption is assumed to be reflected in all different drinking categories, from low to heavy drinkers.

References


