Age, Period and Cohort Effects on Time Trends in Alcohol Consumption in the Swedish Adult Population 1979–2011

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Abstract

Aims: In Sweden, alcohol abstention has increased over the last 20 years and consumption has recently decreased after a peak in 2004. To understand the dynamics of these trends the present study aims at estimating age, period and cohort (APC) effects on trends in alcohol use prevalence as well as overall and beverage-specific volume of drinking over the last three decades.

Methods: APC analysis of seven cross-sectional surveys from 1979 to 2011 was conducted using cross-classified random effects models (CCREMs) by gender. The nationally representative samples comprised 77,598 respondents aged 16–80 years. Outcome measures were 30-day prevalence of alcohol use and overall as well as beverage-specific alcohol volume.

Results: Trends in prevalence, overall and beverage-specific volume were significantly affected by APC. The period effects of prevalence and overall volume show a small decline after an increase up to the year 2005. Mean beer and wine volume levelled off after a peak in 2005 and volume of spirits drinking decreased constantly. Predicted alcohol prevalence rates in male cohorts (1945–1985) remained generally at the same level, while they declined in post-World War II female generations. Results point to high overall and beverage-specific consumption among cohorts born in the 1940s, 1950s and 1980s.

Conclusions: High consuming cohorts of the 1940–1950s were key in rising consumption up to 2005. Progression through the life course of these cohorts, a decrease in prevalence and drinking volume in successive cohorts seem to have contributed to the recent downward trend in alcohol use in Sweden.
consumption constantly increased from 0.7 to 3.6 litres and spirits consumption decreased between 1976 and 2011 by 2.8 litres (Fig. 1). Recent trends taking unrecorded consumption into account show a 26% increase from 1990 to 2004 followed by a decline thereafter (Ramstedt, 2010; Ramstedt et al., 2013). Changes in consumption trends were accompanied by changes in beverage preference and abstinence. Based on sales statistics in the period 1990–2009, per capita consumption of wine and strong beer increased; the latter more than doubled. At the same time, consumption of weak beer with an alcohol content between 2.25 and 3.5 vol % decreased and sales almost halved. Consumption of spirits, formerly the main beverage in Sweden, constantly declined between 1990 and 2009, and the share of total consumption decreased from 37 to 27%, respectively. Moreover, based on survey data, abstention from alcohol in the last 12 months has slightly increased from 9% in 1990 to 11% in 2009 (Ramstedt, 2010).

After a period of relatively strict alcohol policy, Sweden became a member of the European Union (EU) in 1995. Between 1995 and 2004 Sweden step by step adapted its national alcohol policy to European standards, leading to an increased availability of alcohol (Ramstedt, 2010; Källmén et al., 2011). Among other changes, restrictions of travellers’ imports were changed in five steps after 2004 allowing practically free alcohol import for private use (Gustafsson, 2010). Furthermore, Systembolaget (the Swedish government monopoly alcohol retail outlets) extended opening hours on weekdays, and in 2001 to include Saturdays (Ramstedt, 2010). Contrary to expectations, these changes in alcohol policy were not found to increase alcohol consumption (Room et al., 2012).

While aggregated register and survey data describe changes in drinking behaviour at population level, such changes may not be entirely driven by collective moves in drinking in one or the other direction, as Skog had proposed (Skog, 1985). Although successive cohorts influence each other via social networks, one may argue that young people are more susceptible to particular changes of the conditions influencing alcohol consumption than older age groups with well-established drinking patterns. Evidence for this assumption comes from age, period and cohort (APC) analyses showing that cohort variations in drinking strongly affect overall drinking trends (Kerr et al., 2009; Pabst et al., 2010; Harkonen and Makela, 2011; Meng et al., 2014).

APC analyses consider the demographic components cohort and age simultaneously and model time independent of these influences. Disentangling the effects of age, period and cohort is of particular interest. While age is related to biological, psychological and behavioural changes in alcohol use over the individual life course, individuals born in the same calendar year share the same experience of social and historical events at the same age. This may result in cohort-specific drinking behaviour. Similarly, social and political conditions during a specific time period may impact on the behaviour of all age groups and cohorts simultaneously.

In Sweden, previous APC analyses were applied to trends in lifetime abstinence (Ahacic et al., 2012). The major impact of the observed changes in the period between 1968 and 2002 came from birth cohorts, while the effect of age and period were marginal and not statistically significant. In another study, trends of alcohol-related mortality were found to be influenced by period and cohort (Rosén and Haglund, 2006). Building on these analyses, the present paper aims at explaining changes in total alcohol consumption by modelling the independent effects of age, period and cohort. Using data from seven repeated cross-sectional surveys conducted in the general population in Sweden between 1979 and 2011, gender-specific effects of age, period and cohort on (a) alcohol use prevalence, (b) overall alcohol volume and (c) volume by beverage type (beer, wine and spirits) were analysed.
The number of individuals in the analyses varies due to missing information (measured using nine categories: wine, beer, and spirits) in the earlier surveys until 2003, whereas it was the past 30 days for the AMS-05/11 surveys. The respective alcohol contents were: 5.3 cl for beer, 12.3 cl for wine and 38.2 cl for spirits in the earlier surveys, and 3.2 cl, 5.6 cl, 12.8 cl, 16.6 cl and 37.7 cl ethanol per litre for medium strength beer, strong beer, wine, strong wine and spirits in the AMS-05/11. Cider was excluded. Frequency and quantity were multiplied and divided by 365 and 30 in the surveys until 2003 and the AMS-05/11 surveys, respectively. The resulting estimate of volume in centilitres for all drinkers and drinkers by beverage type were converted into grams ethanol per day.

**Statistical analyses**

Descriptive statistics for alcohol use patterns and age are presented as means (standard deviations) and percentages. Repeated cross-sectional surveys provide unique opportunities for APC analysis. However, estimating the independent effects is complicated by the exact linear dependency of age, period and cohort (period = age = cohort) resulting in non-unique regression coefficients (Mason and Fienberg, 1985).

This 'identification problem' can be solved by grouping the components into time intervals of different length (Yang and Land, 2008). In the present study, period refers to the year of survey, age was retained as a continuous variable and birth cohorts were grouped in seventeen 5-year intervals. For the final analyses the first three cohorts were combined into the cohort born between 1911 and 1925. Finally, in order to test for possible curvilinear effects a quadratic term of age was included in the model.

By solving the identification problem, regression analyses estimating fixed effects of age, period and cohort could be conducted. However, as demonstrated by Yang and Land (2006), fixed-effects models ignore the hierarchical (multilevel) structure of the data which can be taken into account by cross-classified random effects models (CCREMs; [Hox and Krav, 1994]). Applying this approach, age and age<sup>2</sup> were included as fixed effects on level 1, and period and cohort were estimated as random effects on level 2 (for details see Supplementary data, Appendix). In addition to reporting parameter estimates for the CCREMs coefficients for age, period and cohort were converted into predicted probabilities (drinking prevalence) and grams of ethanol per day (volume) with corresponding 95-percent confidence intervals, as described in Frenk et al. (2013). The resulting plots facilitate the interpretation of the age, period and cohort effects.

Analyses were conducted using logit CCREMs for 30-day prevalence and linear CCREMs for overall and beverage-specific volume. To avoid confounding by changes in drinking prevalence, beverage-specific analyses were performed for drinkers of a particular beverage. All analyses were based on unweighted data. Natural log transformed values of average alcohol volume were used in all analyses. For testing the significance of the random effects, a restricted model containing only one of the two level-2 effects as well as age and age<sup>2</sup> was estimated. This model was tested against the full (unrestricted) model containing all three dimensions, i.e. APC and the demographic covariates, using a likelihood-ratio test (Rabe-Hesketh and Skrondal, 2005). The final analyses were stratified by gender. This was justified by running initial models for prevalence, overall and beverage-specific volume, including gender as fixed-effect covariate and interaction terms between gender and the APC variables. The results revealed mostly significant interaction effects with regard to all outcomes. All analyses were
RESULTS

Sample description

Table 1 summarizes the age distribution as well as the drinking patterns of participants across survey years for males and females. In both genders prevalence of alcohol use levels off after an increase between 1979 and 1995. Average ethanol volume in grams per day overall and for beer and wine generally increase over time, while volume of spirits decreases.

Alcohol use prevalence and overall volume

Table 2 shows the parameter estimates and 95% confidence intervals of all CCREM models. The individual (fixed) effects for both genders indicate a linear as well as a non-linear association between prevalence and age. With regard to volume, in both genders there was no significant age effect, but a quadratic age effect. With the exception of the period effects for 30-day prevalence in males, the random effects variance components indicate significant variations in males and females for both outcome measures over time and across cohorts.

The model predictions for 30-day prevalence of alcohol use and volume by age, period and cohort are depicted in Fig. 2. Prevalence rates are generally higher for males than for females. Age effects on alcohol use prevalence show an inverse u-shaped trend in both genders. Rates increase up to age 40 in males and up to age 50 in females. In older ages, a gender convergence is seen with prevalence rates declining more strongly in males than females. The period effect for males shows little fluctuation. In females, prevalence rates are lower but decline after a small peak in 2005. Alcohol use prevalence rates in males increase from the oldest cohorts to the cohorts born between 1946 and 1950, remain rather stable in most cohorts until the early 1980s and drop in the youngest cohorts. In females, predictions show a similar increasing trend with lower rates and a later peak. Most notably, prevalence rates of males and females converge in the youngest cohorts.

Age effects on alcohol volume among drinkers exhibit a slightly decreasing trend starting at age 40 in both genders. Similar to prevalence of alcohol use predicted alcohol volume in older ages decreases more strongly in males. The pattern of estimated period effects is rather similar in both genders. Alcohol volume increases up to the year 2005 and levels off thereafter. The predictions of alcohol volume for cohorts of both genders show a peak in cohorts born in the 1940–1950s. In males, volume peaks again in cohorts born in the 1980s. In both genders, predictions show a decreasing trend in the youngest cohorts.

Beverage-specific alcohol volume

The beverage-specific model estimates are shown in Table 3. For both genders and the three beverages, period and cohort are significant predictors of average ethanol intake per day. In addition, linear and quadratic age effects on wine and spirits volume are observed in both males and females.

In Fig. 3, the model predictions for mean volume in grams ethanol per day for drinkers of beer, wine and spirits are presented. While age effects on volume of beer show a decreasing trend, volume of wine increases with age more strongly among males than females. The relationship between age and spirits intake is rather u-shaped, with a significantly decreasing overall trend. Period effects on beer volume indicate an increase between 1979 and 2005 with volume increasing...
Table 2. Results of cross-classified random effects models for 30-day alcohol use prevalence and mean alcohol volume

<table>
<thead>
<tr>
<th>30-day prevalence</th>
<th>Mean volume a</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males (n = 35,579)</td>
<td>Females (n = 28,663)</td>
<td>Males (n = 34,111)</td>
<td>Females (n = 24,411)</td>
</tr>
<tr>
<td>Fixed effects Intercept</td>
<td>0.042***</td>
<td>0.059***</td>
<td>0.035***</td>
<td>0.030***</td>
</tr>
<tr>
<td></td>
<td>0.038; 0.056</td>
<td>0.038; 0.056</td>
<td>0.038; 0.056</td>
<td>0.038; 0.056</td>
</tr>
<tr>
<td>Age</td>
<td>0.056***</td>
<td>0.068***</td>
<td>0.006; 0.015</td>
<td>0.006; 0.015</td>
</tr>
<tr>
<td></td>
<td>0.050; 0.072</td>
<td>0.050; 0.072</td>
<td>0.050; 0.072</td>
<td>0.050; 0.072</td>
</tr>
<tr>
<td>Random effects variance components</td>
<td>0.002</td>
<td>0.004; 0.008</td>
<td>0.002; 0.004</td>
<td>0.002; 0.004</td>
</tr>
<tr>
<td></td>
<td>LR chi² = 17.17***</td>
<td>LR chi² = 25.37***</td>
<td>LR chi² = 17.17***</td>
<td>LR chi² = 25.37***</td>
</tr>
<tr>
<td>Period effect</td>
<td>0.0123</td>
<td>0.0123</td>
<td>0.0123</td>
<td>0.0123</td>
</tr>
<tr>
<td></td>
<td>0.005; 0.020</td>
<td>0.005; 0.020</td>
<td>0.005; 0.020</td>
<td>0.005; 0.020</td>
</tr>
<tr>
<td>Cohort effect</td>
<td>0.114***</td>
<td>0.114***</td>
<td>0.114***</td>
<td>0.114***</td>
</tr>
<tr>
<td></td>
<td>0.084; 0.146</td>
<td>0.084; 0.146</td>
<td>0.084; 0.146</td>
<td>0.084; 0.146</td>
</tr>
</tbody>
</table>

Notes: Est.: Estimate; 95%-CI: 95%-Confidence interval; LR, Likelihood-ratio test; unweighted results.

*P < 0.05
**P < 0.01
***P < 0.001

DISCUSSION

Based on seven general population surveys monitoring alcohol use in Sweden between 1979 and 2011, the present paper aimed at decomposing variations in trends of alcohol use into independent effects of age, period and cohort. The findings suggest significant effects of these components on rates of drinking and on alcohol volume in grams ethanol per day overall and by beverage type.

Independent of period and cohort effects, alcohol use prevalence rates in males and females show a peak in mid-adulthood, then a decline, whereas overall alcohol volume is only weakly associated with age. Age effects on prevalence of use reflect life course patterns of increasing alcohol use rates as people enter adolescence and adulthood, followed by a decline as people get older. Conversely, age effects on mean alcohol volume indicate high levels of use from adolescence to mid-adulthood that only decline at a slow pace after individuals turn into their 40s and 50s. The predicted age effect in Sweden is similar to the pattern found in Germany (Pabst et al., 2010), while studies in the United Kingdom (Meng et al., 2014) and the United States (Kerr et al., 2009) reported peaks in alcohol volume in late adolescence and early adulthood followed by a more pronounced decline in older ages.

After controlling for age and cohort, predictions of prevalence of alcohol use and alcohol volume varied significantly over time. The period effects largely follow the descriptive patterns seen in Table 1. The general increase in alcohol consumption between the late 1980s and the mid-2000s and a stabilization or even small decrease in consumption since then is in line with results from other population surveys and trends observed in sales statistics (Berggren and Nystedt, 2006; Leifman and Ramstedt, 2009; Ramstedt, 2010; Källmén et al., 2011; Ramstedt et al., 2013).

Changes in Swedish alcohol policy when Sweden became a member of the EU in 1995 were expected to result in increased total consumption (Holder et al., 2000). Studies investigating the impact of changes in travellers’ allowances that had been relaxed stepwise between 1995 and 2004 found marked effects associated with the relatively small increment of the first changes (Norstrom, 2000; Ramstedt, 2010). This is reflected as period effect, as these changes in availability seem to have increased drinking collectively. Unexpectedly, however, the predictions show a slightly declining trend between 2005 and 2011. This is corroborated by studies showing that even as private alcohol imports became practically unlimited in 2004, there was no increase in Systembolaget sales (Ramstedt and Gustafsson, 2009) or in registered or self-reported alcohol consumption in Southern Sweden (Room et al., 2012).

Much of the variation in alcohol use prevalence and alcohol volume is due to differences in drinking across cohorts. The cohorts with high prevalence and mean consumption were born in the 1940s and 1950s. These individuals came of age in the 1950s, 1960s and early 1970s, a period of increasing per capita consumption in Sweden.

more strongly in males than females. In both genders, predictions for wine indicate a slight increase in volume up to the year 2005, while volume of spirits consumption decreases over the whole period. Cohort effects were found for all beverage types. Generally, predictions for beer volume show a pattern similar to overall alcohol volume. Cohort effects on wine volume indicate only small changes with very narrow 95% confidence bounds. Predictions for spirits volume show a peak in generations born during World War II, a slightly declining trend in the following generations and an increase in generations born after 1970.
Although the mechanisms of change in drinking behaviour are not yet well understood, marked changes in drinking norms in countries with a strong temperance movement may have affected cohorts that developed their drinking habits in the post-World War II era (Room et al., 2009). Studies assessing trends in substance use discuss several indicators of social change that may affect specific birth cohorts, such as attitudes, beliefs, values, risk perceptions or beverage preferences, youth-oriented reactions to changes in availability and access to alcohol, increased economic pressures or social developments particularly affecting this group (Johnson and Gerstein, 1998; Room et al., 2009; Pabst et al., 2010; Ramstedt, 2010).

Different cohort effects on trends of alcohol use prevalence and consumption in recent APC studies in the UK, the US and Germany clearly indicate differences in the generational process of changes in drinking behaviour. These changes seem to be unique to the drinking culture and the social situation in each country. For instance, while estimated cohort effects on prevalence of alcohol use are rather similar in the UK and Sweden, volume generally increased with younger cohorts in the UK, but not in Sweden (Meng et al., 2014). Also, alcohol volume across cohorts shows a slightly increasing trend in the US (Kerr et al., 2009) and a consistent decreasing trend in Germany (Pabst et al., 2010). Further research is required on the mechanisms of generational change within different drinking cultures.

Age, period and cohort effects clearly differ by beverage type. Most remarkably, in contrast to beer and spirits consumption which decreased with age, wine consumption generally increased up to age 60 in males and age 50 in females. The period effect points to an increase in wine and beer consumption up to the year 2005, compared to a decreasing trend found in spirits drinking. Similarly, sales data also suggest a general trend towards more wine and less spirits.
Table 3. Results of cross-classified random effects models for beverage-specific mean alcohol volume

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 24,339)</td>
<td>(n = 19,180)</td>
<td>(n = 25,312)</td>
<td>(n = 18,297)</td>
<td>(n = 10,431)</td>
<td>(n = 7,810)</td>
</tr>
<tr>
<td>Mean beer volume</td>
<td>2.239***</td>
<td>1.958; 2.480</td>
<td>1.751***</td>
<td>1.553; 1.950</td>
<td>0.480***</td>
<td>0.315; 0.646</td>
</tr>
<tr>
<td>Mean wine volume</td>
<td>0.765***</td>
<td>0.569; 0.961</td>
<td>0.765***</td>
<td>0.569; 0.961</td>
<td>1.976***</td>
<td>1.776; 2.176</td>
</tr>
<tr>
<td>Mean spirits volume</td>
<td>1.681***</td>
<td>1.516; 1.846</td>
<td>1.681***</td>
<td>1.516; 1.846</td>
<td>1.681***</td>
<td>1.516; 1.846</td>
</tr>
<tr>
<td>Intercept</td>
<td>2.239***</td>
<td>1.998; 2.480</td>
<td>1.751***</td>
<td>1.553; 1.950</td>
<td>0.480***</td>
<td>0.315; 0.646</td>
</tr>
<tr>
<td>Age</td>
<td>-0.008*</td>
<td>-0.016; 0.000</td>
<td>-0.020***</td>
<td>-0.028; 0.000</td>
<td>-0.012</td>
<td>-0.037</td>
</tr>
<tr>
<td>Age2</td>
<td>0.016</td>
<td>-0.016; 0.048</td>
<td>0.017</td>
<td>-0.008; 0.016</td>
<td>0.014</td>
<td>-0.009; 0.023</td>
</tr>
<tr>
<td>Random effects variance</td>
<td>0.042</td>
<td>-0.006; 0.000</td>
<td>0.017</td>
<td>-0.008; 0.007</td>
<td>0.014</td>
<td>-0.009; 0.023</td>
</tr>
<tr>
<td>Period effect</td>
<td>0.004</td>
<td>-0.006; 0.002</td>
<td>0.005</td>
<td>-0.007; 0.001</td>
<td>0.005</td>
<td>-0.007; 0.002</td>
</tr>
<tr>
<td>Cohort effect</td>
<td>0.009</td>
<td>-0.004; 0.003</td>
<td>0.009</td>
<td>-0.007; 0.004</td>
<td>0.009</td>
<td>-0.007; 0.004</td>
</tr>
</tbody>
</table>

Notes: Est.: Estimate; 95%-CI: 95%-Confidence interval; LR: Likelihood-ratio test; unweighted results.

Grains ethanol per day, based on past 30-day drinkers of beverage.

* P < 0.05
** P < 0.01
*** P < 0.001

Although there is evidence for the impact of changes in availability on consumption (Babor et al., 2010), the effect on total consumption may be small, or even disappear, if only parts of the population are susceptible to these changes. The complex interaction between factors that push consumption up, such as increased availability and a general rise in wine consumption, and factors that push consumption down, such as higher consuming cohorts being successively replaced by lower consumption in Sweden (Euromonitor International, 2012). The shift in beverage preference from spirits to beer and wine correspond with an increase in average alcohol volume up to 2005, indicating that less spirits drinking was more than substituted by beer and wine drinking. Cohort effects of volume by beverage type differ only slightly from the pattern of overall volume. The observed shift in beverage preference may thus be less specific to cohorts, reflecting changes in all drinkers.

When discussing the results, some limitations have to be considered. First, alcohol use is measured based on self-reports and may be subject to biased reporting (Dawson, 1998). Second, the measures of alcohol use differed across surveys, in terms of the time frame. However, we tested our approach of adapting the time frame by comparing the estimates obtained for the ANS-03 with the AMS-03 data that was not used in the present analysis. The estimates for 30-day alcohol use prevalence as well as those for beverage-specific volume only marginally differed between the two surveys. Third, prevalence and volume estimates in the AMS-05/11 were based on five beverages, but on only three beverages in the earlier surveys. In general, more questions may result in higher estimates, biasing estimates in trend analyses. Visual inspections of the alcohol use indicators, however, do not reveal any striking discontinuity in the observed trends. As differences between surveys would only impact on the period effect, we repeated our analyses by using data from the AMS-05/11 only. The results revealed the same age and cohort effects as when using the full data set. Nevertheless, possible confounding of the period effects resulting from differences in survey design or outcome measurements cannot be ruled out. Fourth, unbalanced sample sizes within cohorts and survey years as in our data may bear the risk of over interpreting APC effects (Yang, 2006). Bayesian hierarchical estimates have been discussed as more appropriate but these models are not yet implemented in standard statistical software. Particular caution is required when interpreting results of participants from the oldest (1911–1925) and youngest cohorts (1991–1995), as they are covered only by the first and the most recent surveys, respectively. Finally, mode of administration also changed over time. Yet, despite mode differences the results of the two 2003 surveys yielded comparable results. Thus, mode effects may be negligible.

The questions of whether society changes its behaviour collectively, whether changes are mainly driven by cohorts and whether these changes relate to changes in alcohol policy, may have no general answer. In a recent analysis, Raninen et al. (2013) argued in favour of the collectivity theory by showing that the decline in per capita consumption between 2004 and 2011 corresponded with a reduction in consumption at all levels of use. This indicates that in their datasets drinking behaviour did not polarize into groups of drinkers drifting in different directions. The cohort effects found in our analysis, however, challenge the collectivity hypothesis by showing that changes in drinking behaviour are not simply transferred from younger to older generations. Otherwise, drinking across cohorts would be almost invariant and changes would appear as period effects. The findings of the few APC studies analysing drinking trends support one possible explanation: older cohorts with established drinking behaviour are less susceptible to change than younger cohorts who are just starting to experience alcohol consumption (Meng et al., 2014).
Fig. 3. Age-, period and cohort effects from CCREMs for males for females (beverage-specific mean alcohol volume.)
drinking cohorts and a general decrease in spirits consumption, may explain why total consumption declined in Sweden, although availability increased.

SUPPLEMENTARY MATERIAL
Supplementary material is available at Alcohol and Alcoholism online.

FUNDING
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CONFLICT OF INTEREST STATEMENT
L.K. and D.P. declare having received a grant from Lundbeck GmbH for a research project on alcohol epidemiology not related to this study.

REFERENCES