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## **The collectivity of changes in alcohol consumption revisited**

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## **Abstract**

### **Aim**

Within-country temporal changes in alcohol consumption in the USA, Finland, and Norway were examined to assess 1) whether a change in mean alcohol consumption is accompanied by a change in the prevalence of heavy drinkers, 2) whether this mean change reflects a collective displacement in the whole distribution of consumption, and 3) whether a collective displacement is found for both an upward and a downward shift in mean consumption.

### **Design, setting, participants**

We applied repeated cross-sectional survey data on distribution measures for estimated annual alcohol consumption from national population sample surveys covering 30 to 40 years periods in two countries with increasing trends in mean consumption (Finland and Norway) and one country with decreasing trends (the USA).

### **Results**

There was a strong positive association ( $P < .001$ ) between changes in mean consumption and changes in the prevalence of heavy drinkers in all three countries. Moreover, a change in mean consumption was accompanied by a consumption change in the same direction in all consumer categories in all three countries, i.e. a collective displacement. The regression coefficients were around 1.

### **Conclusion**

Drinkers at all levels of consumption appear to move in concert, both up and down the consumption scale in Finland, Norway, and the USA, as predicted by Skog's theory of the collectivity of drinking cultures.

Keywords: Population drinking, theory, collective displacement, repeated cross-sectional, heavy drinking, mean consumption.

Numerous studies have demonstrated a close association between mean consumption and the prevalence of alcohol related harm (1), which has been a motivation for policies that aim to reduce total consumption of alcohol in societies. The prime theory that has been used to explain and understand this connection and to justify the control policies, is Skog's theory of the collectivity of drinking cultures (2). As the theory has significant implications for prevention strategies and it has been very influential for alcohol policy (3), its constituent parts also require careful empirical testing.

When developing his theory, Skog's point of departure was the strong regularity in the distribution of alcohol consumption that had been reported in several studies (4-6). Skog hypothesized and demonstrated, first, that – due to stochastic multiplicativity – the distribution was strongly skewed to the right, as also illustrated by the finding that 10% of drinkers consume more than half of the alcohol (7). Secondly, he showed that the population mean was very strongly associated with the proportion of heavy drinkers (2), a key group with respect to chronic alcohol-induced harm in particular. The third, and from a policy point-of-view the most important prediction, was that temporal changes as well as differences between populations take the form of a parallel, i.e. a collective, displacement of the whole distribution of consumption: the change or difference is seen in all consumption categories, including light, moderate and heavy drinkers. It should be noted that the second prediction follows from the third one, but not vice versa, i.e. in principle it is possible for mean consumption and heavy drinking to correlate without collectivity (8). According to the theory, the collectivity is caused by social interaction and interdependence of drinkers (2, 8).

The reason for why the collective nature of the change is so central lies in the policy implications: if the changes are collective, a universal alcohol policy aiming to control mean consumption of the population is rational, whereas if the connection between mean consumption and heavy drinkers is limited to heavy drinkers only, then the connection would seem to be driven by changes in heavy drinking, and universal policies were less justified.

The data used by Skog (2) as evidence of collectivity was mainly cross-sectional. By comparing populations he showed that, for example, in one population with twice the mean consumption of another, both moderate drinkers (whose consumption corresponds to the 50<sup>th</sup> percentile value) and the heavy drinkers (whose consumption corresponds to the 95<sup>th</sup> percentile value) drank roughly twice as much as the corresponding consumer groups in the other population. Also most of the other empirical support for the theory so far stems from comparisons of different populations (e.g. (2, 9)). Although the theory is often applied to predictions of within-population temporal change, there are few studies that have addressed this empirically. For this reason, there has been skepticism towards using the theory to make predictions for within-population temporal change (3). The numerous studies demonstrating close associations between mean consumption and indicators of heavy drinking (1) do not necessarily imply collective displacement. It should be noted that Skog's theory does not make predictions about individual-level change, but of marginal distributions (e.g. what happens to heavy drinking in the population) (8). Therefore, repeated cross-sectional data are more optimal than panel data for testing the predictions and an additional benefit is that problems relating to regression to the mean are avoided.

In his 1985 article, Skog stated that more data on changes over time were needed. Fifteen years later, Gmel and Rehm (3) noted that there was still surprisingly little empirical evidence, especially recently, to support Skog's key assumptions. With regard to observations of changes over time, they referred to eight studies applying such data within populations. Only two of these (10, 11) examined empirically the question of collective displacement over time. These two studies provided empirical support for Skog's theory. In his response to Gmel and Rehm (3), Skog (8) referred to two additional studies of relevance in this respect (12, 13), which illuminated how other social factors (e.g. strict formal or informal control, or structural factors such as income or prices) may result in *exceptions* to collective displacement over time yet not contradict the theory. In addition to these few studies, we have conducted a literature search and examined the following studies: all studies referring to Skog (2) (n=264); to Lemmens and co-workers (11) (n=12); to Gmel and Rehm (3) (n=17)

and Skog (8) (n=11). This search retrieved only one further study of this kind (14). It showed that among Stockholm youth, alcohol consumption was reduced for most drinkers over the 2000-2010 period, while the heaviest consumers mostly increased their consumption (14). Moreover, in recent years there have been some examples of diverging trends in alcohol consumption and alcohol related harms (15, 16), which may suggest that mechanisms other than collective changes in drinking behavior have been at work. Thus, empirical studies that have put Skog's theory to test are still surprisingly few and the findings are mixed with respect to the extent to which temporal changes follow the expectation derived from the theory.

Given that Skog's theory has been so influential with respect to alcohol policy, efforts to overcome several suggested weaknesses of its empirical testability are warranted (3). Among these weaknesses are: 1) the limited empirical support for collectivity in changes of drinking behavior over time, and 2) the question of symmetry in collective changes, i.e. whether collective changes occur in the same way both when mean consumption goes up and when it goes down.

The aim of this study is to put these aspects of the collectivity theory to further empirical test by analyzing data over time within three populations for which population drinking has either significantly increased or decreased over time and for which good-quality survey data comparable across this time exists: the Finnish and the Norwegian population (mainly increasing trends), and the US population (mainly decreasing trend). More specifically, we wanted to assess 1) whether a change in mean consumption is accompanied by a change in the prevalence of heavy drinkers and, more importantly, 2) whether this mean change reflects a collective displacement in the whole distribution of consumption, and 3) whether a collective displacement is found for both an upward and a downward shift in mean consumption.

## **Data and methods**

The analyses are based on repeated cross-sectional general population surveys in which data on annual alcohol consumption cover several decades. The data collection methods and alcohol

consumption measures were by and large the same over time within each country but differed across country and they are therefore described by country.

#### Finland:

The Finnish data came from the Finnish Drinking Habits Surveys carried out in 1968, 1976, 1984, 1992, 2000 and 2008. The study population consisted of Finns aged 15-69 years excluding those living in the Åland Islands (0.5% of the population) and, since 1984, excluding the homeless and the institutionalized (1.5%). In 1968, the sample included women and men in a ratio of 1:3. In the first four surveys, a stratified two-stage cluster sampling design was used, and the surveys were carried out by the staff of the Finnish alcohol monopoly, Alko. In 2000 and 2008, the sample was drawn from population census records using simple random sampling, and the interviews were carried out by Statistics Finland. All data were collected by face-to-face interviews. The net sample sizes are presented in Table 1. Weights calculated by post-stratification for sex, age, and geographical region were used in order to restore the population representation of the respondent sample. Response rates ranged from 74% in 2008 to 97% in 1968.

The annual volume of consumption, or mean consumption, was calculated on the basis of the amounts consumed on all drinking occasions within a period of time preceding the interview that varied between 1 week and 12 months ("survey period") depending on the average drinking frequency of the respondent. In choosing the length of the period, the aim was to get information on four previous drinking occasions (e.g., if drinking frequency was "about once in 2 months", the survey period was 8 months), but the consumption in *all* drinking occasions in the given period was asked about. The volume consumed in the survey period was scaled into a year by multiplying with a constant (e.g. a volume from a one-week period was multiplied with 52).



### Norway:

The Norwegian data stemmed from the Norwegian Drinking Habit surveys that were conducted in 1973, 1979, 1985, 1991, 1994, 1999 and 2004. The study population consisted of the Norwegian adult non-institutionalized population 15 years and above, except for the 1973 survey in which the study population was 18 years and above. The samples were obtained in a three stage procedure, and the surveys were carried out by three opinion poll institutes. Data were collected by personal interviews in the respondent's home. Response rates were not obtained for these surveys. The net samples are presented in Table 1.

Annual alcohol consumption was obtained by beverage-specific frequency and quantity questions and calculated into litres of pure alcohol (17).

### US:

US data for the population aged 18 and older come from seven National Alcohol Surveys conducted between 1979 and 2010. Major differences between surveys are over-sampling of Hispanics and African Americans in all but two surveys (1979 and 1990) and a mode switch from face-to-face interviews with multi-stage clustered sampling to telephone interviews and random-digit dialed sampling in 2000. The 2010 NAS also included a mobile phone sample. All surveys are weighted to the general population of the US at the time they were conducted taking account of age, sex, ethnic group and geographic area. Extensive methodological work on interview modes found no significant difference in national estimates of mean alcohol intake based on modality of interviewing, even though response rates of the telephone surveys were lower than the in-person ones (18, 19). Response rates ranged from 52% in the 2010 survey to 77% in the 1995 survey. Sample sizes are presented in Table 1.

For each beverage type, respondents were asked: “When you drink (wine/ beer/ drinks containing whiskey or liquor), how often do you have 1–2, 3–4, or as many as five or six (glasses/ 12-ounce cans or bottles /drinks)?” Answer categories included ‘*nearly every time*’, ‘*more than half the time*’, ‘*less than half the time*’, ‘*once in a while*’ and ‘*never*’, which were coded as 0.9, 0.7, 0.3, 0.1 and 0, respectively and applied to beverage-specific past year drinking frequencies in the alcohol volume algorithm.

### *Analytical strategy*

Skog assumed that the social interaction that influences individuals’ drinking occurs among drinkers, and his analyses were based on data among drinkers. In line with Skog’s work, the analyses are confined to respondents who reported to have drunk alcohol in the past 12 months. There were six survey samples available from Finland and seven survey samples from both Norway and the US. Calculations summarising the distributions of alcohol consumption were carried out for each country and survey year using individual level data. These figures were applied in further aggregate level analyses for each country. In order to increase statistical power, the aggregate level analyses were first run for gender specific survey samples for each country. In the next step, these gender specific estimates were pooled, whereby the standard errors and thus the risk of Type II error were reduced.

The cut-off value for heavy drinking was set at 40 grams pure alcohol per day; i.e. respondents consuming more than 18.25 litres pure alcohol per year were considered heavy drinkers. The association between mean consumption (independent variable) and the prevalence of heavy drinking (dependent variable) was estimated for each country and gender in linear Ordinary Least Squares (OLS) regression models and the gender specific results were pooled. The association is also illustrated graphically.

In Skog’s analyses on collectivity of drinking (2), the percentile values, which are distribution measures, were used to illustrate consumer categories. A person drinking the amount of the 25<sup>th</sup> percentile value (the consumption level which divides the 25% of drinkers who drink least and the

remaining 75%), was taken to illustrate the prototypical light drinker. Persons drinking the amount of the 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, and 95<sup>th</sup> percentile values were taken to illustrate prototypical medium drinkers, moderate drinkers, near-heavy-drinkers, and heavy drinkers, respectively. Skog demonstrated that in all these consumer categories the consumption level in that category, i.e. the corresponding percentile value, was strongly associated with the mean consumption level of all drinkers in the population in question.

In order to obtain comparable assessments of collective displacements, the analyses were conducted applying the same methods as Skog (2) used; i.e. the log-transformed percentile values of consumption across years (separately for the 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> and 95<sup>th</sup> percentile values) were regressed on the log-transformed values of all drinkers' mean consumption in OLS models. This was done for each country separately, and thus comparable estimates were obtained for populations with increasing consumption (Finland and Norway) and decreasing consumption (the US). In line with Skog's work (2) we have also illustrated the linear relationship between logged mean consumption among drinkers and the logged percentile values graphically. The percentile values by country, year and gender are tabulated in online Supplementary Table 1.

## **Results**

In Finland and Norway the mean consumption per drinker displayed an overall increase over the observation period as did the sales figures, whereas data from the US displayed – for the most part – a decreasing trend (Table 1, Figure 1).

In all three countries a change in mean consumption was strongly associated with a change in the prevalence of heavy drinkers (Table 2a, Figure 2). The gender specific estimates (data not shown) and the pooled estimates were all positive and, apart from Norwegian women, also statistically significant. The pooled estimate was highest in the US and lowest in Finland, and implied that a 1 litre increase in mean consumption was accompanied by an increase in the prevalence of heavy drinkers with about 1 percentage point in Finland and a corresponding decrease in mean consumption in the

USA was accompanied by a decrease in the prevalence of heavy drinkers with about 2 percentage points. In order to reduce the likelihood that the association is a tautology (heavy drinkers determine the mean), these analyses were re-run so that the prevalence of heavy drinkers was regressed on mean consumption among non-heavy drinkers only (those drinking less than 18.25 litres of pure ethanol per year) . Also these associations were positive and, apart from Norwegian women, statistically significant (data not shown). The pooled estimates were positive and statistically significant in all countries (Table 2b).

Both gender specific (data not shown) and pooled estimates showed strong associations between mean consumption and the percentile values in all consumer categories in all three countries, with one exception. For the lightest drinkers in the US, the gender specific estimates were not statistically significant and the pooled estimate was barely so (Table 3, Figure 3). The regression coefficients were around 1, implying that a 20 % increase in mean consumption was accompanied by an increase of approximately 20 % in the level of consumption of for instance the top 10<sup>th</sup> percentile (8). The findings were fairly similar in the Nordic countries where consumption had increased, compared to the US where consumption had decreased.

## **Discussion**

Analyses of data on changes over time from three countries produced findings in line with predictions of Skog's theory of the distribution of alcohol consumption and thus add to the empirical evidence on the theory. The findings further suggested that collective displacements in alcohol consumption are seen both when overall consumption increases and decreases.

Our finding that changes in mean consumption were positively correlated with changes in the prevalence of heavy drinkers is well in line with previous studies, which demonstrated that changes in mean consumption are associated with changes in levels of harm typically seen in heavy drinkers

(20-22) . However, this finding alone is not sufficient to offer any evidence about collectivity. Even a strong association between mean consumption and heavy drinking does not indicate, as a logical necessity, that a change in mean consumption is accompanied by a change in the same direction by all consumer groups (8). As alcohol consumption is strongly skewed and the heaviest drinkers account for a large proportion of the total consumption, changes in heavy drinkers' consumption could, in principle, account for the changes in mean consumption (3). If that had been the case, we would not have found positive associations between mean consumption and low and medium percentile values and the corresponding lines in Figure 3 would not be ascending. Our findings suggest, however, that changes in mean consumption in the three countries studied have reflected changes in consumption at low and medium as well as high levels of consumption. This was further illustrated by the positive association between the prevalence of heavy drinkers and the mean consumption among other than heavy drinkers. In other words, changes in heavy drinking seem to be part of collective changes, represented by the mean consumption, and changes that occur in the population are reflected both in the population's heavy drinking and other forms of drinking.

Our findings mirror those of Skog (2), although there are also differences. Skog's analyses were mainly based on regional differences rather than temporal changes. The variation in population drinking in his data was very large; i.e. the mean consumption varied by a factor of 20, which rarely occurs in temporal variation. Moreover, Skog found that the regression coefficients were larger for the lighter drinking groups; i.e. a change in mean consumption was accompanied by a relatively larger change at lower consumption levels and he interpreted this as light drinkers being more susceptible to variations in the cultural climate than heavy drinkers (2). While this seems generally plausible, such a tendency was only clearly found in the Finnish data in this study.

The few studies that have previously addressed collective changes in alcohol consumption over longer periods of time produced mixed results (10, 11, 14). Whereas the Dutch studies found empirical support for a collective displacement over a period with increasing consumption (10, 11),

this was not the case in the Swedish study of youth alcohol consumption addressing a period with an overall decreasing trend in consumption (14). An analysis of the Finnish panel data from 1968 and 1969, when alcohol consumption increased by about 50 %, demonstrated also a collective change in all consumer groups (23). The present findings from the Finnish and Norwegian data are well in line with the above-mentioned previous studies (10, 11, 23) reporting a collective upward change in consumption in all consumer groups when total consumption increases. Our findings from the US data do not, however, resemble those from the Swedish study (14), but rather suggest a symmetry in the collective displacement, i.e. all consumer groups move collectively in the same direction, both when mean consumption increases and decreases.] Our findings thus lend empirical support to Skog's phrase "As a main rule, the population tends to move in concert up and down the scale of consumption" (2).

### Strengths and limitations

The data applied in these analyses cover fairly long time periods with significant changes in mean alcohol consumption in three different countries, and comparable population samples and measurements within each country were applied. The number of population samples was fairly small for each country, which reduced the test power and increased the risk of non-statistically significant associations (i.e. a Type II error). Methodological changes (e.g. falling response rates) may have affected the inclusion of heavier drinkers, and if this were the case, the variation in estimates of mean and high percentile values may have been deflated. However, the coverage rates have not systematically changed with time, which suggests that heavy drinkers have not increasingly dropped out of the studies. Moreover, the selection of empirical cases was limited to a small number of high income countries where alcohol consumption is fairly widespread and culturally well integrated.

### Implications:

The importance of the present findings pertain both to public health and to the choice of strategies to prevent alcohol related harms at the population level. If changes in mean consumption were attributable only to the heaviest drinkers, one could argue that prevention strategies should be aimed at this high-risk segment of the population. However, the observation of a collective displacement of consumption suggests that universal prevention strategies that target all consumer groups (population strategies) may be more appropriate. They reach all consumer groups, moderate and heavy drinkers alike. By affecting the whole drinking culture collectively, they may actually be an efficient way to affect the heaviest drinkers.

While the present study lends support to Skog's theory with respect to collective changes over time, this literature is still very limited. Further studies are therefore warranted, including studies that address individual changes over time in relation to collective changes and studies from other drinking cultures and other parts of the world.

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**Table 1.** Total number of respondents, the proportion of past year abstainers, mean alcohol consumption among past year drinkers and among all respondents, the sales of alcohol per capita 15 years or over, and coverage rate (mean divided by per capita sales); and mean alcohol consumption and proportion of heavy drinkers among past year drinkers for men and women separately, by country and survey year. Alcohol consumption and alcohol sales are in litres of pure ethanol.

Country and year	Total						Men		Women	
	Sample	Abstainers	Mean per drinker	Mean all	Per capita sales	Coverage rates	Mean per drinker	Heavy drinkers	Mean per drinker	Heavy drinkers
<b>Finland</b>	1823	26.3		1.61	3.91	41.3	3.33	3.30	.64	.00
<b>1968</b>			2.19							
<b>1976</b>	2835	13.3	3.43	2.98	8.06	36.9	5.32	5.33	1.58	.84
<b>1984</b>	3624	19.6	3.06	2.45	8.03	30.5	4.54	3.93	1.32	.41
<b>1992</b>	3446	13.5	4.62	3.99	8.86	45.1	6.88	7.35	2.21	1.17
<b>2000</b>	1932	8.5	3.57	3.26	8.61	37.9	5.29	4.81	1.80	.50
<b>2008</b>	2725	9.9	4.38	3.94	10.26	38.4	6.52	5.69	2.24	1.23
<b>Norway</b>	2009	17.1	2.98	2.47	5.2	47.5	4.51	3.70	1.29	.40
<b>1973</b>										
<b>1979</b>	2021	17.3	3.38	2.80	5.6	50.0	4.87	4.30	1.78	.50
<b>1985</b>	1973	16.3	3.18	2.66	5.14	51.8	4.39	3.20	1.91	.20
<b>1991</b>	2002	15.7	3.06	2.58	4.80	53.8	4.23	2.80	1.75	.80
<b>1994</b>	2222	13.3	3.57	3.09	4.62	66.9	5.04	4.30	2.07	.40
<b>1999</b>	2170	10.5	3.57	3.19	5.50	58.0	5.03	4.20	2.10	.50
<b>2004</b>	3191	13.5	4.27	3.69	6.19	59.6	5.91	6.70	2.59	1.50
<b>The US.</b>	1772	34.0	6.91	4.56	10.75	42.4	9.84	14.31	4.20	3.37
<b>1979</b>										
<b>1985</b>	5221	38.5	7.79	4.79	10.21	46.9	11.33	14.53	4.57	3.35
<b>1990</b>	2058	35.6	6.21	4.00	9.08	44.1	9.16	10.24	3.64	2.02
<b>1995</b>	4925	42.8	6.20	3.54	8.04	44.0	8.54	10.12	3.51	1.65
<b>2000</b>	7612	39.2	6.37	3.87	8.21	47.1	9.29	8.67	3.44	1.62
<b>2005</b>	6919	38.5	6.06	3.73	8.25	45.2	8.47	7.55	3.46	2.54
<b>2010</b>	7969	38.4	5.93	3.65	8.21	44.5	8.72	8.96	3.72	2.09



**Table 2a.** Associations between mean consumption (independent variable) and prevalence of heavy drinkers (dependent variable), pooled for men and women, by country. Linear regression models; regression coefficients (B), standard error of estimate (SE), and test of statistical significance (t- and p-values).

	B	SE	t	p
Finland	0.887	0.117	7.58	<.001
Norway	1.445	0.207	6.98	<.001
The US	1.896	0.382	4.96	<.001

Note: Estimates are based on data from past year drinkers.

**Table 2b)** Associations between mean consumption among non-heavy drinkers (independent variable) and prevalence of heavy drinkers (dependent variable), pooled for men and women, by country. Linear regression models; regression coefficients (B), standard error of estimate (SE), and test of statistical significance (t- and p-values).

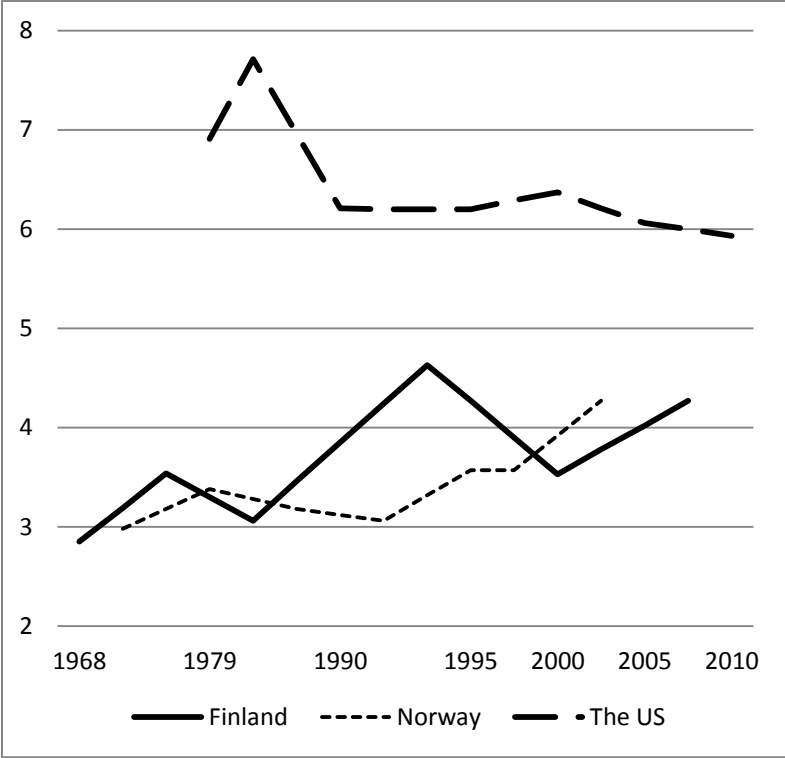
	B	SE	t	p
Finland	1.328	0.275	5.13	<.001
Norway	2.433	0.645	5.27	<.001
The US	3.699	0.841	4.40	<.001

**Table 3.** Associations between mean consumption (independent variable) and percentile values (dependent variable), pooled for men and women, by country and consumer category ( $X_{25}, \dots, X_{95}$ ). Linear regression models; regression coefficients (B), standard error of estimate (SE), and test of statistical significance (t- and p-values).

	Finland				Norway				The US			
	B	SE	t	p	B	SE	t	p	B	SE	t	p
$X_{25}$	1.194	0.161	7.42	<.001	1.359	0.236	5.76	<.001	1.066	0.461	2.31	.044
$X_{50}$	1.174	0.114	10.30	<.001	1.095	0.139	7.88	<.001	1.696	0.265	6.40	<.001
$X_{75}$	1.036	0.078	13.28	<.001	0.984	0.091	10.81	<.001	1.567	0.217	7.22	<.001
$X_{90}$	0.799	0.054	14.80	<.001	1.139	0.104	10.95	<.001	0.808	0.168	4.81	<.001
$X_{95}$	0.833	0.056	14.88	<.001	1.010	0.100	10.10	<.001	0.874	0.161	5.43	<.001

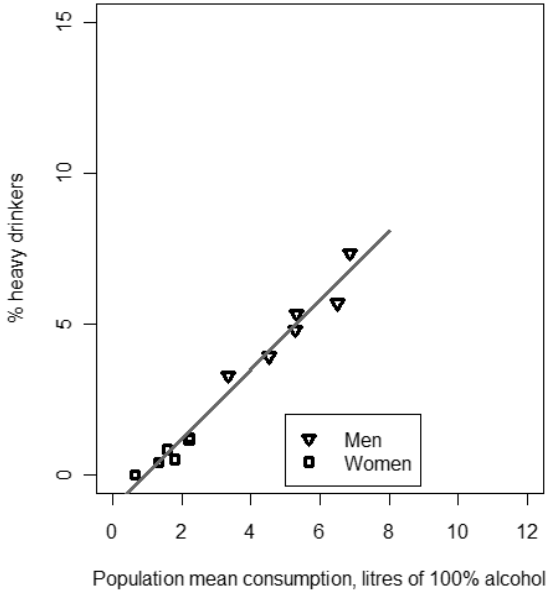
Note: Estimates are based on data from past year drinkers.

Figure 1. Mean annual alcohol consumption in litres of 100% alcohol among past year drinkers by country and survey year.

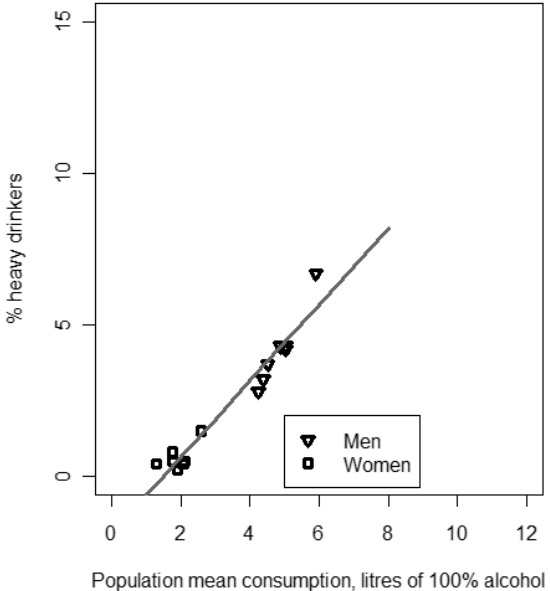


**Figure 2.** Prevalence of heavy drinkers (%) by mean consumption (litres of 100% alcohol) and gender for Finland, Norway and the US. Data from past year drinkers.

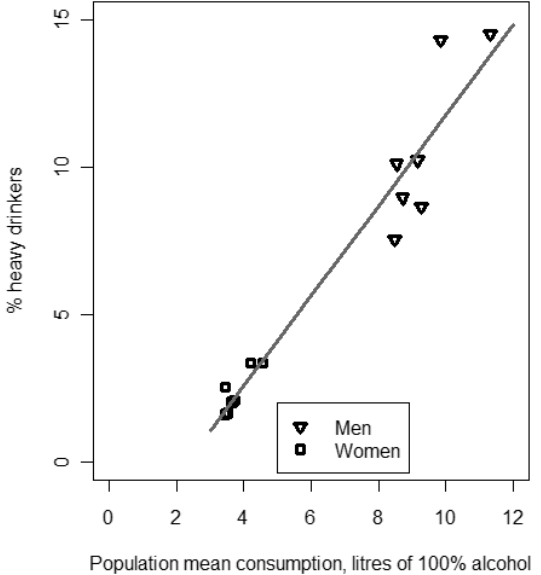
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**Norway**

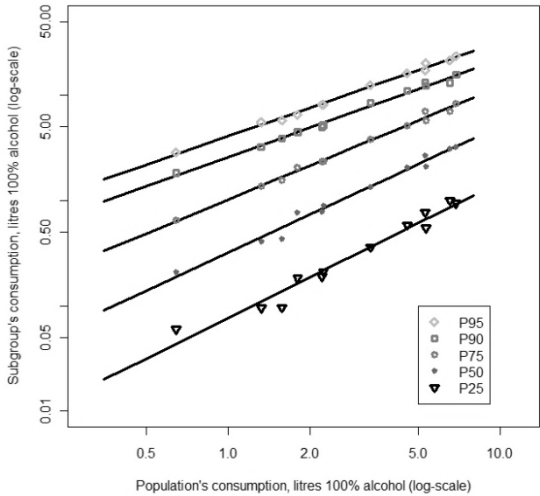


**The US**

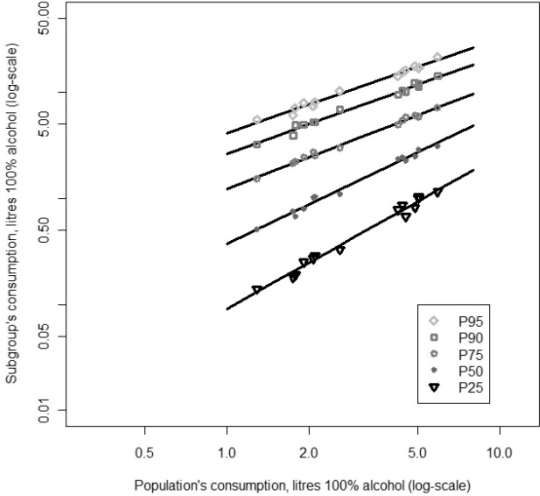


**Figure 3.** Percentile values by mean consumption for Finland, Norway and the US. Data from past year drinkers. Each data point represents a group defined by country (in different sub-figures), consumer category (i.e. the different percentile groups, marked with different symbols in the figure), survey year and gender (the one-half of the data points in each figure which have the lower values of population consumption are women’s data points).

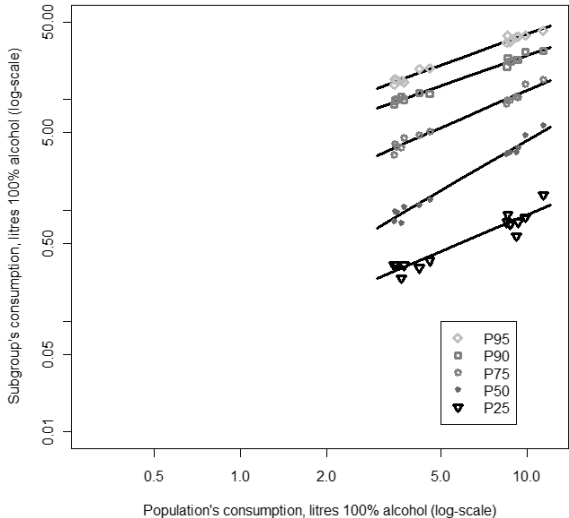
**Finland**



**Norway**



**The US**



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