

Alcohol and the preventive paradox: serious harms and drinking patterns

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ABSTRACT

Aims The preventive paradox prevails if the majority of alcohol problems accrue to the lesser-drinking majority of population, not to heavy drinkers. Evidence for the paradox has been criticized for being based on self-report. The aim was to examine whether the paradox also applies to deaths and hospital admissions. **Design** Data from four surveys representing the Finnish population aged 15–69 years in 1969, 1976, 1984 and 1992 were pooled; those from 1969, 1976 and 1984 ($n = 6726$) to study alcohol-related hospital admissions and alcohol-related deaths, and those from 1984 and 1992 ($n = 5558$) to study self-reported problems. The former data were linked with register data on hospital admission and death up to the end of 2002. **Methods** Comparisons were made separately for men and women (1) between the 10% of population with the highest average alcohol consumption and the remaining 90% of drinkers and (2) between those who reported and those who did not report drinking to intoxication. **Results** A total of 3025 men and 2693 women were available for the study of self-reported problems and 2945 men and 2615 women for deaths and hospital admissions. Seventy per cent of all self-reported problems, 70% of alcohol-related hospitalizations, 64% of alcohol-related deaths and 64% of the premature life-years lost before the age of 65 occurred among the 90% of men consuming less. The respective figures for women were 64%, 60%, 93% and 98%. Drinking five or more drinks per occasion was related to more harm than not drinking that much. **Conclusions** In men, the 'prevention paradox' appears to apply to a broadly similar degree to hospitalizations and deaths as self-report alcohol-related problems; in women the phenomenon was apparent to a greater degree for deaths than for other markers of harm.

Keywords Alcohol drinking, hospitalization, mortality, prevention and control.

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INTRODUCTION

To find the best way of preventing alcohol problems, we must take account of the concept of the preventive paradox. The paradox arises because although the high-risk group of alcoholics and other heavy drinkers are at the highest risk of alcohol problems, most problems still accrue to the lesser-drinking majority of the population simply because the latter group is much larger. The main implication of the preventive paradox is that it is not enough to control drinking among the heaviest drinkers, but efforts should also be targeted to the lesser-drinking majority in proportion to the harms present; hence, in prevention, the whole population is a more appropriate target than the high-risk group alone.

The distribution of total harm between the high-risk group and the rest of the population depends on the distribution of alcohol intake, drinking pattern and the mix of various alcohol-related harms in the population as well as on the shape of risk functions for these harms. As Skog [1] has pointed out, if alcohol-related harm is a linear function of alcohol intake, then the majority of problem cases come from the moderate drinkers and the preventive paradox applies. If, however, the detriment proliferates curvilinearly from zero upwards then the paradox may not apply, because most harms accrue to the heaviest drinkers. We need to add that if the risk of harm follows a *J*-shape, first decreasing and then increasing, then the paradox may also not apply, because favourable effects among moderate drinkers may compensate some part of the detrimental effects.

Data to support the preventive paradox derive mainly from surveys inquiring into self-reports of both alcohol intake and problems attributed to alcohol by the respondent [2–4]. The preventive implications of the paradox have been criticized on the grounds that self-reports of the problems attributed to alcohol during a given time are not sufficient evidence for the distribution of harms among drinkers; the frequency and severity of the harms should also be considered [5], as neglecting variations in them might lead to a distorted picture about the contribution of heavy drinkers to harms. Moreover, what is counted by the respondents as a harmful consequence of drinking may vary between lighter and heavier drinkers. Further, self-reported problems are only one part, and not necessarily the most serious part, of the harms. More comprehensive data are needed, especially on serious harms that are not based on self-reports alone [6]. Some data have already been provided. One study on the diagnosis of alcoholism, convictions on drunkenness and drunken driving [7] found that the evidence for preventive paradox was less strong when the actual frequency of the harms was studied instead of the mere presence or absence of these harms. Another study found that the uppermost 10% of consumers accounted for a relatively small proportion of hospital admissions for attempted suicide and for violent injuries [8], but no distinction could be made between cases that were or were not alcohol-related.

To obtain a more comprehensive view, we study three different types of harm indicators—self-reported problems due to alcohol, alcohol-related hospital admissions and alcohol-related deaths. We compare the distribution of these indicators between the 10% of population with the highest average alcohol consumption and the remaining 90% of drinkers.

Recent studies have elaborated the preventive paradox by looking at the pattern of drinking: the harms to those who do not report heavy total alcohol consumption are caused, to a large extent, by their drinking to intoxication [3,4]. Hence, in the analysis we break down the heavy and non-heavy drinker categories by whether or not the respondents report drinking to intoxication, in order to see how alcohol-related harms will be distributed between these four groups.

MATERIALS AND METHODS

Participants and measures

Face-to-face interview data from four nationally representative cross-sectional Finnish Drinking Habits Surveys conducted in 1969 ($n = 1740$, response rate 92%), 1976 ($n = 2835$, response rate 96%), 1984 ($n = 3624$, response rate 94%) and 1992 ($n = 3446$, response rate

87%) were pooled into two new data sets. Given the suitability of the data, the analyses on self-reported problems used the 1984 and 1992 data sets ($n = 5558$) and those on morbidity and mortality used the 1969, 1976 and 1984 data sets ($n = 6726$), with the older data permitting longer follow-ups. To study self-reported problems, the two largest and most recent data sets from 1984 and 1992 were pooled. Abstainers ($n = 1308$) and respondents with missing information on alcohol consumption ($n = 202$) were excluded. Complete data on self-reported problems and alcohol consumption were available for a total of 2945 men and 2615 women, aged between 15 and 69 years. To study hospital admissions and deaths, data from 1969, 1976 and 1984 were pooled and linked with follow-up information on morbidity and mortality by using a personal identification number. Follow-up was not available for later surveys. Abstainers ($n = 1389$) and those with missing information on alcohol consumption ($n = 70$) or follow-up ($n = 14$) were excluded. Complete data of current alcohol consumption and follow-up information were available for a total of 4009 men and 2717 women, aged between 15 and 69 years. Detailed descriptions of the original study samples and methods are available elsewhere [9,10].

The estimation of alcohol consumption was based on a survey period measure developed by Mäkelä [11]. In the survey period measure, alcohol intake was estimated by recording the amounts drunk by beverage type of all drinking occasions which fell on the given survey period. The respondents were first queried on how often they consumed alcoholic beverages. The length of the survey period for each individual was determined according to the respondent's typical frequency of drinking, so that an average of four drinking occasions was recorded for each respondent. For example, if the reported frequency was once a week the survey period was 4 weeks. The day on which the interview was held was always included in the data. The total annual consumption was estimated by extrapolating the survey period estimate of alcohol consumption to 365 days. Reported amounts of alcohol were recorded as centilitres (cl) of absolute alcohol by using the known ethanol content of the specific alcoholic beverage; for the purposes of the present paper 1 unit of alcohol is defined as 1.5 cl (12 g) of absolute alcohol. For the present study, the annual consumption was categorized separately for men and women by using specific percentage points of the consumption distribution. The cut-off point for heavy annual intake was the highest 10% of the distribution. The remaining 90% of the distribution indicated light or moderate intake. For men the heavy annual intake equated an intake level of at least 1130 cl (9040 g) of absolute alcohol per year and for women at least 320 cl (2560 g) of absolute alcohol per year. For men the heaviest drinking 10% contributed slightly

Table 1 Diagnoses related to alcohol by definition (years of application in Finland).

| | ICD-8 (1967–86) | ICD-9 (1987–95) | ICD-10 (1996–) |
|---|--------------------|--|---------------------------|
| Psychosis and dependence | 291, 303 | 291, 303, 305.0 | F10 |
| Polyneuropathy | | 357.5 | G621 |
| Epilepsy | | | G4051 |
| Degeneration of the nervous system | | | G312 |
| Myopathy | | | G721 |
| Cardiomyopathy | | 425.5 | I426 |
| Diseases of stomach, liver and pancreas | 571.0, 577* | 535.3, 571.0–571.3, 577.0D–577.0F, 577.1C–577.1D | K292, K70, K860, K8600 |
| Poisoning | 980, E860 | 980, E851** | X45, T51 |

*Alcohol not mentioned in this diagnostic designation. Only male deaths. Statistics Finland has ascertained that almost all male deaths in category 577 were due to alcohol-related pancreatitis, while female deaths were mainly not alcohol-related. **E851 is the code for accidental alcohol poisoning in the Finnish modification. The respective code in ICD-9 is E860.

under 50% of the total amount of alcohol consumed, whereas for women the heaviest drinking 10% contributed slightly over 50% of the total amount of alcohol consumed. The rationale for dividing the drinking population into the 10% consuming the most and the 90% consuming less is simply to compare a small high-risk group with a large low-risk group from the preventive point of view. The cut-point is, of course, arbitrary but can be defended by the fact that due to the skewed distribution of alcohol consumption, this small heavy-intake group consumes approximately half of all alcohol in all of our subsamples. We also analysed each annual data set separately and found no material differences with the pooled results.

In addition, we ascertained whether the respondent had consumed five or more (5+) units (60+g) on any single drinking occasion during the study period. Self-reported frequencies of intoxication and hangover during the previous 12 months were available for survey years 1984 and 1992. Intoxication was defined as a drinking occasion when the respondent 'really felt the effects of alcohol', and it was dichotomized to those who did and those who did not report this experience at least once in the previous 12 months. The annual number of hangovers was estimated from the self-reported frequency of hangovers.

Self-reported intoxication is not the same as drinking five or more drinks at a time. However, in Finland, where drinking rapidly outside meals is not uncommon, these two indicators may be roughly commensurate. In a recent general population survey, 75% of the men and 96% of the women estimated that they felt the effects of alcohol at the level of three to five drinks [12].

Self-reported problems were of various types and severity, but all were attributable to alcohol consumption. The problems were related to at least one single drinking

occasion during the past 12 months. Information about self-reported problems was available only for survey years 1984 and 1992. Respondents were asked whether they had or had not experienced any of the following problems: (1) quarrel or argument; (2) scuffle or fight; (3) accident or injury; (4) loss of money or valuables; (5) damage to objects or clothing; (6) police detention; (7) drunken driving; (8) victimized by cheating; and (9) victimized by theft. Totalling the affirmative responses to these questions produced a composite variable showing the number of various types of problems the respondent had reported. This summary measure had values ranging from 0 to 9. We could not calculate the total number of all problem occurrences, as information on the frequency of problems was not available. However, the total number of hangovers per year was estimated for each respondent.

Information about morbidity was obtained through the hospital discharge register at the National Research and Development Centre for Welfare and Health (STAKES) and information about mortality through the cause-of-death statistics at Statistics Finland. Follow-up time was the maximum follow-up time available, beginning at each baseline survey and lasting until the end of 2002 or the number of days until hospitalization or death for the end-point chosen. The maximum follow-up time for the survey from 1969 was 33 years, 26 years from 1976 and 18 years from survey 1984. The end-point for morbidity was hospital admission, with an alcohol diagnosis as the main cause of discharge. For mortality, an alcohol-related diagnosis was either the underlying or a contributory cause of death. The latter were available only from 1987 onwards.

Alcohol diagnoses were comprised of those where 'alcohol' or 'alcoholic' was part of the diagnostic designation and where a causal role for alcohol was implied (Table 1). The respective codes in the registers were

classified by the consecutive revisions of the Finnish modification of the International Classification of Diseases.

Statistical analysis

Both for hospitalizations and for mortality, we first made a dichotomous measure indicating whether the respondent had or did not have an alcohol-related hospital admission or death during the follow-up. We counted the number of alcohol-related hospital admissions per study subject. If the day of hospital discharge was the same day that the next admission took place, or the day of admission was the next day from the previous discharge, the hospital treatment was considered to continue and thus such hospital admissions were regarded as one single admission. The length of hospital stay was estimated by summing the total number of days in hospital for all alcohol-related admissions during the follow-up. In addition, follow-up time until the first alcohol-related hospital admission was estimated. The number of alcohol-related deaths was also computed. In addition, we estimated the number of life-years lost due to alcohol-related death on the assumption that if the subject had not died from an alcohol-related cause he or she would have survived until age 65 years. This overlooks the force of mortality from other causes, and thus overestimates slightly the burden of alcohol-related causes of death under study.

The data were analysed by exploring the distribution of various alcohol-related harms between light to moderate drinkers (90% of the distribution) and heavy drinkers (uppermost tenth of the distribution). Secondly, the 90% consuming less and the 10% consuming most were divided further into two subgroups according to drinking pattern. Individual-level information in each consumption category was summed and presented as percentages in the respective consumption category.

RESULTS

First, the distribution of harms was compared between the 10% of the population with the highest average alcohol consumption and the remaining 90% of drinkers. While the former had the greatest number of harms per person the latter had the greatest number of harms per population group. Table 2 shows data on experiencing any of the nine problems during the previous 12 months (see Methods for the list) attributed to alcohol by the respondent. The 90% consuming less had the majority of self-reported problems, not only in the percentage of 'yes' responses to questions on having had a certain problem at least once, but also when all the 'yes' responses were totalled (Table 2). Of men, the 90% consuming less experienced 70%, and that of women 64% of all problems. Similar distributions were also found for hangovers. The

90% consuming less had 62% of hangovers in men and 49% in women. Most of the problems occurred among those subjects who reported having been intoxicated at least once in the previous year, i.e. having 'really felt the effects of alcohol'. However, those who did not report such an evident intoxicating effect also had a notable percentage of problems.

Hospital admissions showed similar distributions (Table 3). Of men, the 90% consuming less experienced 70%, and of women 60%, of all hospitalizations. Among the 10% consuming the most, almost all men and 98% of women reported drinking occasions with five or more drinks. In contrast to this, both drinking patterns were common among the 90% consuming less. Those consuming five or more drinks per occasion had had as many hospitalizations as would be expected on the basis of its relative population size among alcohol consumers, while the share of hospitalizations was under-represented in the subgroup not consuming five or more drinks per occasion, particularly among the men (Table 3). However, there were alcohol-related hospitalizations even in the latter subgroup.

Similarly, the majority of deaths with an alcohol-related diagnosis and premature life-years lost due to these diagnoses before age 65 years accrued to the 90% consuming less. In men, 64% of these deaths and 64% of the life-years lost occurred among the 90% consuming less. The respective figures in women were as high as 93% and 98% (Table 4). Again, those having consumed five or more drinks per occasion had roughly as many harms as would be expected on the basis of their relative population size among men. Among women, however, the share of harms was higher than expected, perhaps reflecting the higher risk among women than men at similar intake levels.

Although the share of harms was under-represented in the subgroup consuming less than five or more drinks per occasion among both men and women, harms were not absent in this subgroup (Tables 2–4). Men in this subgroup had 7% of all self-reported problems, 6% of hospitalizations, 6% of deaths and 4% of the premature life-years lost among all men. Among women, drinking pattern had less influence. Of all women, 65% belonged to the group that did not report occasions of five or more drinks and this group had 43% of hospitalizations, 57% of deaths and 57% of all premature life-years lost associated with an alcohol-related diagnosis. Similarly, 61% of all women reported light consumption and no intoxication, and this group had 17% of all self-reported problems.

DISCUSSION

We found that the alcohol-related harms under study were not confined to the 10% of the population

Table 2 Number of self-reported problems^a and hangovers by consumption categories^b and intoxication status^c for pooled survey years of 1984 and 1992.

| | <i>Light average intake Reported intoxications</i> | | <i>Heavy average intake Reported intoxications</i> | | <i>Total % (n)</i> |
|------------------------------------|--|------------|--|------------|--------------------|
| | <i>No</i> | <i>Yes</i> | <i>No</i> | <i>Yes</i> | |
| Men | | | | | |
| Total no. of men, % | 29 | 61 | 0 | 10 | 100 (2924) |
| No. of men with problems, % | 8 | 71 | 0 | 21 | 100 (1001) |
| Total no. of problems, % | 7 | 63 | 0 | 30 | 100 (1969) |
| Got into quarrel or argument, % | 5 | 70 | 0 | 25 | 100 (510) |
| Got into scuffle or fight, % | 5 | 64 | – | 31 | 100 (193) |
| Got into accident or injury, % | 6 | 52 | – | 42 | 100 (82) |
| Loss of money or valuables, % | 4 | 61 | – | 35 | 100 (183) |
| Damage to objects or clothing, % | 5 | 65 | – | 30 | 100 (232) |
| Victimized by cheating, % | 2 | 55 | – | 43 | 100 (51) |
| Victimized by theft, % | 6 | 64 | – | 30 | 100 (33) |
| Drunken driving, % | 5 | 64 | – | 31 | 100 (168) |
| Police detention, % | 9 | 62 | 1 | 28 | 100 (245) |
| Average no. of problems per person | 0.2 | 0.7 | 0.5 | 2.0 | |
| No. of hangovers, % | 2 | 60 | 0 | 38 | 100 (20572) |
| Women | | | | | |
| Total no. of women, % | 61 | 29 | 2 | 8 | 100 (2598) |
| No. of women with problems, % | 21 | 50 | 2 | 27 | 100 (532) |
| Total no. of problems, % | 17 | 47 | 2 | 34 | 100 (845) |
| Got into quarrel or argument, % | 19 | 50 | 2 | 29 | 100 (384) |
| Got into scuffle or fight, % | 20 | 33 | 2 | 45 | 100 (60) |
| Got into accident or injury, % | 11 | 44 | – | 45 | 100 (45) |
| Loss of money or valuables, % | 13 | 48 | 3 | 36 | 100 (91) |
| Damage to objects or clothing, % | 6 | 57 | – | 37 | 100 (97) |
| Victimized by cheating, % | 10 | 24 | 5 | 61 | 100 (21) |
| Victimized by theft, % | 10 | 35 | 10 | 45 | 100 (20) |
| Drunken driving, % | 26 | 37 | – | 37 | 100 (19) |
| Police detention, % | 25 | 38 | 4 | 33 | 100 (24) |
| Average no. of problems per person | 0.1 | 0.5 | 0.4 | 1.3 | |
| No. of hangovers, % | 7 | 42 | 4 | 47 | 100 (6681) |

^aNumber of various types of problems associated with alcohol consumption, preceding 12 months. ^bPercentage points of the consumption distribution by gender (lowest 90% and highest 10%), abstainers excluded. ^cDefined as times when respondent 'really felt the effects of alcohol', preceding 12 months. Dichotomized as never versus at least once during the previous 12 months.

consuming most. The majority of problems were found among the 90% consuming less than the uppermost 10% of all alcohol consumers. Earlier studies have shown that this is true for the presence of self-reported problems attributed to alcohol. However, self-reported data on both exposure and outcome are both subject to response bias and if this bias influences both variables in the same direction, strong spurious associations may be found where none actually exist [13]. We showed that the so-called preventive paradox applies not only to self-reported harms, but also to the number of hospitalizations, deaths and life-years lost associated prematurely with an alcohol-related diagnosis. All the outcomes showed similar results, suggesting that the preventive paradox cannot be explained away by response bias.

The present results strengthen the available evidence [3,4], indicating that drinking pattern is of importance for prevention. Among the 90% of men consuming less, the subgroup with drinking occasions with five or more drinks had a notable number of harms. A heavy episodic drinking pattern is one central reason for the preventive paradox.

The harms were under-represented but not absent in the subgroup with no occasions of five or more drinks among the 90% consuming less. It is interesting that females in this category had a substantial number of all types of harms, although the 90th percentile of average alcohol intake was less than one-third of that for men. It may be questioned how there can be any harms in this group. However, risk functions for some harms already

Table 3 Number of hospitalizations and the length of hospitalization with alcohol diagnosis by consumption categories^a and 5 + drinking status.

| | <i>Light average intake</i> | | <i>Heavy average intake</i> | | <i>Total % (n)</i> |
|--|-----------------------------|-------------------------------|-----------------------------|-------------------------------|--------------------|
| | <i>No 5 + occasions</i> | <i>Reported 5 + occasions</i> | <i>No 5 + occasions</i> | <i>Reported 5 + occasions</i> | |
| Men | | | | | |
| Total no. of men, % | 32 | 58 | 0 | 10 | 100 (4009) |
| No. of men with hospitalizations, % | 9 | 62 | 0 | 29 | 100 (228) |
| No. of hospitalizations, % | 6 | 64 | 0 | 30 | 100 (750) |
| No. of days in hospital, % | 3 | 60 | 0 | 37 | 100 (7202) |
| Average follow-up time until hospitalization (years) | 17 | 13 | 4 | 11 | |
| Women | | | | | |
| Total no. of women, % | 65 | 25 | 2 | 8 | 100 (2717) |
| No. of women with hospitalizations, % | 40 | 24 | 2 | 34 | 100 (53) |
| No. of hospitalizations, % | 43 | 17 | 1 | 39 | 100 (119) |
| No. of days in hospital, % | 45 | 15 | 0 | 40 | 100 (1507) |
| Average follow-up time until hospitalization (years) | 12 | 15 | 14 | 11 | |

^aPercentage points of the consumption distribution by gender (lowest 90%, and highest 10%), abstainers excluded.

Table 4 Number of deaths with alcohol diagnosis as main or contributory cause and life-years lost due to alcohol before the age of 65 by alcohol consumption categories^a and 5 + drinking status.

| | <i>Light average intake</i> | | <i>Heavy average intake</i> | | <i>Total % (n)</i> |
|---|-----------------------------|-------------------------------|-----------------------------|-------------------------------|--------------------|
| | <i>No 5 + occasions</i> | <i>Reported 5 + occasions</i> | <i>No 5 + occasions</i> | <i>Reported 5 + occasions</i> | |
| Men | | | | | |
| Total no. of men, % | 32 | 58 | 0 | 10 | 100 (4009) |
| No. of alcohol-related deaths, % | 6 | 58 | 1 | 35 | 100 (108) |
| No. of life-years lost due to alcohol-related deaths, % | 4 | 60 | 0 | 36 | 100 (1453) |
| Women | | | | | |
| Total no. of women, % | 64 | 26 | 2 | 8 | 100 (2717) |
| No. of alcohol-related deaths, % | 57 | 36 | – | 7 | 100 (14) |
| No. of life-years lost due to alcohol-related deaths, % | 57 | 41 | – | 2 | 100 (64) |

^aPercentage points of the consumption distribution by gender (lowest 90%, and highest 10%), abstainers excluded.

imply a small but increasing risk at low to moderate consumption levels and women are more susceptible to some alcohol-related harms than men. Other explanations are discussed below with regard to limitations.

We were not able to study crime and other long-term social problems related to alcohol. As in most other follow-up studies on morbidity and mortality, data on alcohol intake pertained only to one time-period, assumed to represent average long-term drinking, and changes in alcohol intake were not studied.

The present results are valid if under-reporting does not differ materially between the consumption groups. If, however, drinkers in the heaviest consumption group under-report more than the other drinkers, the prevalence of alcohol-related harms in the lower 90% of consumers is overestimated. It is possible that alcohol-related

diseases are under-diagnosed. This might bias the results in favour of the preventive paradox. Under-diagnosis is more likely among light and moderate drinkers than among heavy drinkers. This might bias the results against the preventive paradox.

Our cohorts were based on survey samples. Surveys almost always have some non-respondents. It has been shown that non-respondents have higher mortality from alcohol-related causes than respondents [14], which indicates that there are more heavy drinkers among the non-respondents. Therefore the number of problems in the 90% consuming less, i.e. the degree of the preventive paradox, is likely to be overestimated. However, the response rates in the present data were high, especially for hospitalization and mortality data. For these three data sets the response varied from 92% to 96%. For the

two surveys pooled to study the self-reported problems the response rates were 94% and 87%. Therefore, the possible overestimation seems to be low.

The choice between a total population strategy and a high-risk strategy is population-specific, depending on the occurrence of various consumption groups and harms in a given population. For example, in a population with a high proportion of abstainers an unfocused mass-media campaign may not be cost-effective. Evidence for policy options may vary considerably, depending on which harms are under study. For example, focusing on liver cirrhosis would emphasize the risk of heavy drinkers, while studying accidents might stress the importance of drinking to intoxication irrespective of long-term average consumption. Ideally, all kinds of alcohol-related harms and possible benefits should be taken into account. Simulations with actual population data can be useful when policy options are being considered. One simulation based on Swedish data on liver cirrhosis, accidents and suicide deaths has been published [15]. Moreover, the choice between a total population strategy and a high-risk strategy depends on the differential effectiveness of the available methods. If, for example, drinking-related harms could be prevented only among the 90% consuming less of all alcohol consumers, but not among the 10% consuming most, this should, of course, influence policy.

The main targets for prevention are both those who have high average alcohol intake and those who have episodes of heavy drinking. A central question is what preventive methods are effective. In countries where intoxicating drinking is prevalent, it is important to ask how the drinking culture favouring heavy episodic drinking can be changed. No success stories have been documented so far. The 'taming of the drinking culture' was the aim during the entire 20th century in Nordic alcohol policy [16], with methods varying from prohibition to favouring mild drinks over stronger ones, but the result has been that new drinking patterns have added to the old ones with little effect on the popularity of heavy episodic drinking [10,17]. Informing the public about the risks of heavy episodic drinking or heavy drinking is a popular suggestion, but it has been shown to be ineffective [18]. Brief interventions have been found to reduce alcohol intake. Typically, these interventions target people with heavy average intake. Our results suggest that interventions to also reduce heavy episodic drinking might be worth trying. Nordic alcohol studies [19,20] have shown that the most efficient way of affecting heavy drinking may be to address the whole population: most of the biggest changes in alcohol policy in the 50 years were directed at the whole population in the form of changes in availability or prices, and they usually had the strongest effects on problem-

atic drinkers. This agrees with the implication of the theory of the collectivity of drinking cultures [21]; because both heavy drinkers and heavy episodic drinkers are part of a collective, it is hard to change their drinking in isolation from the collective.

Our results showed that the majority of alcohol-related hospital admissions and alcohol-related deaths occur among light to moderate drinkers, and thus the preventive paradox is not confined to self-reported consequences of alcohol intake. Further, it was shown that this preventive paradox was related to heavy episodic drinking, particularly among men. However, problems occurred even in the 90% consuming less and with no drinking to intoxication, although more so in women. The findings suggest a combined approach: the prevention of alcohol-related harms should target both those who drink to intoxication and all drinkers. The present results can probably be generalized to populations where abstaining is infrequent and heavy drinking patterns are common. For these populations, evidence for the preventive paradox was corroborated, strengthened and extended by the present findings.

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