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ORIGINAL ARTICLE

The number of persons with alcohol problems in the Danish population

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Abstract

Aims: A) To qualify the existing estimates of the prevalence of heavy drinking, harmful alcohol use and alcohol dependency by applying adjustment for non-participation. B) To describe socio-demographic correlates of heavy drinkers. *Methods:* Data came from the Danish Health Interview Survey 2005, which included a personal interview of 14,566 individuals (response rate 66.7 %), and of 5,552 individuals who completed a self-administered questionnaire containing the Alcohol Use Disorder Test (AUDIT) (response rate 50.9%). Heavy drinkers were defined as consuming >14/21 drinks/week (women/men). Identification of harmful alcohol users and dependent drinkers was based on the score of specific AUDIT questions (harmful alcohol use a score of ≥4 in questions 7–10, dependent drinkers ≥4 in questions 4–6). Adjustment for non-participation was performed using data from the Danish National Patient Registry. *Results:* In the Danish population, 20% were heavy drinkers (862,876 persons 95% confidence interval (95% CI): 672,002–1,195,069), 14% had harmful alcohol use (620,301 persons 95% CI: 439,221–944,992), 3% were dependent drinkers (147,528 persons 95% CI: 118,196–188,384). Being male was associated with heavy drinking (odds ratio (OR): 1.70; 95% CI: 1.53–1.89), as was being a single male (OR: 1.27; 95% CI: 1.01–1.61) and being a smoker (men: OR: 1.96; 95% CI: 1.67–2.30 / women: OR: 2.08; 95% CI: 1.72–2.52). ***Conclusions:*** **The number of heavy drinkers in the Danish population and the number of people with harmful alcohol use is considerably higher than earlier prevalence estimates. The number of dependent drinkers is similar to earlier estimates.**

Key Words: *Adjusting for non-participation, alcohol, alcohol dependency, AUDIT, Denmark, epidemiology, harmful alcohol use, heavy drinking, non-participation analysis*

Introduction

Alcohol dependency and heavy alcohol drinking in general represent huge public health problems in most countries worldwide, interfering with many people's lives. In addition, excessive alcohol use leads to numerous diseases, such as liver cirrhosis, chronic pancreatitis, upper gastrointestinal cancers, cardiomyopathy, polyneuropathy and dementia. Furthermore, alcohol is a contributing cause of many accidents [1]. Thus, approximately 5% of all deaths in Denmark, similar to other Western countries, can be attributed to alcohol [2,3]. A prerequisite for calculating the burden of morbidity and mortality attributable to alcohol is a reliable estimate of the prevalence of alcohol drinking in the general population. Usually, such estimates are based on self-reported alcohol intake from general population surveys. For example, by using data from a health interview survey and extrapolating to the general population, 14% of adult Danes are estimated to be heavy drinkers [4]. However, this number is most likely underestimated because unhealthy lifestyle factors are known to be associated with non-participation in health surveys, and it is therefore probable that individuals who choose not to participate have a higher alcohol intake than individuals who participate [5–7].

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The number of individuals with harmful alcohol use in the Danish population (190,000) is estimated by direct extrapolation from an American survey [8,9]. The validity of this method is questionable and the estimate of prevalence of different categories of problem drinking needs to be qualified.

In this study, we used AUDIT to provide data to estimate prevalences of problem drinking. The aims of the present study were to qualify existing estimates of the prevalence of different categories of problem drinking (heavy drinking, harmful alcohol use and alcohol dependency), by using data from a Danish Health Interview Survey (DHIS) and by applying adjustment for non-participation. This was done using register information on alcohol-related diseases for individuals who were invited but did not participate, and for individuals who were invited and participated. Additionally, the aim was to describe socio-demographic correlates of heavy drinkers.

Methods

Data were derived from the Danish Health Interview Survey (DHIS) that is based on a region-stratified sample of the general adult population (16 years or older). The sample was drawn at random from the Danish population using the Danish Civil Registration System (each Dane has a unique personal registration number). The Danish Civil Registration System contains information on sex, age, address, citizenship and marital status for each

individual. DHIS was carried out in 1987, 1994, 2000 and 2005. The purpose of DHIS is to describe the status and trends in health and morbidity in the Danish population and the factors that influence health status, including health behaviour and health habits, lifestyles, environmental and occupational health risks and health resources [10].

In the present study, we used data from DHIS 2005, where 21,832 individuals were invited. Data were collected through a personal interview at the respondent's home, supplemented by one of two self-administered questionnaires, which was returned by mail after the interview. One was distributed to half of the sample ($n = 10,916$), and the other (including AUDIT) was distributed to the other half of the sample ($n = 10,916$).

Data collection

Figure 1 shows the flow chart of DHIS 2005. A total of 14,566 individuals completed the personal interview (response rate 66.7%). Of these, 7,275 received questionnaire 2, and 5,552 individuals completed this questionnaire (response rate 50.9% among sample) [4].

Information on the amount of alcohol consumption during the previous week was given at the personal interview. Heavy drinking was defined as drinking more than 14/21 drinks/week among women and men (according to the sensible drinking limits given by the Danish National Board of Health) – one drink contain 12 grams of pure alcohol [11].
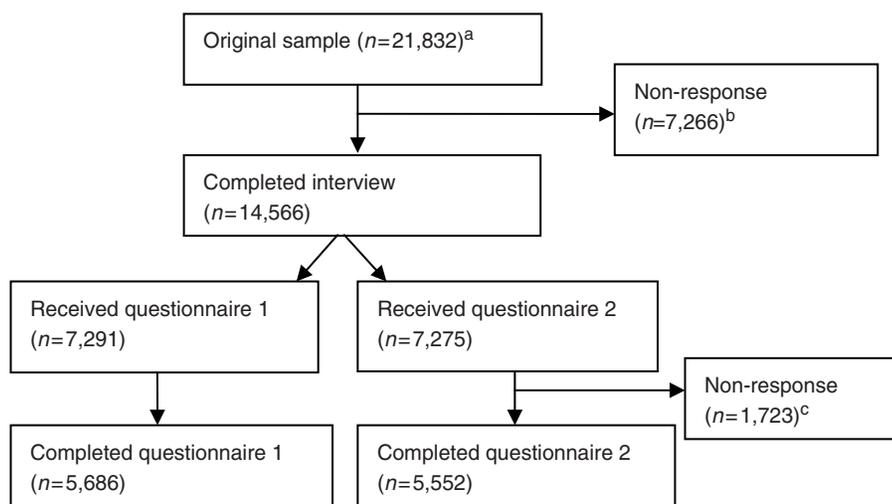

Figure 1. Flow chart of the Danish Health Interview Survey 2005.
[a]21,832 persons, from a region-stratified random sample of the general adult population (16 years or older), were invited to a face-to-face interview.
[b]Non-participants who never completed the interview. Used for the adjustment of the heavy drinking estimate.
[c]Persons who received but never completed questionnaire 2. Non-response used for the adjustment of the harmful and dependence estimate.

The Alcohol Use Disorder Test (AUDIT)

AUDIT consists of 10 questions divided into three domains: three questions covering hazardous alcohol use (nos. 1–3); three questions covering dependency symptoms (nos. 4–6); and four questions covering harmful alcohol use (nos. 7–10). Each question has a set of responses, with a scoring range of 0–4. We defined individuals who had an AUDIT score of ≥4 in questions 7–10 as having harmful alcohol use, and individuals who had a score of ≥4 in questions 4–6 as dependent drinkers. This classification is proposed by the World Health Organization (WHO) [12]. In boxes 1 and 2 the domains, item content and questions of AUDIT are shown.

Adjustment for non-participation

The prevalence of heavy drinkers was estimated using the population of 14,566 individuals who completed the personal interview. The prevalence of harmful alcohol use and dependent drinkers was estimated using the population of 5,552 individuals who completed the questionnaire containing AUDIT. These prevalences were adjusted for non-participation based on the assumption that differences in the incidence of alcohol-related diagnosis between participants and non-participants (defined as those who were invited but did not participate) are equivalent to differences in alcohol consumption between participants and non-participants as follows:

$$Pa = P\left(\text{response rate} + R * [1 - \text{response rate}]\right)$$

Where *Pa* is the prevalence adjusted for non-participation, *P* is the crude prevalence among

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Box 1. Domains and Item Content of the AUDIT[a]

Domains and item content of the AUDIT

Domains	Question number	Item content
Hazardous	1	Frequency of drinking
Alcohol	2	Typical quantity
Use	3	Frequency of heavy drinking
Dependence	4	Impaired control over drinking
Symptoms	5	Increased salience of drinking
	6	Morning drinking
	7	Guilt after drinking
Harmful	8	Blackouts
alcohol	9	Alcohol-related injuries
use	10	Others concerned about drinking

[a]From Babor et al. [12] (reproduced with permission by World Health Organization (WHO)).

Box 2. AUDIT questions[a]

The Alcohol Use Disorders Identification Test: self-report version

Questions	0	1	2	3	4
1. How often do you have one drink containing alcohol?	Never	Monthly or less	2–4 times a month	2–3 times a week	4 or more times a week
2. How many drinks containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 to 9	10 or more
3. How often do you have four or more drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
4. How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
9. Have you or someone else been injured as a result of your drinking?	No		Yes, but not in the last year		Yes, during the last year
10. Has a relative or friend or doctor or other health worker been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year
					Total

[a]From Babor et al. [12] (reproduced with permission by World Health Organization (WHO)).

participants of the survey, response rate is the fraction of invited individuals who participated, *R* is the ratio of incidence proportions of alcohol-related diseases between non-participants and participants. The adjusted prevalences were calculated in the following age groups: 16–24 years, 25–44 years, 45–64 years and 65 + years and extrapolated to the corresponding Danish population (+16 years), where the population as of 1 January 2005 was 4,328,449 persons (2,122,222 men and 2,206,227 women). Finally, 95% confidence intervals (CI) were calculated from the standard error of *R*.

Information on alcohol-related diagnoses was obtained by record linkage to the Danish National Patient Registry (DNPR), where both participants and non-participants were followed via the personal registration number. The DNPR receives information about all patients admitted to hospitals in Denmark, including administrative data as well as information on treatment and diagnosis. In the patient registry, diagnoses are classified according to the international classification of diseases (ICD) 10th revision [13]. Within the time period 1994–2005, first alcohol specific diagnosis was recorded. The time frame of 11 years was chosen to ensure an adequate incidence of the relatively rare alcohol-related diagnoses and because the ICD-10 classification in Denmark was introduced in 1994.

Estimates of the number of heavy drinkers and persons with harmful alcohol use were adjusted on the basis of ICD-10 diagnoses of alcoholic liver disease (K70), alcohol-induced chronic pancreatitis (K86.0), ascites (R18), malignant neoplasm of liver and intrahepatic bile ducts (C22) and oseophageal varices (I85), alcoholic polyneuropathy (G62.1), degeneration of nervous system due to alcohol (G31.2), alcoholic myopathy (G72.1), alcoholic cardiomyopathy (I42.6) and alcoholic gastritis (K29.2), while estimates of dependency were adjusted on the basis of ICD-10 diagnosis of mental and behavioural disorders due to use of alcohol (F10.0 – F10.9).

The problem drinking categories are not mutually exclusive, which means that heavy drinkers can also be categorized as dependent drinkers or as having harmful alcohol use, and dependent drinkers and harmful drinkers can be categorized as heavy drinkers.

Statistical analyses were performed using SAS version 9.1. Participants with incomplete information on alcohol intake were excluded from the analysis ($n = 1,021$).

The Danish Data Protection Agency has approved the linking of the registers and the survey data and all local confidentiality and privacy requirements have been met.

Results

Table I presents the baseline characteristics of the DHIS 2005 population, which consists of 14,566 persons with a median age of 49 years for women and 48 years for men. Women consumed a median of six alcoholic drinks a week (10th to 90th percentiles, 0–15) and men consumed a median of 13 alcoholic drinks a week (10th to 90th percentiles, 0–29). Among men, 73% were married or living with a partner, 45% had more than 13 years of school education, 38% were current smokers, and 70% were employed. Corresponding figures for women were 69%, 38%, 34%, and 62% (Table I).

Table II shows the updated adjusted estimates of heavy drinkers, persons with harmful alcohol use and dependent drinkers. Among the participants in DHIS 2005, 11% of women and 18% of men were classified as heavy drinkers (620,795), 4.9% of women and 12.9% of men were classified as having harmful alcohol use (414,660), and 1.1% of the women and 2.8% of the men were classified as being dependent drinkers (85,619) according to AUDIT definitions. When adjusting for non-participation and extrapolating directly to the Danish population, this gives an estimate of 862,876 heavy drinkers (95% CI: 672,002–1,195,069), 620,301 persons with harmful alcohol use (95% CI: 439,221–944,992) and 147,528 dependent drinkers in the Danish population (95% CI: 118,196–188,384). The adjusted estimates are based on the ratio of incidence proportions of alcohol-related diseases between non-participants and participants, which were twice as high among non-participants (2.17 (95% CI: 1.25–3.78) among heavy drinkers, 2.00 (95% CI: 1.12–3.60) among persons with harmful alcohol use and 2.47 (95% CI: 1.77–3.44) among dependent drinkers). The incidence of alcohol-related diagnoses

Table I. Baseline characteristics of 14,566 persons who participated in the Danish Health Interview Survey 2005.[a]

Characteristics	Women ($n = 7,490$)	Men ($n = 7,076$)
Sex, %	51	49
Age (years)	49 (24, 72)	48 (25, 74)
Alcohol intake, drinks per week[b]	6 (0, 15)	13 (0, 29)
School education ≤ 13 years, %	38	45
Employed, %	62	70
Current smokers, %	34	38
Marital status		
Married or cohabiting, %	68.6	72.8
Single (unmarried), %	13.8	18.8
Single (previously married), %	17.6	8.4

[a]Continuous characteristics are shown as medians (10th to 90th percentiles). [b]1 drink corresponds to 12 grams of pure alcohol.

in our population was 176 among non-participants and 90 among participants.

A sensitivity analysis was performed to assess whether the length of the time alcohol specific diagnosis was recorded from the DNPR would affect the estimates. Using a restriction on the time (1994–2000) did not substantially change the results (heavy drinkers: 869,842; harmful alcohol use: 632,713; dependent drinkers: 161,269).

The odds ratios (OR) for heavy drinking show that men are heavy drinkers more often than women (OR: 1.70; 95% CI: 1.53–1.89), and that the prevalence of heavy drinking is lower among younger men (25–44 years) compared with elderly men (65+ years) (OR: 0.72; 95% CI: 0.55–0.95). A lower prevalence of heavy drinking is seen among women with less than 13 years of total education (OR: 0.65; 95% CI: 0.53–0.78) and among men with low income (<€40,323/year) (OR: 0.74; 95% CI: 0.59–0.93), compared with persons with high education (13+ years) and high income (≥€80,511/year). Marital status and children are associated with heavy drinking, as a higher prevalence is present among unmarried men compared with married men (OR: 1.27; 95% CI: 1.01–1.61) and among persons without children compared with persons with children (men: OR: 1.80; 95% CI: 1.49–2.18 / women: OR: 1.40; 95% CI: 1.10–1.78). A higher prevalence of heavy drinking is also seen among present smokers (men: OR: 1.96; 95% CI: 1.67–2.30 / women: OR: 2.08; 95% CI: 1.72–2.52) and ex-smokers (men: OR: 1.36; 95% CI: 1.13–1.63 / women: OR: 1.56;

95% CI: 1.26–1.93) compared with non-smokers (see Table III).

Discussion

Summary of the main findings

In this study the adjusted estimate shows that the number of heavy drinkers is 860,000 persons. The number of persons with harmful alcohol use is 620,000 and the number of dependent drinkers is approximately 150,000 persons. The number of heavy drinkers is considerably higher than the 500,000–600,000 previously estimated for the Danish population [4]. The number of persons with harmful alcohol use also exceeds the previously quoted estimate of 190,000 persons [9]. The number of dependent drinkers roughly corresponds to the earlier estimates of 160,000 persons [9]. The existing estimate of the number of Danes having a harmful alcohol use (190,000) was extrapolated directly from an American survey using the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) abuse category [8,9]. Extrapolating American numbers into a Danish context and translating DSM-IV abuse into harmful alcohol use is not unproblematic [14]. In this respect, using AUDIT questions 7–10 to define harmful alcohol use and adjust for non-participation seems to give a more qualified estimate.

Various socio-demographic factors in relation to heavy drinking were also examined. The prevalence

Table II. Quantification of the numbers of heavy drinkers, persons with harmful alcohol use and dependent drinkers on the basis of data from the Danish Health Interview Survey 2005 (DHIS)

	Heavy drinkers[a]	Harmful alcohol use[b]	Dependent drinkers[c]
Men			
%, *n*	18.0 (1259)	12.9 (311)	2.8 (68)
Estimate extrapolated to the Danish population	383,482[d]	302,449[d]	61,443[d]
Women			
%, *n*	10.7 (795)	4.9 (132)	1.1 (29)
Estimate extrapolated to the Danish population	237,313[d]	112,161[d]	24,176[d]
Total			
%, *n*	14.4 (2054)	8.9 (443)	2.0 (97)
Estimate extrapolated to the Danish population	620,795[d]	414,660[d]	85,619[d]
Adjusted estimate (95% CI)[e]	862,876 (672,002–1,195,069)	620,301 (439,221–944,992)	147,528 (118,196–188,384)

[a]Defined as consuming more than 14/21 drinks (12 g. of pure alcohol)/week for respectively women and men. Based on the whole DHIS-2005 population (*n* = 14,566). [b]Defined as AUDIT-score 4 + in question 7–10. Based on the population (*n* = 5,552) who completed the questionnaire containing AUDIT in DHIS-2005. [c] Defined as AUDIT-score 4 + in question 4–6. Based on the population (*n* = 5,552) who completed the questionnaire containing AUDIT in DHIS-2005. [d] Age standardized. [e] Adjusted for non-participation.

Table III. OR for heavy drinking[a] for the 14,566 persons who participated in The Danish Health Interview Survey 2005

	Men				Women			
	Crude[b]		Adjusted for all factors[c]		Crude		Adjusted for all factors	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Gender	1.78	(1.16–1.97)[e]	1.70	(1.53–1.89)[e]	1.00	(reference)	1.00	(reference)
Age (years)								
16–24	1.50	(1.15–1.96)[d]	1.33	(0.94–1.89)	1.10	(0.78–1.54)	0.83	(0.53–1.29)
25–44	0.68	(0.57–0.83)[e]	0.72	(0.55–0.95)[d]	0.76	(0.60–0.96)[d]	0.74	(0.52–1.04)
45–64	1.19	(1.00–1.42)[d]	1.05	(0.84–1.31)	1.48	(1.19–1.83)[d]	1.27	(0.97–1.66)
65 +	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
School education								
Pupil	0.82	(0,40–1.65)	0.98	(0.48–2.01)	1.96	(0.99–3.88)	1.76	(0.87–3.57)
<13 year	1.00	(0.88–1.15)	1.01	(0.88–1.17)	0.70	(0.59–0.84)[e]	0.65	(0.53–0.78)[e]
13+ year	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
Total income of family (€)								
<40,323 /year	0.97	(0.80–1.16)	0.74	(0.59–0.93)[d]	0.83	(0.66–1.03)	0.78	(0.59–1.02)
40,323–80,511/year	0.98	(0.84–1.15)	0.90	(0.76–1.06)	0.80	(0.65–0.97)[d]	0.78	(0.63–0.96)[d]
80,645+/year	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
Employed								
No	0.94	(0.78–1.12)	0.88	(0.73–1.06)	1.13	(0.93–1.37)	1.25	(1.01–1.55)[d]
Yes	1.00	(reference)	1.00	(reference)	1.00	(reference	1.00	(reference)
Marital status								
Single (unmarried)	1.52	(1.24–1.87)[e]	1.27	(1.01–1.61)[d]	1.43	(1.10–1.86)[d]	1.23	(0.91–1.67)
Single (previous married)	1.10	(0.87–1.39)	1.02	(0.80–1.31)	0.83	(0.66–1.04)	0.79	(0.61–1.02)
Cohabitation	1.18	(0.97–1.43)	1.03	(0.84–1.26)	0.91	(0.70–1.18)	0.83	(0.63–1.08)
Married	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
Children <15 year								
No children	1.84	(1.54–2.19)[e]	1.80	(1.49–2.18)[e]	1.38	(1.10–1.74)[d]	1.40	(1.10–1.78)[d]
1+ children	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
Smoking status								
Yes	1.94	(1.66–2.27)[e]	1.96	(1.67–2.30)[c]	1.95	(1.62–2.4)[e]	2.08	(1.72–2.52)[e]
Ex-smoker	1.35	(1.12–1.62)[d]	1.36	(1.13–1.63)[d]	1.54	(1.25–1.91)[e]	1.56	(1.26–1.93)[e]
Never	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)

[a]Defined as consuming more than 14/21 drinks (12 g. of pure alcohol)/week for respectively women and men.
[b]Adjusted for gender and age.
[c]Adjusted for gender, age, school education, income, employment status, marital status, children and smoking status.
[d]P < 0.05.
[e]P < 0.001.

of heavy drinking was found to be higher among men compared with women, and lower among younger persons (25–44 years) compared with elderly persons (65+ years). Household income, length of education, smoking status (smoker or ex-smoker), being single and having no children were positively associated with heavy drinking. Some of these socio-demographic factors correspond to previous findings, with regard to higher drinking prevalence among men [15], but there is a lack of consistency in research that has investigated the relationship between socio-demographic factors and volumes of alcohol consumed [16]. In one multinational study of alcohol use in 15 countries, Bloomfield et al. concluded that in five European countries women of higher educational status were more likely to be heavy drinkers compared with women of medium or lower educational status. With regard to men the prevailing pattern was that those of lower educational attainment were more likely to be heavy drinkers than those of higher educational attainment [17].

Methodological considerations

A major strength of our study is the fact that we obtained information from non-participants from the Danish National Patient Registry. Especially when non-participation is systematically related to the variables of interest (alcohol drinking), the potential bias of non-participation needs to be analyzed [6]. Our adjustment safeguards against the well-known biases that persons with the most severe health and alcohol problems are the most likely to decline to

participate in population surveys [5–7]. The adjustment method is built on the assumption that differences in the incidence of alcohol-related diagnosis between participants and non-participants can be transformed into differences in alcohol consumption. However, individuals with a similar degree of alcohol dependency or harmful alcohol use may not be equally prone to referral to hospital for these conditions, especially because alcohol problems are often stigmatized by healthcare professionals, and this may affect how often patients are given an alcohol-related diagnosis or referred for treatment [18]. One study indicates that perceptions about public stigma are highly prevalent among individuals in need of alcohol treatment [19]. Also, the fact that alcohol problems often remain undetected in hospital inpatients could contribute to a bias. In hospital studies where all new patients were screened for alcoholism, the physicians' identification of alcohol-related problems in screen-positive patients were typically less than 50% [20,21]. The abovementioned facts may lead to low sensitivity for alcohol-related diagnoses, but will probably not affect our result, as this is the case for both participants and non-participants registered in the DNPR.

A methodological shortcoming of this study was the low incidence of alcohol-related diagnoses in our population. Still, the result of the sensitivity analysis performed, using the time period 1994–2000, did not substantially change the results (heavy drinkers: 869,842; harmful alcohol use: 632,713; dependent drinkers: 161,269). The result of this restriction suggests that the estimates are robust.

Another limitation of this study concerns the fact that the ICD-10 diagnoses, alcohol dependence and harmful use per definition are mutually exclusive [14]. When using AUDIT data to estimate prevalence estimates in different categories of problem drinking, the possibility of double counting of harmful users and dependent drinkers could occur, because the problem drinking categories are not mutually exclusive. This is a potential drawback, as one could hypothesize that AUDIT shows a response pattern where affirmative responses to more severe items commonly include affirmative responses to easier items, and thus many dependent drinkers may also be included in the harmful drinker estimates. This was also confirmed by the results, which showed that 57% of the dependent drinkers were included in the heavy drinking estimate, and 39% of the harmful drinkers were included in the heavy drinking estimate. The consequence of this is that one should be aware of not adding up the different estimates to make one aggregated estimate for all Danes having a problem with alcohol.

In this study, we chose to focus on the participant's scores for specific questions, instead of focusing on the total AUDIT score. Thus, for example, scores within questions about withdrawal symptoms (question 6) and the experience of not being able to stop drinking (question 4) indicate dependence, and points within questions about guilt after drinking, blackouts, alcohol-related injuries and other concerns about drinking (item 7–10), indicate having harmful alcohol use (see box 1) [12]. The theoretically well-established tri-dimensional construct of "consumption", "dependence" and "harm" model has also been used by previous studies, but has been much discussed [22–26]. Some studies conclude that a two-factor model is preferable, including a consumption factor (items 1–3) and a problem factor (items 4–10) [25,27]. However, in cultures, where drinking is part of everyday life, a two-factor solution may not be preferable, because frequency of drinking would carry heavily in the total AUDIT score and, therefore, should not be used as an indicator of drinking problems [28]. Overall, since much research has shown that AUDIT cannot be viewed as a one-dimensional instrument (even though it is typically used as such), it seems reasonable not to use the full instrument and instead use certain scores in different items to screen for dependence or harmful use. However using a screening instrument like AUDIT, with the cut-off of 4+ in items 7–10 and 4–6, respectively, instead of a diagnostic instrument, also raises some areas of concern. No studies, to our knowledge, have investigated the validity and reliability of this cut-off in population studies. It could be argued that screening questionnaires developed in clinical settings are not automatically suitable for population surveys and hence structured diagnostic evaluations based on a "gold standard" (such as ICD-10 or DSM-IV) should be carried out to provide clear estimates of validity and reliability [23,29]. However such a diagnostic procedure would be too comprehensive in the context of this study, and therefore we must rely on the AUDIT as a tool to provide prevalence estimates, even though data of screening measures in the general population have to be interpreted carefully [23,29]. The overall benefits of using AUDIT as an epidemiological tool for estimating prevalences of different categories of problem drinking are multiple. AUDIT is easy to administer as a survey instrument, and it is short and easy to score. Future research is needed to investigate the validity and reliability of the abovementioned 4+cutoff in population studies.

Public health aspects and implications of the findings

By using a relatively simple non-participation analysis, it was possible to qualify the existing estimates of the prevalence of alcohol drinking in Denmark. Our estimates are likely to be more realistic than previous estimates, because we took account of non-participation. By doing this, a bias of non-participation was quantified, as the relative difference in incidence of alcohol-related diseases between non-participants and participants were approximately twice as high among non-participants.

The estimates found in this study can be seen as an important indicator of the level of alcohol use in a population. Epidemiological assessments of the public health importance of different categories of problem drinking can provide important information on prevention needs. As an example, a remarkable finding of our research is that approximately 860,000 Danes are heavy drinkers; in relation to the Danish population, this means that one in five adult Danes can be categorized as heavy drinkers. This calls for the implementation of preventive measures towards heavy drinking.

Conflicts of interest

None declared.

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