

## Mortality and life expectancy of people with alcohol use disorder in Denmark, Finland and Sweden

Westman J, Wahlbeck K, Laursen TM, Gissler M, Nordentoft M, Hällgren J, Arffman M, Ösby U. Mortality and life expectancy of people with alcohol use disorder in Denmark, Finland and Sweden.

**Objective:** To analyse mortality and life expectancy in people with alcohol use disorder in Denmark, Finland and Sweden.

**Method:** A population-based register study including all patients admitted to hospital diagnosed with alcohol use disorder (1 158 486 person-years) from 1987 to 2006 in Denmark, Finland and Sweden.

**Results:** Life expectancy was 24–28 years shorter in people with alcohol use disorder than in the general population. From 1987 to 2006, the difference in life expectancy between patients with alcohol use disorder and the general population increased in men (Denmark, 1.8 years; Finland, 2.6 years; Sweden, 1.0 years); in women, the difference in life expectancy increased in Denmark (0.3 years) but decreased in Finland (–0.8 years) and Sweden (–1.8 years). People with alcohol use disorder had higher mortality from all causes of death (mortality rate ratio, 3.0–5.2), all diseases and medical conditions (2.3–4.8), and suicide (9.3–35.9).

**Conclusion:** People hospitalized with alcohol use disorder have an average life expectancy of 47–53 years (men) and 50–58 years (women) and die 24–28 years earlier than people in the general population.

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Key words: alcoholism; mortality; epidemiology; Scandinavia

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### Significant outcomes

- People with alcohol use disorder have 24–28 years shorter life expectancy than the general population in the Nordic countries.
- Alcohol use disorder is a major public health problem that causes many years of lost life, even in countries with restrictive alcohol consumption policies.

### Limitations

- A major limitation of the present study was the inclusion only of patients with alcohol use disorder from inpatient care, which may have caused selection bias of patients with the most severe health problems.
- The study was register-based and lacked clinical data about treatment and adherence.
- Alcohol consumption per capita was determined from aggregate data and not from alcohol exposure for individuals.

## Introduction

Alcohol use disorder (AUD) is a major cause of morbidity and mortality (1). People with AUD have among the highest all-cause mortality of all people who receive treatment for mental disorders (2, 3). A meta-analysis that included 81 observational studies from many countries showed that people with AUD have three-fold higher mortality in men and four-fold higher mortality in women than the general population (4). In all people who have AUD, mortality is relatively higher in women, younger people and people in treatment for addiction (4). However, comprehensive mortality data over time of patients with AUD are not available from Nordic countries.

Increased alcohol consumption is associated with increased disease burden, accidents, and social problems (4, 5). In response to these effects, alcohol policies were created in Nordic countries (Sweden, Norway, Denmark, Finland and Iceland) to promote a decrease in alcohol consumption and restrict alcohol availability. The governments of all Nordic countries except Denmark have a monopoly of alcohol retail. However, after joining the European Union in 1995, Finland and Sweden shifted from a highly restrictive to a more liberal alcohol policy. The price of alcohol was reduced by tax reduction on alcoholic beverages in Denmark and Finland, abolition of quantitative quotas on alcoholic beverages in Sweden and Finland, and more generous opening hours of alcohol retailers in Sweden. These changes made alcohol more accessible to the public in these countries since 2003. The alcohol control policies of the countries were associated with total alcohol consumption (6, 7); Sweden has the most restrictive, and Denmark has the least restrictive alcohol policies. Frequency of heavy alcohol drinkers and alcohol-related problems are often assumed to depend on the level of alcohol consumption in the general population (7–9).

The reliable nationwide health care registers in Denmark, Finland and Sweden provide a unique opportunity to study mortality in people diagnosed with AUD.

### Aims of the study

The purpose of this study was to evaluate mortality and life expectancy in people who had AUD in Denmark, Finland and Sweden between 1987 and 2006.

## Material and methods

### Study populations

National health registers from Denmark, Finland and Sweden were used to follow the entire population, approximately 20 million people, aged 15 years or above, in these three countries and identify all people who were admitted to hospital because of AUD as the primary or secondary diagnosis during 20 years (January 1, 1987 to December 31, 2006). Data about patients were retrieved from the national hospital discharge registers in each country. In Denmark, the data about patients were retrieved from the Psychiatric Care Register and the Hospital Discharge Register for medical care. In Finland and Sweden, the Hospital Discharge Registers, which contained information about medical and psychiatric care, were used. The hospital register information was linked to the national registers about causes of death in each country to retrieve data about date and cause of death. Data about alcohol consumption per capita were collected from an international database (6). Follow-up started on the date of first hospital admission for AUD. Each person was followed from the day of first hospital admission until death or the end of a 5-year period to estimate time trends with a sufficient number of deaths; therefore, a person could be counted in more than one time period if readmitted during a different period. For analysis of time trends, the 20-year observation period was divided into 5-year periods: 1987–1991, 1992–1996, 1997–2001 and 2002–2006. Ethical approval was obtained from the regional ethics committee in Gothenburg. The data-keeping authorities from each country gave permission to use health register data in this study.

### Definitions

The diagnosis of AUD (mental and behavioural disorders due to alcohol use) was defined according to the World Health Organization classification system (International Classification of Diseases [ICD]): ICD-8, codes 291, 303; ICD-9, codes 291, 303, 305A; ICD-10, codes F10.0 to F10.9 (10–12). Causes of death were defined according to the classification as (1) all-cause mortality (ICD-8, codes 001 to E999; ICD-9, codes 001 to E999; ICD-10, codes A00 to Y98); (2) death from diseases and medical conditions (ICD-8, codes 001 to 796; ICD-9, codes 001 to 799; ICD-

10, codes A00 to R99); (3) suicide (ICD-8, codes E950 to E959; ICD-9, codes E950 to E959; ICD-10, codes X60 to 84); and (4) external causes of death other than suicide (ICD-8, codes E800 to E999, excluding codes E950 to E959; ICD-9, codes E800 to E999, excluding codes E950 to E959; ICD-10, codes V01 to Y98, excluding codes X60 to 84) (10–12).

Alcohol consumption was defined as the national average of registered amount of alcohol consumed (litres of pure alcohol) per capita aged  $\geq 15$  years during a calendar year. The aggregate indicator from taxation data included consumption for the entire population based on production, import, export and sales (6).

#### Statistical analysis

The study population for each country was stratified into 5 age groups (15–29 years; 30–44 years; 45–59 years; 60–74 years;  $\geq 75$  years), and frequency of mortality was calculated for each group. Person-years and number of deaths were determined for each age group and 5-year period. Standardized mortality per 100 000 person-years was calculated for each country and standardized using Nordic population data for the year 2000 (13). Mortality rate ratios were calculated by taking standardized mortality rate in people with AUD divided by standardized mortality rate in general population. We calculated life expectancy for people with AUD aged  $\geq 15$  years, stratified by sex, using Wiesler method with 1-year age stratification (14). Life expectancy for each of the 5-year periods was determined. Population life expectancy data for each country, calculated and published by the World Health Organization (6), were used for population comparisons. The difference in life expectancy was calculated by taking life expectancy in general population minus life expectancy in people with AUD. Data from national registers in the Nordic countries include all individuals and are not samples. Therefore, confidence intervals (CI) are not relevant.

## Results

### Alcohol use disorder: incidence and associated mortality

In Denmark, the number of men and women hospitalized because of AUD was similar for the 5-year periods from 1987 to 2001 but increased for 2002 to 2006 (Table 1). In Finland, the number of men and women with AUD increased from 1987 to 2001 and remained unchanged for 2002 to 2006. In Sweden, the number of men

with AUD decreased and the number of women with AUD increased from 1987 to 2006 (Table 1).

Mortality was higher in Denmark than Finland or Sweden (Table 1, Figs 1 and 2). Standardized mortality per 100 000 increased during the entire study period in men and women with AUD in Denmark (Table 1). In Finland and Sweden, the standardized mortality per 100 000 decreased in men and women with AUD during the entire study period (Table 1).

### Life expectancy

Life expectancy in people with AUD was lowest in Denmark and highest in Sweden (Table 2, Figs 3 and 4). In all three countries, life expectancy was longer for women than men, both for people with AUD and the general population (Table 2). In men and women in Denmark, life expectancy for people with AUD and the general population increased during the entire study, and the difference in life expectancy between people with AUD and the general population increased more for men than women (Table 2). In Finland, life expectancy for people with AUD increased more for women than men, and the difference in life expectancy between people with AUD and the general population increased for men but decreased for women during the entire study (Table 2). In Sweden, life expectancy for people with AUD and the general population increased in men and women, and the difference in life expectancy between people with AUD and the general population increased in men but decreased in women during the entire study (Table 2).

### Age

In all three countries, mortality rate ratios in people with AUD were higher in young age groups. In Denmark, mortality rate ratios increased during the entire study in men and women for most age groups, especially ages 30–59 years (Table 3). In Finland, mortality rate ratios increased during the entire study period in men and women aged 30–44 years. In Sweden, mortality rate ratios increased during the entire study period in men aged 30–74 years and women aged 45–74 years (Table 3).

### Cause of death

In all three countries, people with AUD had higher mortality from all causes of death (Figs 5 and 6), all diseases and medical conditions, and suicide,

Table 1. Alcohol use disorder and associated mortality in Denmark, Finland and Sweden from 1987 to 2006

Study period	Denmark				Finland				Sweden			
	1987-1991	1992-1996	1997-2001	2002-2006	1987-1991	1992-1996	1997-2001	2002-2006	1987-1991	1992-1996	1997-2001	2002-2006
<b>Men</b>												
People with AUD												
No. of people	32 368	29 818	31 646	39 163	27 845	32 232	41 748	40 489	51 411	49 097	43 715	46 840
No. of deaths	4866	5042	5041	6997	3229	3465	5355	5458	7338	6705	5497	6313
Person-years	84 192	76 142	75 011	93 981	63 452	67 223	95 952	90 994	143 990	134 416	114 017	119 116
Mortality per 100 000 person-years	5780	6622	6720	7445	5082	5154	5581	5998	5096	4988	4821	5300
Standardized mortality per 100 000 person-years	7591	8142	7838	7720	6327	6476	6196	6067	5855	5459	5245	5119
General population												
Standardized mortality per 100 000 person-years	1888	1867	1704	1576	1977	2011	2045	2009	1660	1524	1413	1294
<b>Women</b>												
People with AUD												
No. of people	13 542	13 168	14 188	17 658	5428	7446	12 235	12 999	14 366	14 978	16 939	19 926
No. of deaths	1673	1827	1804	2579	435	523	976	1128	1305	1331	1327	1585
Person-years	36 070	33 464	35 090	43 735	12 098	14 844	28 136	29 502	39 488	39 879	43 150	49 649
Mortality per 100 000 person-years	4638	5460	5141	5897	3596	3523	3469	3824	3305	3338	3075	3192
Standardized mortality per 100 000 person-years	5379	5764	5249	5746	4614	4381	4152	4134	4352	4040	3788	3779
General population												
Standardized mortality per 100 000 person-years	1223	1242	1164	1097	1162	1197	1190	1142	1046	979	934	891

AUD, alcohol use disorder.

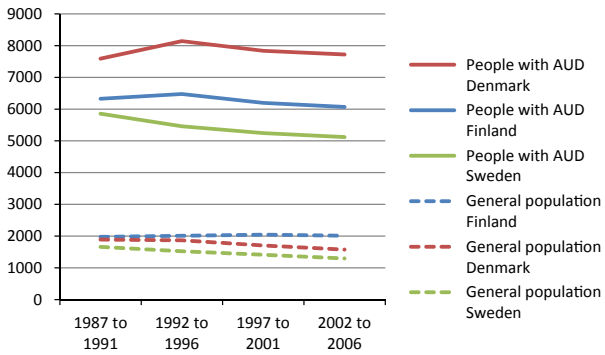


Fig. 1. Alcohol Use Disorder (AUD) and associated mortality in Denmark, Finland and Sweden from 1987 to 2006. Standardized mortality per 100 000 person-years. Men.

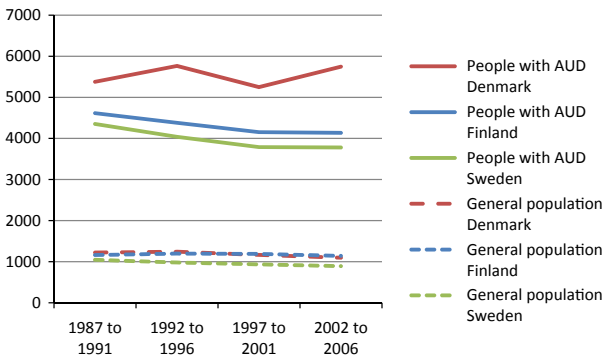


Fig. 2. Alcohol use disorder (AUD) and associated mortality in Denmark, Finland and Sweden from 1987 to 2006. Standardized mortality per 100 000 person-years. Women.

than people in the general population (Table 3). In Denmark, mortality rate ratios in people with AUD increased from 1987 to 2006 from all diseases and medical conditions; mortality rate ratio from suicide was increased only in women during 2002 to 2006 (Table 3). In Finland, mortality rate ratios from all causes of death decreased during the entire study in both men and women; mortality rate ratios from all diseases and medical conditions were unchanged during the entire study for men and women, and mortality rate ratios from suicide increased in women but not men (Table 3). In Sweden, mortality rate ratios from all causes of death increased in men but was unchanged in women during the entire study; mortality rate ratio from suicide increased in both men and women (Table 3).

Alcohol consumption

During the entire study, registered alcohol consumption per capita was highest in Denmark and lowest in Sweden (Fig. 7). In Denmark, registered alcohol consumption per capita decreased slightly

Table 2. Life expectancy of people with alcohol use disorder and people in the general population in Denmark, Finland and Sweden from 1987 to 2006

Life expectancy (years) Study period	Denmark			Finland			Sweden					
	1987–1991	1992–1996	1997–2001	2002–2006	1987–1991	1992–1996	1997–2001	2002–2006	1987–1991	1992–1996	1997–2001	2002–2006
Men												
People with AUD	46.6	46.1	46.7	47.5	46.8	46.4	46.8	48.3	50.3	51.4	52.1	52.7
General population	72.3	72.8	74.0	75.0	71.7	73.1	74.5	75.8	75.0	76.2	77.3	78.4
Difference†	25.7	26.7	27.3	27.5	24.9	26.7	27.7	27.5	24.7	24.8	25.2	25.7
Women												
People with AUD	49.8	49.5	51.4	51.2	52.7	52.4	54.3	56.4	54.8	56.5	57.7	58.6
General population	77.9	77.9	78.7	79.6	79.7	80.7	81.7	82.6	80.7	81.4	82.1	82.7
Difference†	28.1	28.4	27.3	28.4	27.0	28.3	27.4	26.2	25.9	24.9	24.4	24.1

AUD, alcohol use disorder.

†Difference: life expectancy in general population minus life expectancy in people with AUD.



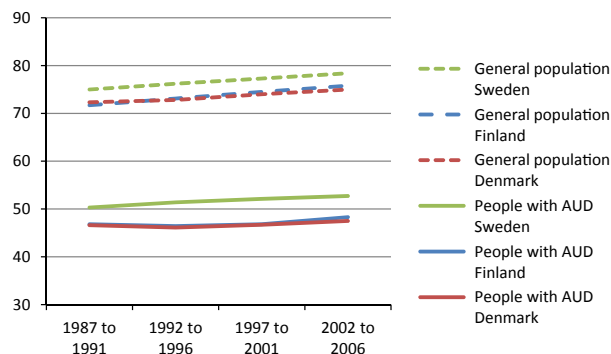


Fig. 3. Life expectancy of people with alcohol use disorder (AUD) and people in the general population in Denmark, Finland and Sweden from 1987 to 2006. Men.

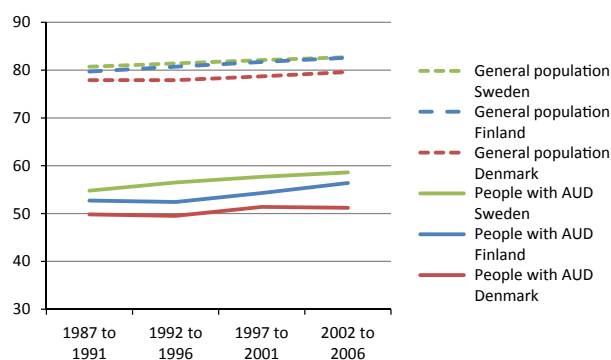


Fig. 4. Life expectancy of people with alcohol use disorder (AUD) and people in the general population in Denmark, Finland and Sweden from 1987 to 2006. Women.

after the year 2002. In Finland, registered alcohol consumption per capita peaked in the time period 2002–2006 in connection with an alcohol tax reduction. In Sweden, registered alcohol consumption per capita decreased slightly in the 90s and increased thereafter.

## Discussion

### Main findings

In this study, our main finding was a 24- to 28-year shorter life expectancy in people with AUD compared with the general population. Mortality associated with AUD was sex-dependent; men with AUD in all three countries had over time an increased difference in life expectancy, but women with AUD in Finland and Sweden (not Denmark) had a decreased difference in life expectancy. The changes in mortality and life expectancy during the study were most negative in Denmark and least negative in Sweden.

### Strengths and limitations

A major strength of this study was the comparison of life expectancy and mortality in all people who had AUD diagnosed in three Nordic countries with different alcohol policies and patterns of alcohol consumption. The availability of nationwide health registers enabled us to follow the entire study population. The large population size (all people treated for AUD from three countries) provided highly reliable data. Much time and effort was invested in quality assurance of statistical analytical techniques, which made the data comparable between the different countries.

A major limitation of this study was the inclusion of patients from inpatient care only, which may have caused selection bias towards AUD patients with the most severe health problems. Patients with AUD who had only outpatient care were not included. The study was register-based and lacked clinical data about the type of treatment and adherence. In addition to disease prevalence in the population, patterns of hospitalization data including clinical diagnoses may be affected by other factors that were not analysed, such as changes in the number of hospital beds available, changes in hospital remuneration policies, and differences in clinical indications for hospital treatment. A common shortcoming in register studies is that they rarely can provide satisfactory answers on why the mortality is high or whether its decrease is due to policy changes, improved care or merely administrative decisions (15), although they can hint at the answer and provide directions (15, 16).

Another study limitation was that alcohol consumption per capita was determined from aggregate data and not from alcohol exposure for individuals. However, the World Health Organization data used in this study were supported by similar results from population surveys in Denmark, Finland and Sweden (17–19). In the aggregate data, neither age- nor sex-specific alcohol consumption data were available. The results based on aggregated data were exploratory and may not be used to draw definitive causative conclusions. In addition, data about illegal alcohol production and individual cross-border import were not included in the national statistics (6) and could not be evaluated in this study.

### Life expectancy and mortality

The difference in life expectancy between people with AUD and the general population during the study increased in men in all three countries,

Table 3. Mortality rate ratio for people with alcohol use disorder compared with people in the general population in Denmark, Finland and Sweden from 1987 to 2006

Mortality rate ratio* Study period	Denmark				Finland				Sweden			
	1987-1991	1992-1996	1997-2001	2002-2006	1987-1991	1992-1996	1997-2001	2002-2006	1987-1991	1992-1996	1997-2001	2002-2006
	<b>Men</b>											
Age (years)												
15-29	9.5	9.1	8.7	7.5	15.1	21.7	18.8	16.8	9.6	11.5	9.2	10.3
30-44	14.2	16.4	19.6	19.3	12.7	13.5	17.6	20.7	14.7	15.5	18.5	18.7
45-59	8.8	11	11.6	13.1	6.9	7.0	6.6	6.7	8.4	9.4	10.3	11.4
60-74	5.0	5.3	5.8	6.3	3.1	3.3	3.3	3.6	4.2	4.3	4.6	5.3
≥75	2.0	2.2	2.2	2.4	1.5	1.8	1.3	1.3	2.0	2.0	2.0	2.1
Cause of death												
All causes	4.0	4.4	4.6	4.9	3.2	3.2	3.0	3.0	3.5	3.6	3.7	4.0
All diseases and medical conditions†	3.7	4.0	4.2	4.6	2.3	2.3	2.3	2.3	3.1	3.1	3.2	3.4
Suicide	11.3	11.6	13.2	10.7	12.0	13.3	12.9	12.3	9.7	9.3	12.6	12.3
Other external causes‡	8.6	9.3	9.5	11.5	12.3	13.5	10.0	11.0	10.2	11.4	11.0	12.0
<b>Women</b>												
Age (years)												
15-29	19.2	11.0	7.8	11.7	32.4	41.4	37.0	26.3	18.2	16.7	12.4	12.3
30-44	21.7	24.3	24.7	28.4	23.9	25.9	26.1	30.9	19.5	18.6	19.7	19.2
45-59	10.2	13.0	13.3	15.6	13.9	12.9	10.1	10.7	10.8	11.8	12.3	11.9
60-74	5.6	6.1	5.8	6.9	4.9	4.7	5.5	6.4	5.9	6.3	6.5	7.4
≥75	2.0	1.9	1.9	2.4	1.5	1.5	1.5	1.4	2.2	2.1	2.0	2.1
Cause of death												
All causes	4.4	4.6	4.5	5.2	4.0	3.7	3.5	3.6	4.2	4.1	4.1	4.2
All diseases and medical conditions†	3.7	4.1	4.0	4.8	3.0	2.6	2.6	2.8	3.6	3.6	3.5	3.6
Suicide	21.4	22.4	20.4	24.9	22	35.5	35.9	27.3	15.9	23.5	26.8	28.5
Other external causes‡	13.5	13.4	13.1	15.0	23.8	20.2	16.9	16.3	17.2	15.1	15.5	15.6

\*Mortality rate ratio: Standardized mortality rate in people with AUD divided by standardized mortality rate in general population.

†Excludes suicides and other external causes.

‡Other external causes exclude suicides.

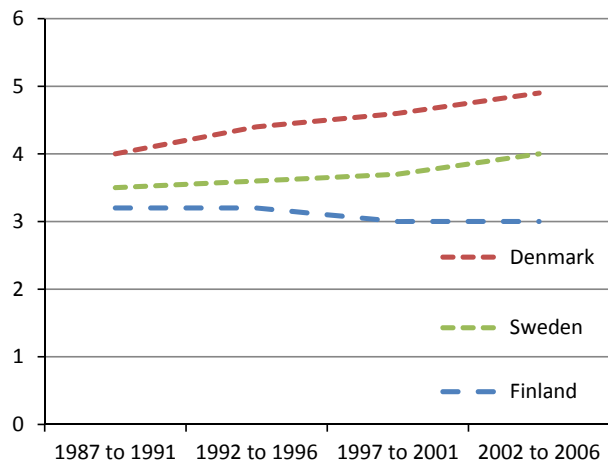


Fig. 5. Mortality rate ratio for people with alcohol use disorder compared with people in the general population in Denmark, Finland and Sweden from 1987 to 2006. Men.

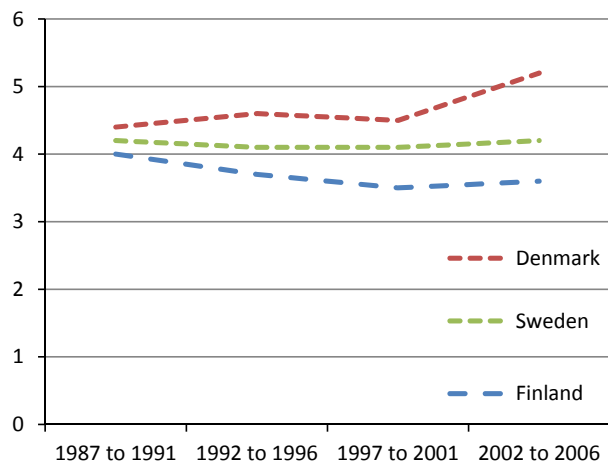


Fig. 6. Mortality rate ratio for people with alcohol use disorder compared with people in the general population in Denmark, Finland and Sweden from 1987 to 2006. Women.

decreased in women in Finland and Sweden, and was unchanged in women in Denmark (Table 2). However, the number of women hospitalized because of AUD increased during the study in all three countries (Table 1), consistent with documented increase in alcohol consumption in women (13). In addition, there has been a decrease in the perceived stigma associated with seeking treatment for AUD (20, 21). Therefore, diagnosis and treatment of AUD may be more common in women currently than 20 years ago. Nevertheless, only 1 in 3 people with AUD seek treatment (21).

This study showed that people with AUD had a four-fold greater risk of premature death than people in the general population, and people with AUD died on average 24–28 years earlier than people in the general population. Previous studies

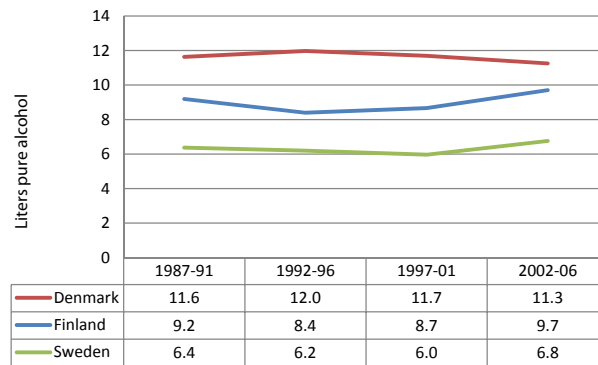


Fig. 7. Registered total alcohol consumption in litres pure alcohol per capita in Denmark, Finland and Sweden from 1987 to 2006.

showed the mortality risk to be two- to six-fold greater in people with AUD (4, 22). In this study, people with AUD had a greater risk of death from all diseases and medical conditions, suicide, and other external causes of death, than people in the general population, consistent with findings from previous studies (2–4, 22, 23).

In men, the difference in mortality between patients with AUD and the general population increased more in Denmark and Finland than Sweden. These differences may be associated with the overall level of alcohol consumption, which is highest in Denmark and lowest in Sweden. The difference in mortality between people with AUD and the general population was smaller for both men and women in all study periods in Sweden than Denmark or Finland (Table 2). The number of deaths among women increased in all three countries during the study period, due to increasing numbers of women diagnosed with AUD in all countries, although standard mortality ratios did not increase. The alcohol control policies of the countries are associated with total alcohol consumption; Sweden had the most restrictive, and Denmark had the least restrictive alcohol policies. Other studies have shown that the negative effects of the increased availability of alcohol in Finland mainly occurred in people with AUD (24–27). For example, in Finland, deaths from liver disease increased by 30% and alcohol-related sudden deaths increased by 17% after changes in alcohol regulations in 2004 (27–29).

#### Clinical implications

Findings from the present study show that AUD in the Nordic countries is associated with substantially increased mortality, even though alcohol control policies are restrictive compared with other countries. What might be important to add to the general restrictive alcohol policies would be



selective efforts aimed at high alcohol consumers, to achieve preventive effects in terms of reducing the rate of high consumers converting to AUD. In this field, a wider focus is necessary including testing new preventive efforts, with the aim of reducing alcohol-related harm in people with AUD. In addition the somatic care of people with AUD should be substantially improved.

In summary, the present study of the entire populations of Denmark, Finland and Sweden showed that people hospitalized with AUD had an average life expectancy of 47–53 years for men and 50–58 years for women. People hospitalized with AUD had a 24- to 28-year shorter life expectancy than the general population. During the study, the difference in life expectancy between people with AUD and the general population increased in men but not in women. Mortality and life expectancy were associated with total alcohol consumption in the three countries. Furthermore, the comprehensive population data confirmed that AUD is a major public health problem that causes many years of lost life, also in countries with restrictive alcohol consumption policies.

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### Declarations of interest

Jeanette Westman, Kristian Wahlbeck, Thomas Munk Laurssen, Mika Gissler, Merete Nordentoft, Jonas Hällgren, Martti Arffman, and Urban Ösby have no connections (direct or indirect) with the alcohol or pharmaceutical industries.

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