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Erstveröffentlichung in / First published in:

*European addiction research. 2015, 21(1), S. 6 – 18 [Zugriff am: 29.04.2020]. Karger. ISSN
1421-9891.*

DOI: <https://doi.org/10.1159/000365284>

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Prevalence of and Potential Influencing Factors for Alcohol Dependence in Europe

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Key Words

Alcohol · Alcohol dependence · Alcohol use disorders · Heavy drinking · Prevalence · Liver cirrhosis · Injury · Europe

Abstract

Alcohol use disorders (AUDs), and alcohol dependence (AD) in particular, are prevalent and associated with a large burden of disability and mortality. The aim of this study was to estimate prevalence of AD in the European Union (EU),

Iceland, Norway, and Switzerland for the year 2010, and to investigate potential influencing factors. The 1-year prevalence of AD in the EU was estimated at 3.4% among people 18–64 years of age in Europe (women 1.7%, men 5.2%), resulting in close to 11 million affected people. Taking into account all people of all ages, AD, abuse and harmful use resulted in an estimate of 23 million affected people. Prevalence of AD varied widely between European countries, and was significantly impacted by drinking cultures and social norms. Correlations with level of drinking and other drinking

variables and with major known outcomes of heavy drinking, such as liver cirrhosis or injury, were moderate. These results suggest a need to rethink the definition of AUDs.

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Introduction

Alcohol consumption is a major risk factor for the burden of disease [1–3]. Alcohol use disorders (AUDs), as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM) version IV [4] or the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) [5], are associated with the most detrimental health consequences caused by alcohol consumption [6–9]. For instance, for the European Union (EU) in 2004, alcohol dependence (AD), the most severe form of AUDs, was estimated to be responsible for more than 60% of all alcohol-attributable mortality, causing 85,000 deaths (12,000 deaths among women and 73,000 deaths among men) [10, 11].

Estimates of the burden caused by AUDs are usually based on attributable fractions and require information on the prevalence of AUDs and the relative risk for outcomes causally related to AUDs ([12]; for disease-specific relative risks associated with AUDs, see [13]). Thus, reliable and valid data on the prevalence of AD and alcohol abuse (DSM-IV) or the harmful use of alcohol (ICD-10) would be required to measure and monitor the prevalence of AUDs and their consequences (no European studies were available up to 2013 using DSM-5). As the last systematic epidemiologic review of AUDs in Europe was published in 2005 [14], it is the aim of this study to present an overview of current knowledge on the prevalence of AD and AUDs in the EU-27 and the other European ALICE-RAP participating countries (Iceland, Norway and Switzerland). We will examine the availability, validity, and reliability of the currently available data. We will also analyze potential covariates and influencing factors.

Large comparative international studies by the World Health Organization (WHO) on the validity and reliability of diagnostic categories in ten countries showed that the diagnostic concordance coefficients between the usual instruments used to measure AUDs and psychiatric judgments were good to very good for dependence, but considerably lower for the abuse and harmful use [15, 16]. This finding has been corroborated by other studies [17]. Thus, this study focuses on AD as the most severe [18, 19] and valid sub-diagnosis of AUDs.

Methods

Selection of Studies for Prevalence Data and the Derivation of Prevalence Estimates

Prevalence estimates for AD were based on an earlier systematic literature review for each country examined ([10], updated to September 2013 based on the latest WHO Global Status Report on Alcohol and Health [20]), to obtain best estimates for 2010. The data obtained from the systematic review were then adjusted for biases and checked for validity and comprehensiveness by the Addiction and Lifestyles in Contemporary Europe-Reframing Addictions Project (ALICE-RAP) experts in all participating countries.

The following selection criteria for prevalence estimates of AD were used: the highest priority was given to prevalence estimates obtained from nationally representative surveys of the general population that used a standardized and validated instrument to measure AD, such as the Composite International Diagnostic Interview (CIDI [21]) or the Schedules for Clinical Assessment in Neuropsychiatry (SCAN [22]) in its various forms (for reliability and validity of these instruments to assess AD, see [15, 16]). Within this category, we preferred studies where the prevalence of AD and alcohol abuse/harmful use was assessed independently.

The second highest priority was given to prevalence estimates for AD that were obtained from nationally representative surveys of the general population using a standardized and validated instrument where AD and alcohol abuse/harmful use were not assessed independently. Most importantly in this category, the early round of the World Mental Health Survey in European countries [23] assessed AD only if at least one criterion for alcohol abuse was fulfilled; as a consequence, the prevalence of AD was severely underestimated by the World Mental Health Surveys (WMHS) [24]. The WMHS were used in estimating AD for Belgium (part of the overall estimate; see table 1), Bulgaria (see also [25, 26], for details on the operationalization), the Czech Republic [27], France, Italy [28], Romania [29] and Spain [30]. For each of these countries the prevalence estimates had to be adjusted as these empirical estimates were severely underestimated; only people with a symptom of alcohol abuse were screened for AD. These prevalence estimates were adjusted by upshifting the empirical prevalence by the proportion of overall AD, where no symptoms of alcohol abuse were observed (based on data from the German National Health Interview and Examination Survey [31, 32]). For countries in Central or Eastern Europe, the Slovakian WHO Multi-Country Survey Study [33] was used for upshifting. While this procedure could be seen as correcting the underestimation of AD, it may have been too conservative a method for countries in the South of Europe where AD is relatively more prevalent than alcohol abuse because of these countries' drinking patterns [10].

The third highest priority was given to national prevalence estimates of AD that were accompanied (either directly or indirectly) by a clear description of the methodology used (for an example, see Switzerland [34]). The lowest priority was given to prevalence estimates obtained from national or international organizations that were not accompanied (neither directly nor indirectly) by a clear indication of sources or of the methodology used (e.g. from the WHO or the EU, e.g. http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]; see table 1). If only the prevalence of AUDs was presented, these figures were adjusted as to only report the prevalence of AD based on the relative prevalence of AUD and AD observed for neighboring countries. Not

Table 1. Prevalence and number of people 18–64 years of age with AD (best estimate 2010)

Country	Prevalence of AD, %			Year	Number of people who were alcohol-dependent (2010)			Source
	women	men	total		women	men	total	
Austria	3.0	8.8	5.9	2004	79,700	235,700	315,400	[39]; this prevalence was derived from an overall prevalence of AD for Austria, and it was assumed that the age pattern in Austria followed the pattern in Germany [40]
Belgium ¹	2.3	6.3	4.3	2001/2002	76,300	211,000	287,300	Mean of two major surveys in 1 year (WMHS adjusted and Belgian Health Survey 2001, cf. GSRA); original age range corrected
Bulgaria	0.4	4.3	2.3	2003–2007	8,700	104,900	113,600	Data were part of WMHS; adjusted for methodological problems with algorithm for asking dependence; for a documentation of fieldwork [25, 26]; age range 18–79 in original study
Cyprus	1.6	5.3	3.5	2004	5,600	20,000	25,600	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
Czech Republic	0.8	5.0	2.9	1989–1999	28,000	178,700	206,700	WMHS; adjusted for methodological problems with algorithm for asking dependence [27]; age range 18–79 in original study
Denmark	2.2	5.6	3.9	2005	37,400	96,600	134,000	[94]; estimation taken into consideration adjustment for non-participation; 16+ population of Denmark in the original study was converted for 18- to 64-year-olds
Estonia	1.4	13.0	7.0	1999	6,300	53,600	59,900	[95]; no clear indication about age range in the original publication, so we assumed 18- to 64-year-olds
Finland	1.9	7.2	4.6	2000	31,500	121,900	153,400	[96] for under 30-year-olds; [97] for 30- to 64-year-olds [see also 98]
France	1.5	5.3	3.4	2001–2002	290,500	1,012,300	1,302,800	WMHS, adjusted for methodological problems with algorithm for asking dependence; original age range corrected [see also 99]
Germany ²	2.0	5.0	3.6	2009–2012	514,100	1,311,200	1,825,300	Mean of German Epidemiological Survey of Substance Abuse; ages 18–64 with n = 9,084 [53], and the German National Health Interview and Examination Survey for Adults conducted 2009–2012, age group 18–79 with 5,318 respondents [40, 100, 101]. For the latter survey, only the age groups 18–64 were used. Germany is the country with the most surveys on AD in Europe (see footnote 1 to the table)
Greece	1.5	4.8	3.2	2004	53,800	176,400	230,200	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
Hungary	3.7	10.1	6.8	2010	121,000	323,700	444,700	Hungarian Statistical Office; http://www.ksh.hu/ ; based on a version of the Jellinek formula; adjusted for age pattern of Bulgaria
Iceland	0.7	10.5	5.7	2005–2007	700	10,700	11,400	[102]; based on a census study of the greater Reykjavik area with sampling of all born in 1931, 1951 and 1971
Ireland	2.0	6.4	4.2	2004	28,100	91,400	119,500	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
Italy ³	<1	<1	<1	2001–2003	84,700	86,000	170,700	[28]; WMHS, too small numbers with AD to do proper statistical adjustments; the authors found 7 people with AUD in a sample of n = 4,712 people aged 18 years and older (general population), in the majority people with alcohol abuse only
Latvia	4.3	21.2	12.5	2011	32,500	149,300	181,800	[103]; estimate is for people aged 15–64 years
Lithuania	1.9	9.9	5.8	2004	21,200	102,900	124,100	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]

Table 1. (continued)

Country	Prevalence of AD, %			Year	Number of people who were alcohol-dependent (2010)			Source
	women	men	total		women	men	total	
Luxembourg	1.8	5.2	3.5		2,800	8,700	11,500	Mean of France and Germany
Malta	0.8	2.8	1.8	2004	1,100	4,000	5,100	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
The Netherlands ⁴	0.5	1.0	0.8	2007/2009	26,000	53,100	79,100	[104], 18–64 years old
Norway	1.8	6.1	4.0	1994–1997; 1997–1999	26,900	95,200	122,100	[52, 105], with the average of Oslo and rural sample taken: 18–65 years old
Poland ⁵	1.6	8.4	5.0	2004	209,100	1,078,100	1,287,200	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
Portugal ⁶	1.7	5.6	3.6	2004	58,500	188,800	247,300	Data from EU: http://ec.europa.eu/health/alcohol/policy/country_profiles/ based on [35]
Romania	0.7	2.2	1.5	2005/2006	50,400	156,300	206,700	[29] WMHS, adjusted for methodological problems with algorithm for asking dependence
Slovakia	1.3	9.2	5.2	2000/2001	24,400	172,300	196,700	MCSS only age groups 15–64 taken with age-specific prevalence weighted by population size
Slovenia	2.0	10.5	6.3	1999	13,300	72,000	85,300	GSRA (adjusted for screening scale), taken from [14]
Spain	0.2	1.2	0.7	2000/2001	29,700	182,400	212,100	WMHS, adjusted for methodological problems with algorithm for asking dependence
Sweden ⁷	3.8	6.4	5.1	2003–2007	107,300	186,400	293,700	[106]; only age groups 18–65 taken
Switzerland	1.6	8.1	4.9	2007	39,400	200,900	240,300	[34]
UK (England only) ⁸	3.9	9.9	6.9	2007	755,000	1,907,100	2,662,100	[55] https://catalogue.ic.nhs.uk/publications/mental-health/surveys/adul-psyc-morb-res-hou-sur-eng-2007/adul-psyc-morb-res-hou-sur-eng-2007-rep.pdf
European Union	1.7	5.2	3.4	2010	2,697,000	8,284,800	10,981,800	Own population-weighted calculation for 2010

The red-shaded cells indicate more than 150%, the green-shaded cells less than 50% of the EU average (color only in online version). If both women and men have the same shading, the country name is also shaded. GSRA = Global Status Report on Alcohol 2004 [107]; MCSS = Multi-Country Survey Study [33]; WHS = World Health Survey [108]; WMHS = World Mental Health Survey [109].

¹ Based on the CAGE with a criterion of at least two positive answers, 2.2% of women 65 years and older, and 7.1% of men in that age range were screened for AD [110]. ² There are several regional studies in Germany (see overview for studies until 2005 [14]) as well as two traditions of national surveys: the German National Health Interview and Examination Survey [40] and German Epidemiological Survey of Substance Abuse [53]. The prior wave of the German National Health Interview and Examination Survey for Adults conducted 1997–1999 found similar data: 1.3% for women and 5.4% for men for the age group 18–64 [31, 32]. See text for a description of prevalence trends over time. ³ The Istituto Superiore di Sanita estimates the prevalence

to be 2% overall [111]. No details about the methodology were given. See also [112] for a discussion of the prevalence of AD in Italy. Numbers of people afflicted were based on 0.45%. ⁴ The prevalence of abuse was found to be 5 times higher. AUDs as the sum of AD and abuse have been stable for the past decade [54], but AD estimates had been considerably higher in the preceding survey [58]. ⁵ The prevalence of AD in primary healthcare was found to be 19% using the CAGE screening scale [113]. ⁶ The national survey for 2012 found a prevalence of 0.3% for AD based on AUDIT thresholds in the age group 15–74 [114]. ⁷ The Part Study showed 3.3% for women and 7.7% for men [see 14, 115; see also 116]. ⁸ There are other estimates such as the one cited by the National Institute for Health and Clinical Excellence [117], which amounted to 6% of men and 2% of women. The prevalence for Northern Ireland was substantially lower in 1993/1994 (1.4% for both sexes [118]). There is another study on Northern Ireland as part of the WMHS (field work 2004–2008) which showed a prevalence rate of 4.2% when adjusted for independent assessment of abuse and dependence [119].

included in our systematic review were prevalence estimates of AD that were derived from screening scales such as the Alcohol Use Disorders Identification Test (AUDIT) [36] or the CAGE questionnaire [37]; however, these estimates are provided as footnotes to table 1, if no estimate form the highest priority was available, or used in other parts of the paper (for trends, if there were comparable surveys).

Age Standardization and Estimation of the Number of People Affected

Population estimates in 5-year intervals were obtained from the United Nations 2008 population revisions [38]. If prevalence data for AD were reported by sex and age, we used weighted averages of the various age groups to formulate population estimates. If only estimates of AD for wider age groups (such as for Austria

[39]) were provided, we used the age structure of an adjacent country with a similar drinking pattern to estimate the prevalence of AD for people 18–64 years of age (for example, in the case of Austria, we used the German survey [40]).

Countries and Regions Examined

The prevalence of AD was examined for the 2010 members of the EU and for Iceland, Norway, and Switzerland. Regions used in this analysis were defined as follows: Central-West and Western Europe (Austria, Belgium, France, Germany, Ireland, Luxembourg, the Netherlands, Switzerland, and the United Kingdom); Central-East and Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia); Southern Europe (Cyprus, Greece, Italy, Malta, Portugal, and Spain), and Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden).

Modelling the Associations between Alcohol Dependence and Various Measures

The following factors were tested for association with gender-specific AD rates: gross domestic product per capita adjusted for purchasing power parity (GDP-PPP), adult per capita total consumption of alcohol, patterns of drinking scores, liver cirrhosis mortality, injury mortality, and alcohol-attributable mortality.

GDP-PPP data for 2010 were obtained from the World Economic Outlook Database of the International Monetary Fund [41]. Adult per capita consumption of alcohol was composed of recorded, tourist, and unrecorded consumption. Data on per capita consumption were obtained from the WHO Regional Office for Health (for the databank and definitions, see <http://www.euro.who.int/en/what-we-do/data-and-evidence/databases/european-health-for-all-database-hfa-db2>, and [42]). Data were for 2010 and identical to data from the WHO in the Global Information System for Alcohol and Health (GISAH) (<http://www.who.int/gho/alcohol/en/index.html>). The proportion of unrecorded consumption in Europe to total per capita consumption was found to be lower than the global estimates (see [42]; for a general discussion of the term, see [43]). The pattern of drinking score is a population summary measure that indicates how alcohol is consumed. It is comprised of four indicators of heavy drinking occasions and intoxication, one measure of drinking in public places, and one measure of drinking with meals [44, 45]. Patterns of drinking scores were obtained from the GISAH. The prevalence of heavy drinking, defined as 60 g and more of ethanol/day for men or 40 g and more for women (for the thresholds in the definition, see [49]) was estimated using the methodology developed for the CRA [46–48] and was calculated using data on per capita consumption and lifetime abstinence obtained from the GISAH. Alcohol-attributable mortality (using the categories of liver cirrhosis, cancer, and injury) were obtained from a WHO European region publication [50].

All associations were modeled using Pearson product-moment correlation coefficients using the statistical software package R (version 3.0.1) [51].

Results

Based on data from population studies, close to 11 million (10.98) adults 18–64 years of age were estimated to be alcohol-dependent in the EU in 2010, with approx-

imately 3 times more men than women being alcohol-dependent (see table 1 for details). Adding AD estimates for Iceland, Norway, and Switzerland to the EU estimates, the total number of individuals who were alcohol-dependent increased to 11.36 million; however, the underlying prevalence of AD did not noticeably change. The main results of the review are summarized in table 1, showing a lack of quality data as defined by the highest priority.

The overall prevalence of alcohol abuse including all comparable ages was approximately equal to the prevalence of AD (lower prevalence of abuse: Germany [40], Norway Oslo [52]; about the same, $\pm 0.3\%$: Germany [53]; higher prevalence of abuse: the Netherlands [54], Norway rural [52]; in Slovakia, in the WHO multi-country study [33], women had a higher prevalence of alcohol abuse and men had a higher prevalence of AD). These results included only studies that independently measured AD and alcohol abuse, so the WMHS results were excluded since dependence in those surveys was only assessed if there was at least one symptom of abuse. The observation of approximately equal prevalence of AD and alcohol abuse was corroborated by earlier European studies (listed in [14]).

In terms of age, the proportion of abuse among all AUDs is larger in young adults [14], which is consistent with the assertion that more severe AD can be observed in later age groups [55]. Overall, among people 18–64 years of age, we estimate that approximately 23 million people in our studied countries have an AUD, as defined by AD or abuse/harmful use.

Trends in the Prevalence of Alcohol Use Disorders over Time

Data on AD that are comparable over time were available for only a few countries, and often based on screening scales or other more indirect measures for AUDs. For Belgium, the National Health Interview Survey used the CAGE screener as a comparable indicator; according to the CAGE screener, the prevalence of AUDs increased among women (6.6, 7.8, and 10.2% for 2001, 2004, and 2008, respectively), and among men (9.2, 10.5, and 13.1% for 2001, 2004, and 2008, respectively) [56]. Additionally, between 2001 and 2008, an increase in the prevalence of AUDs defined by CAGE was observed for all age groups for both women and men (https://www.wiv-isp.be/scripts92/broker.exe?_service=default&_program=phisia.alcohol08.sas).

In Germany, data on AUDs based on DSM-IV diagnostic criteria and a standardized methodology [57] have been available since 1997, allowing for comparisons over

Table 2. Correlations between the prevalence of AD and variables hypothesized to be associated with AD (EU countries, Iceland, Norway, and Switzerland, 2010)

	Women			Men			Total		
	r ¹	95% CI	p value	r ¹	95% CI	p value	r ¹	95% CI	p value
Gross domestic product (purchasing power parity)	0.07	-0.30–0.42	0.710	-0.22	-0.54–0.15	0.245	-0.16	-0.49–0.21	0.404
Per capita consumption	0.17	-0.21–0.50	0.383	0.25	-0.12–0.56	0.179	0.24	-0.13–0.56	0.192
Unrecorded consumption ²	-0.02	-0.38–0.34	0.922	-0.06	-0.41–0.31	0.772	-0.06	-0.41–0.31	0.763
Patterns of drinking score ³	0.27	-0.10–0.58	0.145	0.63	0.35–0.81	0.000	0.59	0.29–0.78	0.001
Prevalence of heavy alcohol consumption ⁴	0.24	-0.13–0.55	0.199	0.18	-0.19–0.51	0.333	0.23	-0.14–0.55	0.219
Liver cirrhosis mortality	0.08	-0.33–0.46	0.713	0.25	-0.16–0.59	0.234	0.21	-0.21–0.56	0.324
Injury mortality	0.62	0.30–0.82	0.001	0.39	0.01–0.68	0.054	0.45	0.07–0.72	0.024
Alcohol-attributable liver cirrhosis, cancer and injury deaths	0.21	-0.20–0.56	0.304	0.47	0.09–0.73	0.018	0.39	0.00–0.68	0.053

¹ Pearson product-moment correlation coefficients. ² Unrecorded consumption in liters adult per capita (see above and WHO [21]). ³ Pattern of drinking score (see Methods above and Rehm et al. [44, 120]). ⁴ On average a consumption of alcohol ≥ 60 g/day for men and 40 g/day for women.

time. Within the German Epidemiological Survey of Substance Abuse, AUD criteria were assessed using the Munich Composite International Diagnostic Interview (M-CIDI). AD was measured in 1997, 2000, 2006, and 2012, and comparisons can be made for both sexes for people 18–59 years of age [53]. Twelve-month prevalence estimates revealed a significant increase in the prevalence of AD in men between 2006 (4.0%) and 2012 (5.2%), with a constant prevalence in the previous surveys before 2006. Similarly, a significant increase in the rate of AD in females can be observed between 2006 (1.5%) and 2012 (2.1%). Rates in 1995 and 2000 were 1.0 and 1.2%, respectively. For alcohol abuse, the data were relatively stable, with the prevalence of abuse being higher overall than the prevalence of AD [53, 57]. Thus, for the period of 1995–2012, the data suggest an increase in the number and rate of people with AD (and AUD) in the general population in Germany.

For the Netherlands, the prevalence of AUDs did not change between 1996 and 2009 [54] when the values from 1996 were statistically adjusted for differences in the diagnostic instrument and CIDI version used. However, AD seems to have decreased from 4.3 to 0.7% [54, 58]. This decrease may be explained by the use of the WMHS procedure of asking dependence questions only of those people who answer affirmatively to abuse questions; however, the description of the exact methodology used was unclear [54], and thus we did not adjust the 2009 prevalence. For Switzerland, only comparisons based on different versions of the AUDIT were available (versions differing in the operationalization of the consumption questions), and they seem to indicate stability of prevalence of people with an AUDIT score of 16 and more between 1997 and 2012 (all

prevalence below 1% [59, 60]). Overall, for those countries with comparable assessments, the prevalence of AUDs seemed to remain stable or may be increasing. However, the lack of studies with comparable quality indicators was even more apparent for trends than for rates.

Associations between the Prevalence of Alcohol Dependence and Hypothesized Correlates

Corroborating the results of the last review [14], patterns of drinking scores had the highest level of association with the prevalence of AD among men; however, this association was not significant for women. In contrast, the measures of per capita total and unrecorded consumption of alcohol and the prevalence of heavy alcohol consumption were found to be not significantly associated with the prevalence of AD for either men or women. A significant association was found between the prevalence of AD and injury mortality for women (a non-significant association was observed for men); however, the associations between liver cirrhosis mortality and all alcohol-attributable deaths (liver cirrhosis, cancer and injury) and AD were not significant for either women or men. Additionally, the economic wealth of a country in Europe (measured as GDP-PPP) had no association with the prevalence of AD for either men or women. Table 2 outlines the associations between the prevalence of AD and the hypothesized correlates for women, men, and the total population.

Heavy Drinking and Alcohol Dependence

Figures 1 and 2 outline the prevalence of AD and heavy alcohol consumption by region in Europe in 2010 for women and men 18–64 years of age respectively. In 2010

Fig. 1. Prevalence of alcohol dependence and heavy alcohol consumption (40+ g of ethanol/day) in Europe by region in 2010 for women.

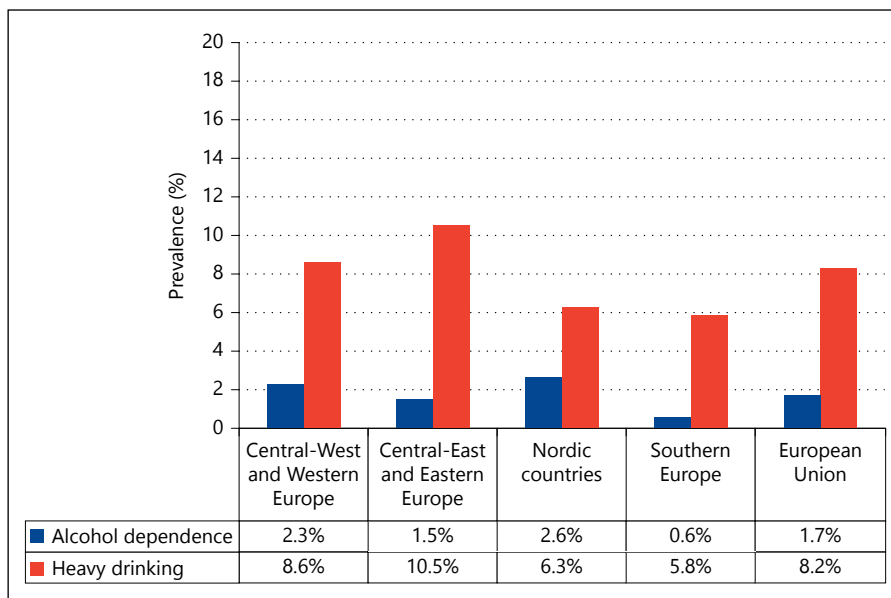
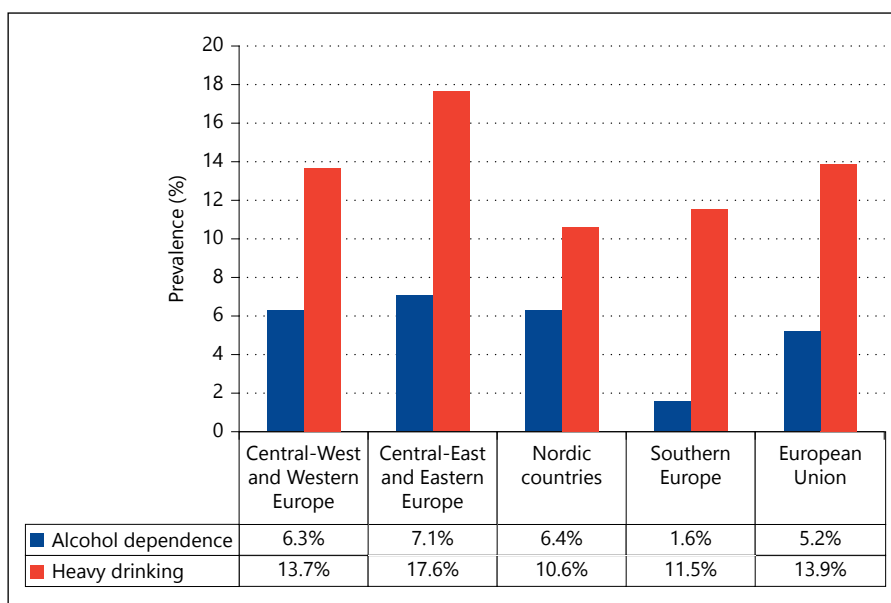


Fig. 2. Prevalence of alcohol dependence and heavy alcohol consumption (60+ g of ethanol/day) in Europe by region in 2010 for men.



in the EU, 3.5% of people 18–64 years of age were estimated to be alcohol-dependent, while 11.1% were estimated as heavy drinkers. The ratio of people who were alcohol-dependent as compared to the number of people who were heavy drinkers varied by sex and region. For men in the EU in 2010 the prevalence of heavy drinking was 2.7 times the prevalence of AD, while for women the prevalence of heavy drinking was 4.9 times the prevalence of AD. Within Europe, the South had the highest ratio, with the prevalence of heavy drinking being 8.1 times the

prevalence of AD, while Nordic countries had the lowest ratio, with the prevalence of heavy drinking being 1.9 times the prevalence of AD.

Discussion

This study found that AD and AUDs are common in the EU. We estimated that in 2010 approximately 11 million adults in the EU were alcohol-dependent and that

more than 22 million adults in the EU qualified as having AUDs. The AUD estimates may become important when systems of care shift to treatments in accordance with the DSM-5 [61]. The prevalence of alcohol abuse was higher in young adults [14], which is consistent with the notion that more severe AD was found in the later age groups [9, 55].

The prevalence figures for AD presented in this paper may be underestimated as they are derived from general population surveys which do not include special and marginalized groups such as the homeless, people who are incarcerated, and people who are institutionalized [62]. In marginalized groups, heavier drinking patterns and a markedly higher prevalence of AD and AUDs are common. For example, in a systematic review of mental illness among homeless men in Western societies, Fazel et al. [63] found a pooled prevalence estimate of 38% for AD, with two factors being associated with the heterogeneity across studies: the more recent the study (as analyzed by decade), the higher the prevalence of AD, and studies from mainland Europe showed a higher prevalence of AD. For instance, two German studies observed a prevalence of AD that exceeded 50% among the homeless [64, 65], and in Ireland alcohol was found to be the most prevalent drug among the homeless, with alcohol problem rates above 70% as measured with the AUDIT [66]. Furthermore, in the Irish study, 13% of respondents named alcohol problems as the main reason for them becoming homeless.

AD has also been found to be highly prevalent in incarcerated populations [67]. In their systematic review, Fazel et al. [67] found that the prevalence for alcohol abuse and AD among males who were incarcerated ranged from 18 to 30%, and ranged from 10 to 24% among females who were incarcerated. Additionally, in a representative study of Irish males who were incarcerated remand, a 6-month prevalence of 28.8% for AD and 39.3% for AUDs was observed (alcohol abuse and AD were defined to be exclusive [68]). In two English prisons in 2003, the prevalence of AD was 57% among men [69]. In a Greek prison, 37.5% of a randomly drawn sample of male inmates were diagnosed as having AD [70]. In a study of male inmates of a French prison in 2004, 19% were alcohol-dependent [71].

It has been observed in numerous studies that AD and AUDs show a high comorbidity with somatic and mental disorders, and thus are significantly more prevalent in both acute and psychiatric hospital wards [72, 73].

Thus, in specialized and marginalized populations not covered in surveys there is a much higher prevalence of

AD and AUDs when compared to the general population. This indicates that the prevalence figures presented in our paper markedly underestimate the true prevalence; however, additional research is needed on the exact size of homeless, incarcerated and other institutionalized populations in various European countries to determine the extent of the underestimation of the population prevalence of AD. It is conceivable that this underestimation may be substantial [74]. In their working document titled 'Confronting Homelessness in the European Union' (<http://ec.europa.eu/social/BlobServlet?docId=9770&langId=en>), the EU referred to 410,000 homeless people (defined as being without a house or a roof on any given night in the EU). This could imply that about 4.1 million people in the EU are exposed to rooflessness and houselessness over the span of 1 year for a shorter or longer period (calculations consistent with being based on 'any' night, combined with assumptions on the length of homelessness). Based on this prevalence, the overall number of people with AD in the EU would increase by an additional 1.5 million if homeless people were accounted for in the surveys. The additional numbers coming from incarcerated people would be comparatively lower, with about 200,000 additional people with AUD (based on the meta-analyses above and incarceration rates from <http://www.nationmaster.com/country-info/stats/Crime/Prisoners/Per-capita>).

We also hypothesize that marginalized populations overproportionally contribute to the harms which result from AD and AUDs, illustrated, for example, by the high standardized mortality rates associated with people with AD in treatment compared to the general population [7]. This finding may be the result of including some marginalized groups in treatment programs.

With respect to the associations examined in this paper, we found no association of AD with wealth at the between country level; however, this observation was expected as the strong correlations between economic wealth and alcohol consumption are restricted to low- and middle-income countries [75, 76]. We would have expected much stronger correlations of AD with both alcohol exposure (heavy drinking) and especially outcome (liver cirrhosis, injury). Additionally, heavy drinking is not included in the definition of AD and AUDs, as these are defined and measured by a number of criteria, some of which are based on loss of control, as specified in the ICD-10 or DSM IV (see above). It should be noted, however, that loss of control is perceived differently in different cultures [77, 78], which may seriously distort the relations with other variables. Where loss of control is stig-

matized in countries like Italy, Spain, and France, in Nordic or Central Eastern European countries loss of control may be one of the reasons why people drink. Thus, 'admitting' to losing control equates in some countries to a statement that people had a good time, while for countries in the South or Central West of Europe such an admission is perceived as a weakness. We believe that these cultural differences are at the core of the multifold differences in the prevalence of AD between these regions [79]. Accordingly, it seems that AUD prevalence is very culture-specific, and thus correlations with other health indicators are biased downwards because of the high culture-specific variability. Heavy drinking rates may be the better indicator for public health and health-care planning [11, 79, 80]. Other factors contributing to the low prevalence of AUDs in the South of Europe may be lack of training in physicians, leading to perceptions that some less severe AUDs may be 'normal drinking' [81].

Additionally, other alcohol-related, genetic, and social factors, such as alcohol excise prices, taxation rates and taxation types [82], alcohol availability [83, 84], alcohol marketing policies [85], prevalence of people with variants in the genes that metabolize alcohol such as *ALDH2* [86], prevalence of various religions [87], emancipation of women [88], and unemployment rates [89], have also been hypothesized to be causally related to alcohol consumption and/or AD rates. In future studies associations with these variables should be explored.

Other limitations of our work include measurement errors stemming from the different operationalizations of AD and AUDs in different countries (table 1). Thus, it is not only the different cultures which impact on answers to assessment instruments. There are also substantial differences in how AD is measured, from the Statistical Office making estimations based on the liver cirrhosis rate in Hungary, to various assessments in different countries using variants of the CIDI, and a variety of operationalizations in between (table 1). Multifold differences can result from only asking questions on AD of people who show at least one criterion of abuse. Moreover, the variants of the CIDI are different with respect to who will be asked any question on AUDs (e.g. all drinkers or all drinkers who consumed above a threshold). These different operationalizations create biases, which are reflected in the final comparisons. Additional systematic work on assessing AUDs may necessary to be able to compare the prevalence of AUDs in European countries, e.g. a comparative survey in the EU using standardized methodology.

However, given the cultural specificity of criteria and the relatively low correlations with outcomes, it may be more advisable to invest into better ways to comparatively measure heavy drinking. Heavy drinking over time may be a better indicator for what we currently call an AUD, as it is better linked to biological and biochemical definitions as a brain disease, as well as to health and social outcomes [79, 80]. As an example from the dataset we used in this study, AD prevalence was associated with liver cirrhosis, one of the main outcomes of AD, with Pearson correlations of $r = 0.08$ for women, and $r = 0.25$ for men; the associations of AD with heavy drinking were $r = 0.57$ for women and $r = 0.58$ for men. Relying on heavy drinking as the best definition may also reduce the very high stigmatization of AD [90], as it could be handled similarly to continuous indicators such as blood pressure (for the association between continuous indicators and stigma, see [91]), and different interventions could be planned to reduce drinking without necessarily involving a label such as dependence or addiction [79, 92]. Of primary importance is that reducing drinking has been shown as an effective form of treatment for AD, and has been linked to reductions in mortality and disability as well as to reductions in social harms [79, 93].

Acknowledgements

The research leading to these results has been conducted in the context of the European Community's Seventh Framework Programme under grant agreement No. 266813 – Addiction and Lifestyles in Contemporary Europe-Reframing Addictions Project (ALICE-RAP). Participant organizations in ALICE-RAP can be found at <http://www.alicerap.eu/about-alice-rap/partners.html>. We would like to thank all members of the WP5 on counting addictions for contributing to this research. The Ontario Ministry of Health and Long-Term Care has provided support to CAMH for the salary of J.R. The contents of this paper are solely the responsibility of the authors, and do not necessarily represent the official views of the Ministry of Health and Long-Term Care or other funders.

Disclosure Statement

No funding other than acknowledged above was received for conceptualizing or writing the article. With respect to funding from the pharmaceutical industry involved in the treatment of substance use disorders, which could be perceived as a potential conflict of interest, A.G. received honoraria and consultancy fees from Abbvie, D&A Pharma and Lundbeck. L.K. received funding for a research project from Lundbeck. J.R. received honoraria and unrestricted educational grants from Lundbeck.

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