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Estimating alcohol-attributable fractions for injuries based on data from emergency department and observational studies: a comparison of two methods

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Abstract

Aim: To compare the injury alcohol-attributable fractions (AAFs) estimated using emergency department (ED) data to AAFs estimated by combining population alcohol consumption data with corresponding relative risks (RRs).

Design: Comparative Risk Assessment

Setting and participants: ED studies in 27 countries (n = 24,971)

Measurements: AAFs were estimated by means of an acute method using data on injury cases from 36 ED studies combined with odds ratios obtained from ED case-crossover studies. Corresponding AAFs for injuries were estimated by combining population-level data on alcohol consumption obtained from the Global Information System on Alcohol and Health with corresponding RRs obtained from a previous meta-analysis.

Findings: ED-based injury AAF estimates ranged from 5% (Canada 2002 and the Czech Republic) to 40% (South Africa), with a mean AAF across all studies of 15% (19% for males and 8% for females). Population-based injury AAF estimates ranged from 21% (India) to 51% (Spain and the Czech Republic), with a mean AAF across all country-years of 37% (43% for males and

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23% for females). The Pearson correlation coefficient for the two types of injury AAF estimates was 0.09 for the total, 0.06 for males, and 0.32 for females.

Conclusions: Two methods of estimating the injury alcohol-attributable fractions (AAFs) – emergency department data versus population method - produce widely differing results. Across 36 country-years, the mean AAF using the population method was 36.8%, more than twice as large as emergency department data-based acute estimates, which average 15.4%.

INTRODUCTION

Alcohol is a leading risk factor for mortality globally, accounting for 5.1% of all deaths in 2016 (1). A substantial proportion of alcohol-attributable deaths result from injuries (38% and 34% of male and female alcohol-attributable deaths respectively, according to (2)). The method used to calculate the alcohol-attributable fractions (AAFs) is critical to determining the accuracy of the results. Accurate estimates of injuries attributable to alcohol are needed to formulate effective public health policies (3). There are some unique features of the estimation of injury mortality and morbidity AAFs, given that the onset of an injury is usually abrupt and the effect of alcohol on such injury is acute and transient (4, 5). Thus, the causal mechanism of alcohol's effect on the risk of injury differs from the accumulative and long-term exposure effects of alcohol on the risk of most chronic diseases, and this distinction needs to be taken into consideration when estimating the AAFs of injury mortality and morbidity.

Traditionally, AAF estimates for injury were based on a 'direct' estimation method (6), where criteria (in the case of injuries, a blood alcohol concentration (BAC) above a certain threshold) are applied to case-series samples with the intent of identifying those injuries where alcohol likely played a causal role. For example, in the United States, alcohol-attributable motor vehicle deaths were assessed by the proportion of deaths among fatal crashes where the driver had a BAC ≥ 0.10 g/dL (7). However, this direct method is limited as BACs above this threshold may not necessarily lead to injuries, and there is an increased risk of accidents even at a modest departure from zero BAC (8). Alternatively, the AAF for injuries can be estimated using a Levin-based approach (9), in which AAFs are calculated by combining the prevalence of exposure with corresponding relative risks (RRs) or Odds Ratio (ORs; used to approximate the RRs). The indirect 'acute method' of estimating the AAFs combines data on alcohol consumption before an injury (i.e., acute exposure) with corresponding ORs obtained from case-crossover or case-control studies (where the AAFs are estimated among cases only). Alternatively, the AAFs for injuries can also be estimated using an indirect "population method," where population measures of alcohol consumption (e.g., *per capita* consumption (PCC) and survey-based drinking prevalence (average and binge alcohol consumption)) are combined with corresponding RRs.

These three methods have been used in the estimation of the burden of injuries attributable to alcohol consumption in various settings. The direct approach (based on a BAC cut point of ≥ 0.10 g/dL) using case-series samples from medical examiner studies (10, 11) has been used by the United States Centers for Disease Control and Prevention to estimate the AAFs for non-traffic injuries (12). The indirect acute method, together with the direct method, was

used to estimate the injury mortality AAFs in Australia (6, 13). The indirect acute method was also used to estimate the AAF for injury morbidity from emergency department (ED) injured patient samples (14–16). In the 2000 Global Burden of Disease (GBD) study, Australian injury AAFs estimated using indirect acute and direct methods (6, 13) were scaled to other countries based on their populations' alcohol consumption (2, 17). For the 2010 GBD study (18), population AAFs for injuries were estimated by combining population-level data on alcohol consumption with the RR of injury from acute drinking based on case samples (19–21). The most recent method for the estimation of the population AAFs for injury, used in the 2014 Global Status Report on Alcohol and Health and in subsequent World Health Organization (WHO) regional reports (22, 23), combined the population consumption prevalence of alcohol consumption, including binge drinking, with the RR of injury based on average volumes of alcohol consumption from the Corrao meta-analysis (24), modified to account for binge drinking.

This constant evolution in methods to estimate AAFs for injuries reflects the challenges epidemiologists face when attempting to estimate AAFs with accuracy and precision. The 'acute method' has the advantage of linking directly the exposure to the event, yet it demands representative case sample data. The population method uses population-level alcohol consumption data which have a greater availability and a relatively higher accuracy of measurement; however, the validity of this approach is unknown because it assumes that the causal mechanism of alcohol's effects on the risk of injury is similar to that for chronic diseases. Despite the differences in source data and estimation approaches, no effort has been made to compare the acute and population methods directly. Accordingly, the aim of this study was to compare the injury AAFs estimated using ED data for 27 countries to injury AAFs estimated using population-level alcohol consumption data.

METHODS

Injury AAFs were estimated using (i) an acute method based on exposure and corresponding OR data from ED studies, and (ii) a population method based on population-level alcohol consumption data and corresponding RRs from a previously performed meta-analysis. When the ED studies spanned two years (e.g., Tanzania 2013–14), population AAFs took the average of the two-year estimates. These AAFs were then compared at the country level by examining the ratios between the two sets of estimates. Furthermore, as the Global Information System on Alcohol and Health tracks population drinking prevalences from 1990 onward, the drinking prevalence for 1990 was used to estimate population AAFs when making comparisons to ED studies conducted before 1990.

Injury alcohol-attributable fractions based on emergency department data

Acute method AAFs of injury based on ED injury data were estimated using Formula 1, in which P_{ci} is the prevalence of acute consumption at a given level among injured patients, and OR_i is the OR of injury at that level compared to no alcohol consumed. A detailed description of injury AAF estimation using the combined ED data can be found elsewhere (16). For this analysis, data on acute drinking before an injury were obtained from specific

ED studies, while the OR for injuries (based on fractional polynomial functions) was obtained from the case-crossover analysis of combined ED studies (25).

$$AAF = \sum P_{ci} (1 - \frac{1}{OR_i}) \quad [\text{Formula 1}]$$

The combined ED data from 36 studies in 27 countries constituted a total sample size of 24,971 injured patients. These data were obtained from the International Collaborative Alcohol and Injury Study (ICAIS) (26), which includes data from four international collaborative research projects: the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) (27), and three other international collaborative studies conducted by the WHO (28), the Pan American Health Organization (PAHO) (29), and the United States National Institute on Alcohol Abuse and Alcoholism. Full information regarding the included ED studies, such as the city where each study was performed, study design, and references is provided in the supplemental material (Table S1). In each ED study, acute alcohol exposure was measured by asking injured patients whether they had consumed any alcohol within 6 hours before the injury event, and, if yes, how much they had consumed. Volume of consumption was assessed from the beverage-specific number, size, and alcohol concentration of drinks, covering all alcoholic beverage types, including those commonly consumed locally, to determine acute exposure before injury. Bootstrap Confidence Intervals (CI) for ED-specific AAFs as well as the mean AAFs across studies were derived by resampling 1000 replications (16).

Injury alcohol-attributable fractions based on population-level data

The population method of estimating the AAFs of injury used Formula 2, based on the methods of a 2016 WHO Europe report (23). Specifically, the population AAFs were estimated by combining data on the prevalence of past year abstainers (P_{abs}), the probability density for current drinkers at a given average volume of alcohol consumption ($P_{cd}(x)$), the corresponding RR for current drinkers at a given consumption ($RR_{cd}(x)$), the prevalence of binge drinkers (at least one occasion with an intake of at least 60g of pure alcohol in the past 30 days) among current drinkers (P_{bd}), and a RR scaling factor for the RR based on the population prevalence of binge drinkers (SF_{bd}).

$$AAF = \frac{\int_{>0}^{150} P_{cd}(x) (RR_{cd}(x) - 1) P_{bd} SF_{bd} dx}{P_{abs} + \int_{>0}^{150} P_{cd}(x) RR_{cd}(x) P_{bd} SF_{bd} dx} \quad [\text{Formula 2}]$$

Data on alcohol consumption were obtained from the Global Information System on Alcohol and Health (30). Prevalences of past year abstainers, current drinkers, and binge drinkers were based on population surveys. The average volume of alcohol consumed among current drinkers was estimated using the PCC of alcohol (using a correction factor of 0.8 to account for (i) alcohol produced but not consumed, and (ii) undercoverage of alcohol

consumption in epidemiological studies which were used in estimating the corresponding RR estimates (31)) and the relative consumption among current drinkers by sex (obtained from population surveys). The distribution of alcohol consumption among current drinkers was modeled using a gamma distribution (31), where the standard deviation of this distribution was predicted using the mean based on an analysis by Kehoe and colleagues (31).

RR estimates for injury based on average daily alcohol consumption were obtained from the meta-analysis by Corrao and colleagues (24). A gender-specific scaling factor was applied to these RR estimates, which accounts for the increased risk of injury for binge drinkers (23). Since the majority of the 12 studies included in Corrao and colleagues' meta-analysis involved injured patients seeking treatment rather than deaths from injury as the outcome, the binge drinking scaling also upshifts the effect of average daily consumption to characterize injury mortality. Specifically, based on preliminary data from the 2014 Global Status Report on Alcohol and Health (22)), the scaling coefficients (SCs) for men and women were constructed such that the minimum adjustment factor was 1 for men and women (for the country with the lowest prevalence of binge drinkers among current drinkers) and the maximum adjustment factor was 2 for men and women (for the country with the highest prevalence of binge drinkers among current drinkers). The scaling coefficient can be expressed according to Formula 3, where P represents the prevalence of binge drinkers among current drinkers, and CF represents a correction factor which was estimated so the SC ranged from 1 to 2.

$$SC[1, 2] \text{ where } SC = P * CF + 1 \quad [\text{Formula 3}]$$

Gender-specific AAFs were first estimated, and then combined with country-level injury mortality data to derive the AAFs for the total population. CIs for population AAF estimates were generated using a Monte Carlo-like procedure, based on simulating 1000 AAFs which were estimated by sampling the lowest level parameters from their respective error distributions.

RESULTS

Table 1 outlines the prevalence of acute drinking before injury and injury AAF estimates based on ED data for 27 countries for the total sample and by gender. Estimates of 36 studies are presented, with several countries having multiple ED studies across years. Large variations in the AAF estimates were observed across years for New Zealand, Canada, and Mexico, while consistent estimates were found for China and the United States. The total ED injury AAF estimates ranged from 5% (Canada 2002 and the Czech Republic) to 40% (South Africa). The mean estimate across 36 studies was 15.4% (CI: 15.0–15.9%, median 15.5%) for the total, 18.9% for males (CI: 18.3–19.5%, median 18.6%), and 8.4% for females (CI: 8.1–8.8%, median 7.0%).

Table 2 shows the population-based injury AAF estimates for the same 27 countries, matching country-years of ED studies. Across the 36 country-years, the population injury

AAF estimates ranged from 21% (India) to 51% (Spain and the Czech Republic). The mean population AAF was 36.8% (CI: 35.5–38.1%, median 37.3%) for the total, and 42.5% (CI: 40.7–44.3%, median 43.6%) and 22.5% (CI: 21.8–23.2%, median 22.1%) for males and females, respectively. As a sensitivity analysis, when the AAFs were estimated without adjustment for binge drinking, they ranged from 2.4% to 13.1%, with an average of 8.6%, much lower than the AAF estimates outlined above using either the population or acute method. A sensitivity analysis was performed which excluded the pre-1990 studies. The mean AAFs across country-years for the studies included in the sensitivity analysis were similar to the mean AAFs across all studies.

We then compared directly the two estimation methods across the 36 studies. The correlation coefficient for the two types of AAF estimates was 0.09 (CI: –0.05–0.24) for the total, 0.06 (CI: –0.13–0.25) for males, and 0.32 (CI: 0.23–0.42) for females. Figure 1 shows the ratio between population- and ED-based total AAF estimates, sorted from the lowest ratio to the highest. AAFs from multiple years' data were averaged into one estimate per country in Figure 1 to reduce variations, particularly among ED-based estimates. South Africa was the only country with an ED AAF higher than the population estimate (ratio = 0.96), and the population estimate was 10 times as large as the ED-based AAF for the Czech Republic (ratio = 9.9). The mean ratio across countries was 2.4. Using the 20% range of mean ratios (2.0–2.8) as the standard, seven countries (the Czech Republic, Poland, Brazil, Sweden, Spain, Canada, and Costa Rica) were at the upper end, with population AAF estimates much larger than ED-based AAFs, while five countries (South Africa, India, Guatemala, Nicaragua, and Tanzania) were at the lower end. The CIs for the AAF estimates and the country-specific ratios are presented in the supplemental material (Table S2 and S3).

DISCUSSION

The injury AAF estimates using the two methods differed widely with the relative difference between AAFs estimates being inconsistent. Across 36 country-years, the mean AAF using the population method was 36.8%, more than twice as large as the ED-based acute estimates which were 15.4% on average. Notably, for the Czech Republic, the ED-based AAF was 5.1%, while the population based AAF was 51%. Given the low correlation between the two sets of AAF estimates, there is a need to further investigate the potential biases and limitations of these methods, which method has greater validity, and what improvements can be made to generate more accurate AAF estimates.

Several biases affect the accuracy of the ED-based injury AAFs. While injury samples in the EDs covered all shifts and day of the weeks, unrepresentativeness can still arise both at the regional level (i.e., whether the region/city represents the country as a whole) and at the ED level (i.e., whether ED injured patients represent the morbidity of the given region). Secondly, for ED studies, non-response bias is another source of limitation, as non-respondents are more likely to have consumed alcohol before their injury than are respondents. The ED-based AAF estimates seem unrealistically low for the Czech Republic (5.1%) and Poland (8.5%), especially considering the high prevalence of binge drinking in these two countries. Furthermore, for the Czech Republic, the ED sample may not be representative as the emergency medicine system in the country delivers critically ill patients

to hospital Intensive Care Units (ICUs) (32, 33). Similarly, the ED-based AAFs for Brazil and Costa Rica (9.2% and 6.9% respectively) are relatively low when compared to the estimates for other countries in the Central and South America regions. Additionally, the ED-based AAF estimates for Canada in 2002 (4.6%) are relatively low compared to the Canadian ED-based AAFs for 1990, 2009, and 2014. This may be the result of data for the 2002 estimates having been collected from a health center located in an Ontario town, which center served an area with a much smaller percentage of minorities and an unemployment rate one-half the rate of the province of Ontario. Thirdly, several ED studies were quite old (earlier than 1990s), making comparisons with population data difficult. Lastly, the OR estimates used in the ED-based AAFs which were derived from case-crossover analyses may be biased upward (34); however, the ED-based AAFs were on average less than the population-based AAFs.

Several biases affect the accuracy of the population-based injury AAFs. Firstly, the RRs are based on epidemiological studies which have inherent biases by design (24). In addition, a scaling factor was applied to the RRs from Corrao and colleagues (24). This correction assumes that the effect of binge drinking on injury relates to average volume and has no independent effect on risk. Thus, the population-based AAFs may be overly sensitive to country-level PCC. As an example of the sensitivity of the population approach to PCC, India, Guatemala, and Nicaragua were among the countries with the lowest population AAF estimates, mainly due to their low PCC. In contrast, their ED-based AAF estimates were all higher than the cross-country average.

The population method does not account for the social and cultural differences related to drinking across countries (e.g., the RR may be higher in countries where drinking in bars and at social events is more popular). Furthermore, some discrepancies in the results may be explained by the various countries' Pattern of Drinking Score (PDS) which covers multiple dimensions, such as festive drinking, drinking in public places, drinking with meals, and heavy drinking (17, 22). Almost all WHO Member States have risky drinking scores between 1 and 4, with the exception of Russia and the Ukraine having the most detrimental score of 5. Based on the PDS, the pattern of drinking is riskier in all five countries at the lower end of the ratio graph (South Africa, Guatemala, and Nicaragua scored 4, and Tanzania and India scored 3), which may partly explain the relatively higher ED-based AAF estimates for these countries. The population method also does not account for the effect of alcohol control policies (the effectiveness of which has been evidenced by vast differences in injury prevalences between countries (35)). The much lower ED-based AAF injury estimate for Sweden could be explained by the country's strict alcohol control policies concerning drinking and driving and the availability of alcohol, policies which are more rigorous than most high-income countries (36, 37).

Differences in alcohol's involvement in injury mortality compared to morbidity may also explain in part the discrepancies observed in the AAFs. The population method was designed to estimate the AAF of injury mortality, resulting in a larger mean AAF compared to the ED acute method (37% vs 15%). Earlier studies comparing ED and coroners' data from the same area consistently found much higher alcohol involvement among injury deaths (38, 39). The comprehensive meta-analysis by Smith et al. (12) reviewed 65 medical

examiners' studies between 1975 and 1995 in the United States and found the aggregate intoxication prevalence (BAC $\geq$ 0.10 g/dL) was mostly between 31–33% among injury deaths. In comparison, the current study found the ED-based AAFs around 15–16% in the United States during 1985–1996. Furthermore, for the United States, the population-based AAFs were around 39–41%, suggesting that these AAFs may be biased upward. A recent study of a representative sample of injury fatalities in São Paulo (40) found a 30% prevalence of alcohol presence (BAC $\geq$ 0.01 g/dL), higher than our ED estimate (9%), but lower than the population estimate (41%). More research is needed for comparison with studies such as medical examiners' reports or registry data, including updating the systematic review by Smith et al. (12) to cover international data rather than focusing on the United States. Thus, it is premature to conclude which method is less biased and provides more valid estimates. Furthermore, a correction factor applied to the AAFs estimated from ED studies (to correct for the AAF underestimation of mortality) would increase these AAFs; however, this correction factor would not affect the inconsistencies between the AAFs estimated by the population-based and ED-based methods.

CONCLUSIONS

While this study can only describe and provide explanations for the differences between both methods, future research needs to systematically elaborate on the quantification of these differences. Given that unrepresentativeness is the major threat to the validity of ED studies, one way to improve the ED research approach would be to abandon the more or less opportunistic sampling of ED studies, and to actually sample more sites per country, with smaller samples per site to limit costs. For the population approach, improvements can be made in the future in several aspects. First, RR estimates from the Corrao meta-analysis need to be updated, with the risk of usual drinking directly linked to injury mortality. Average consumption and binge drinking should also be modeled as independent risk factors before any interaction effects can be examined. Country-level alcohol control policies and socio-cultural behaviors related to drinking also need to be taken into consideration. An additional way to improve the population approach would be to base the RRs on country-specific data analyses (e.g., for Russia see (41)), or – if there are not enough data for countries – on regional RRs based on countries with similar drinking patterns and alcohol policies. Finally, future research should try to develop better models to combine both approaches, which should be validated in selected jurisdictions using death statistics where vital registries which capture these data exist.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Ratios dividing the injury alcohol-attributable fractions (AAFs) estimated using the population method by AAF estimates using the acute method from emergency department data

Note: The solid line represents the mean ratio between population- and emergency department-based alcohol-attributable fraction estimates for injuries, while the dashed lines are the 20% range from the mean ratio

Table 1.

Alcohol-attributable fraction estimates for injuries based on emergency room data

Region and country	Year	Total			Male			Female		
		Sample size (n)	Exposure (%)	AAF (%)	Sample size (n)	Exposure (%)	AAF (%)	Sample size (n)	Exposure (%)	AAF (%)
Africa										
Mozambique	2001	459	17.1	12.1	329	20.4	14.2	129	8.7	6.2
South Africa	2001	464	46.4	40.2	353	51.3	43.8	111	31.0	28.8
Tanzania	2013-14	516	28.0	21.3	394	31.4	23.2	122	17.4	14.4
Asia and Pacific										
Australia	1997	662	21.9	16.8	446	24.4	18.7	216	16.7	13.0
New Zealand	2000	153	38.5	29.9	99	43.1	33.2	54	29.9	24.0
	2016	484	21.1	16.7	279	24.7	19.8	204	16.2	12.6
China	2001	533	18.8	13.2	372	25.5	17.6	161	3.1	2.4
	2008	2540	16.5	11.9	1642	20.6	14.6	898	9.0	6.8
India	2001	544	21.7	16.9	408	27.7	21.3	133	3.0	2.5
Korea	2008-09	1989	23.9	19.3	1220	30.5	24.7	769	13.6	10.8
Europe										
Belarus	2001	457	30.0	23.2	270	38.9	30.1	187	17.1	13.2
Czech Republic	2001	510	7.8	5.1	283	11.3	7.3	227	3.5	2.3
Ireland	2003-04	2088	22.9	19.7	1354	26.1	22.4	734	17.0	14.9
Poland	2002-03	542	12.4	8.5	348	15.2	10.5	194	7.2	4.7
Spain	1987	933	20.2	12.3	486	29.8	18.1	447	9.6	5.8
Sweden	2001	497	15.1	11.5	269	20.3	15.3	228	9.0	7.0
	2007	281	11.6	6.9	200	13.3	7.5	81	7.6	5.1
Switzerland	2006	325	25.4	17.5	217	31.0	21.3	108	14.0	9.6
North America										
Canada	1989	316	22.5	15.2	195	27.2	18.6	112	16.1	10.3
	2002	222	6.3	4.6	133	8.8	6.4	89	2.2	1.5
	2009	249	22.2	16.3	156	24.4	18.3	93	18.5	12.9
	2014	1191	14.7	11.2	713	16.6	12.8	475	12.1	9.2
Mexico	1986-87	1305	26.9	21.4	931	34.3	26.9	374	8.4	7.0

Region and country	Year	Total			Male			Female		
		Sample size (n)	Exposure (%)	AAF (%)	Sample size (n)	Exposure (%)	AAF (%)	Sample size (n)	Exposure (%)	AAF (%)
United States	1996	486	13.0	10.1	328	17.8	13.7	158	3.7	2.7
	2002	456	17.2	13.7	273	25.5	20.0	183	4.9	4.1
	1985-89	1526	21.0	14.6	963	25.2	17.5	563	13.7	9.4
	1992-96	293	23.1	16.4	175	32.2	23.2	118	9.3	5.8
Central and South America										
Argentina	2001	682	23.5	16.2	456	29.2	20.1	218	11.7	7.6
Brazil	2001	496	12.8	9.2	330	17.2	12.2	164	4.3	3.1
Dominican Rep	2010	501	19.3	15.0	396	20.4	15.7	94	16.5	12.9
Guatemala	2011	513	21.1	16.9	356	27.7	21.8	157	6.4	5.3
Guyana	2010	485	21.0	15.8	351	26.8	19.9	134	6.0	4.5
Nicaragua	2010	518	21.5	17.9	358	29.6	24.3	160	3.8	3.6
Panama	2010	490	20.8	16.3	335	25.8	20.3	155	9.9	7.6
Costa Rica	2012-13	1013	8.7	6.9	644	12.3	9.7	369	2.5	1.8
Trinidad & Tobago	2015	252	20.6	14.8	182	23.6	16.5	70	12.7	9.8

¹ Across ED studies, the average ED AAF estimates are 18.9% for males, 8.4% for females, 15.4% total

AAF: Alcohol-Attributable Fraction

Table 2.

Alcohol consumption statistics and alcohol-attributable fraction estimates based on a population-based model

Region and country	Year	Alcohol consumption - Males			Alcohol consumption - Females			AAF estimates (%) ^I		
		Per capita consumption (L)	Current Drinkers (%)	Binge Drinking (%)	Per capita consumption (L)	Current Drinkers (%)	Binge Drinking (%)	Male	Female	Total
Africa										
Mozambique	2001	7.5	44.6	63.5	1.3	20.4	27.7	32.5	11.7	26.0
South Africa	2001	19.2	56.2	77.4	3.6	28.6	43.2	44.9	23.5	38.8
Tanzania	2013-14	16.0	50.0	68.9	2.9	24.0	33.2	39.5	16.9	31.9
Asia and Pacific										
Australia	1997	18.1	91.3	68.0	5.4	76.2	32.6	51.9	36.6	47.1
New Zealand	2000	15.7	87.8	63.4	4.4	69.1	28.3	48.9	31.2	43.2
	2016	16.9	85.9	58.3	4.6	65.8	24.6	47.1	27.9	40.3
China	2001	6.2	62.5	54.7	1.3	37.6	21.2	34.7	15.1	28.3
	2008	9.1	65.9	55.2	2.0	39.6	21.7	37.7	16.5	31.1
India	2001	3.7	48.6	54.6	0.7	23.3	21.0	28.4	9.6	21.1
Korea	2008-09	16.6	83.4	70.9	4.2	60.6	34.8	50.6	32.8	44.8
Europe										
Belarus	2001	24.7	71.0	71.3	5.2	42.4	34.1	49.1	27.0	44.5
Czech Republic	2001	24.0	89.2	76.6	6.7	71.1	41.7	55.2	41.3	50.6
Ireland	2003-04	21.4	93.0	68.3	6.6	80.2	32.8	53.2	38.5	48.7
Poland	2002-03	17.1	79.3	68.9	4.1	53.9	32.4	49.1	29.1	44.1
Spain	1990	22.6	93.3	71.5	7.0	80.9	35.9	54.5	40.9	50.7
Sweden	2001	13.9	86.2	55.7	3.7	65.5	21.8	45.1	25.1	37.5
	2007	14.3	86.5	54.5	3.8	66.1	21.2	44.9	24.9	37.2
Switzerland	2006	17.0	90.3	59.5	4.8	73.8	24.7	48.5	30.1	41.2
North America										
Canada	1990	17.0	88.0	59.9	4.7	69.1	24.8	48.2	29.0	42.2
	2002	15.3	83.1	52.3	3.9	60.2	19.5	43.7	22.2	36.2
	2009	16.8	82.8	51.0	4.2	59.8	18.8	43.6	21.9	35.6
	2014	14.8	79.2	45.8	3.5	54.2	15.9	39.9	17.8	31.6
Mexico	1990	11.1	71.2	63.0	2.6	43.9	27.3	42.9	21.6	38.3

Region and country	Year	Alcohol consumption - Males				Alcohol consumption - Females				AAE estimates (%) ^J	
		Per capita consumption (L)	Current Drinkers (%)	Binge Drinking (%)	Per capita consumption (L)	Current Drinkers (%)	Binge Drinking (%)	Male	Female	Total	Total
	1996-97	10.2	66.2	59.3	2.2	38.2	24.4	39.8	17.8	35.0	35.0
	2002	10.8	63.5	57.6	2.2	35.5	23.1	38.7	16.3	33.6	33.6
United States	1990	15.6	87.4	57.9	4.3	67.8	23.1	46.8	27.1	41.0	41.0
	1994	14.4	85.3	54.8	3.8	64.0	20.8	44.8	24.1	38.5	38.5
Central and South America											
Argentina	2001	14.1	82.2	46.9	3.7	58.7	16.0	40.8	19.0	35.0	35.0
Brazil	2001	15.1	65.9	69.0	3.2	37.8	32.9	44.8	22.9	40.9	40.9
Dominican Rep	2010	11.5	58.2	61.7	2.2	30.6	26.7	38.8	16.3	33.6	33.6
Guatemala	2011	6.1	43.9	47.8	1.0	20.0	16.7	26.3	7.4	22.7	22.7
Guyana	2010	9.8	52.9	59.8	1.7	26.0	24.6	35.6	13.2	30.3	30.3
Nicaragua	2010	8.4	48.0	51.0	1.5	22.6	18.5	30.3	9.3	25.7	25.7
Panama	2010	12.9	62.2	55.8	2.6	34.2	22.0	38.6	15.6	34.7	34.7
Costa Rica	2012-13	7.7	49.9	47.4	1.3	23.7	16.6	29.2	8.7	24.8	24.8
Trinidad & Tobago	2015	13.3	68.4	61.6	2.8	40.2	26.3	42.5	20.0	38.1	38.1

^J Across country-years, the average population AAF estimates are 42.5% for males, 22.5% for females, 36.8% total

AAE: Alcohol-Attributable Fraction