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Alcohol consumption and burden of disease in the Americas in 2012: implications for alcohol policy

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ABSTRACT

Objective. *To describe the volume and patterns of alcohol consumption up to and including 2012, and to estimate the burden of disease attributable to alcohol consumption as measured in deaths and disability-adjusted life years (DALYs) lost in the Americas in 2012.*

Methods. *Measures of alcohol consumption were obtained from the World Health Organization (WHO) Global Information System on Alcohol and Health (GISAH). The burden of alcohol consumption was estimated in both deaths and DALYs lost based on mortality data obtained from WHO, using alcohol-attributable fractions. Regional groupings for the Americas were based on the WHO classifications for 2004 (according to child and adult mortality).*

Results. *Regional variations were observed in the overall volume of alcohol consumed, the proportion of the alcohol market attributable to unrecorded alcohol consumption, drinking patterns, prevalence of drinking, and prevalence of heavy episodic drinking, with inhabitants of the Americas consuming more alcohol (8.4 L of pure alcohol per adult in 2012) compared to the world average. The Americas also experienced a high burden of disease attributable to alcohol consumption (4.7% of all deaths and 6.7% of all DALYs lost), especially in terms of injuries attributable to alcohol consumption.*

Conclusions. *Alcohol is consumed in a harmful manner in the Americas, leading to a high burden of disease, especially in terms of injuries. New cost-effective alcohol policies, such as increasing alcohol taxation, increasing the minimum legal age to purchase alcohol, and decreasing the maximum legal blood alcohol content while driving, should be implemented to decrease the harmful consumption of alcohol and the resulting burden of disease.*

Key words Ethanol; mortality; morbidity; policy; Americas.

Alcohol consumption causes a large health, social, and economic burden in the Americas (1–4) and results in an increasingly large burden in developing countries, especially as economic development causes the burden of disease to shift from communicable to noncommunicable diseases (NCDs) (5) and alcohol consumption to increase (6, 7). Therefore, decreasing harmful alcohol consumption and its effects has become a global priority (8).

Alcohol consumption is causally related to more than 230 three-digit ICD-10[3] codes.[4] To address the large burden of disease attributed to this behavior, numerous suggestions have been set forth to strengthen monitoring of both alcohol consumption and its harmful effects (11–13), and to increase awareness about the issue. For example, the objectives of the

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[3] International Classification of Diseases, 10th Revision.

[4] An overview of diseases, injuries and other health conditions causally related to alcohol consumption can be found elsewhere (9, 10).

World Health Organization (WHO) Global Strategy to Reduce the Harmful Use of Alcohol ("Global Strategy") include 1) raising awareness of the magnitude of health problems caused by the harmful use of alcohol; 2) strengthening knowledge of the magnitude and determinants of alcohol-related harms and of effective interventions to reduce and prevent such harms; and 3) improving the dissemination of information for advocacy, policy development, and evaluations (8). The effects of alcohol consumption are also recognized in WHO's strategy for prevention and control of NCDs, which names alcohol as one of these chronic diseases' top four modifiable risk factors (4).

Several articles and reports have outlined the prevalence of alcohol consumption and its harmful effects in the Americas (1). In 2011, the Pan American Health Organization (PAHO) adopted a Regional Plan of Action consistent with the objectives of the WHO Global Strategy, and in 2014, PAHO published the 2014 Global Status Report on Alcohol and Health, which provides data for estimating the burden of disease attributable to alcohol consumption in the Americas for 2012. The objective of this study was to provide an update of the previous analyses of alcohol consumption and its harmful effects in the Americas. Specifically, this study aimed to 1) describe the volume and patterns of alcohol consumption in the Americas up to and including 2012, and 2) estimate the burden of disease attributable to alcohol consumption as measured in deaths and disability-adjusted life years (DALYs) lost (a measure of both premature mortality and years lived with disability) in the Americas for 2012.

MATERIALS AND METHODS

Alcohol exposure estimates

Alcohol exposure estimates were obtained from the Global Information System on Alcohol and Health (GISAH).[5] The estimates include the adult per capita consumption of alcohol (total, recorded, unrecorded, and tourist); prevalence of current abstainers (lifetime abstainers and former drinkers) and current drinkers; prevalence of heavy episodic drinking (HED) (defined as consumption of five international standard drinks (≥ 60 g of pure alcohol) on one or more occasion in the past 30 days); and pattern of drinking (POD) scores (scaled from 1 to 5, with "1" representing the least risky drinking pattern and "5" representing the most risky pattern).

Alcohol-attributable burden calculations for 2012

The number of alcohol-attributable deaths was calculated by age, sex, and cause, using alcohol population-attributable fractions (PAFs) combined with data on number of deaths, years of life lost (YLL) due to premature mortality, and years lived with disability (YLD) in the Americas obtained from WHO (3, 4). For diseases where alcohol is a necessary cause (i.e., the diseases would not occur without alcohol consumption), such as alcohol use disorders, the alcohol PAF is equal to 1 (i.e., 100% would not occur without alcohol consumption).[6]

Regions and population data

Statistics on alcohol consumption and the burden of disease attributable to alcohol consumption are reported to WHO by regional subgroups ("subregions") defined by WHO (14) based on patterns of child and adult mortality. Table 1 and Table 2, respectively, list these statistics by country (the 35 PAHO Member States included in this report) and Americas subregion ("A": Canada, Cuba, United States of America (very low childhood and very low adult mortality rates); "B": Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of) (low childhood and low adult mortality rates); and "D": Bolivia (Plurinational State of), Ecuador, Guatemala, Haiti, Nicaragua, Peru (high childhood and high adult mortality)). Population data by age, sex, and country were obtained from WHO (4).

Economic data

Data on gross domestic product (GDP) per capita for 2012, adjusted and unadjusted for purchasing power parity (PPP), were obtained from the World Bank (15). If those data were not available for a particular country for 2012, the numbers were estimated based on the linear trend over previous years; if no GDP data for a particular country were available from the World Bank, the data were obtained from the International Monetary Fund (16).

Statistical methods

Correlations were performed using Pearson's product-moment correlation coefficient. All statistics were performed using R version 3.1.2 (17).

RESULTS

Per capita consumption of alcohol

In 2012, in the Americas, total adult per capita consumption of alcohol (8.4 L of pure alcohol) was 24% higher than the global average (6.8 L of pure alcohol) and ranged from 3.2 L in El Salvador to 10.3 L in Chile in 2012 (Table 1). While unrecorded alcohol consumption[7] constituted a large proportion of all alcohol consumed in the Americas (14.7%) (Table 2), this variable value was less than the global average (22.8%). Unrecorded alcohol consumption and the proportion of the market constituted by unrecorded alcohol showed considerable variation in the Americas, ranging from 0.2 L per adult in Saint Lucia to 3.1 L per adult in Ecuador (Table 1), and from 1.92% in Saint Lucia to 42.11% in Guatemala (not shown) respectively. Tourist consumption only affected countries in the Caribbean, specifically Antigua and Barbuda, Bahamas, Barbados, Dominica, Grenada, Saint Kitts and Nevis, and Saint Lucia (Table 1). In these countries, the number of tourists and their overall alcohol consumption far exceeded the number of tourists who visited other countries and their overall alcohol consumption in the host countries.

[5] For more details on the information sources for the alcohol exposure estimates, see the GISAH website (www.who.int/globalatlas/alcohol) and the Supplementary Material ("Web Appendix") supplied by the authors.

[6] For more information on calculating the alcohol PAF, see the Supplementary Material.

[7] Alcohol consumption not recorded by retail or government statistics.

TABLE 1. Alcohol consumption, economic characteristics, and World Health Organization subregion, by country, Americas, 2012

Country	WHO subregion (grouped by level of child and adult mortality)	Total adult per capita consumption (L)[a]	Total adult per capita unrecorded consumption (L)[a]	Total adult per capita tourist consumption (L)[a]	Pattern of drinking (POD) score[b]	Current abstainers (%)			Total adult per capita consumption per drinker (L)[a]	Per capita GDP (US$)[c]	Per capita GDP–PPP (ID)[d]	Adult population (≥ 15 years old) (in 000s)
						Men	Women	Total				
Antigua and Barbuda	B	4.7	0.3	2.9	3	39.5	26.9	33.4	7.0	13 406	20 742	66.0
Argentina	B	9.4	1.0	0.0	2	51.7	30.0	41.2	16.0	14 680	21 647	31 055.5
Bahamas	B	6.1	0.4	3.7	2	56.6	32.5	45.0	11.1	21 908	23 102	291.5
Barbados	B	7.4	0.5	0.7	2	37.6	25.1	31.4	10.8	14 917	15 566	229.4
Belize	B	8.2	1.6	0.0	4	88.1	54.6	71.4	28.7	4 852	8 459	212.6
Bolivia (Plurinational State of)	D	6.2	2.2	0.0	3	58.7	37.6	48.3	12.0	2 576	5 749	6 798.2
Brazil	B	8.9	1.5	0.0	3	53.2	30.7	42.3	15.5	11 320	14 574	149 850.3
Canada	A	10.1	2.0	0.0	2	26.0	19.7	22.9	13.1	52 409	41 924	29 136.5
Chile	B	10.3	2.1	0.0	2	40.6	27.3	34.1	15.6	15 245	21 045	13 730.9
Colombia	B	6.2	2.0	0.0	3	62.6	40.1	51.7	12.9	7 763	11 840	34 334.8
Costa Rica	B	5.0	0.9	0.0	3	59.5	38.0	48.6	9.8	9 443	13 388	3 654.8
Cuba	A	5.1	1.0	0.0	2	47.3	28.2	37.8	8.1	6 400	19 654	9 402.7
Dominica	B	6.3	0.4	0.4	3	51.5	30.0	40.9	10.7	6 913	10 001	53.1
Dominican Republic	B	6.6	0.7	0.0	3	56.2	33.2	44.8	12.0	5 733	11 208	7 139.2
Ecuador	D	7.5	3.1	0.0	3	64.1	41.0	52.7	15.8	5 425	10 073	10 800.1
El Salvador	B	3.2	1.0	0.0	3	65.8	44.5	56.0	7.2	3 782	7 572	4 369.0
Grenada	B	10.3	0.6	0.8	4	63.0	39.9	51.5	21.2	7 598	11 167	77.0
Guatemala	D	3.7	1.5	0.0	4	68.2	46.0	57.7	8.7	3 341	7 107	8 929.4
Guyana	B	8.1	1.0	0.0	3	50.8	29.8	40.4	13.7	3 585	6 159	502.9
Haiti	D	5.9	0.6	0.0	3	56.2	32.4	44.6	10.7	776	1 631	6 577.0
Honduras	B	3.8	1.0	0.0	3	64.0	40.9	52.6	8.1	2 339	4 500	5 101.4
Jamaica	B	4.8	1.5	0.0	2	64.6	43.2	54.2	10.5	5 464	8 670	1 999.6
Mexico	B	7.2	1.8	0.0	3	53.7	31.1	43.0	12.6	9 818	16 178	85 791.4
Nicaragua	D	4.7	1.4	0.0	3	61.5	39.3	50.7	9.6	1 777	4 368	3 992.5
Panama	B	8.5	0.8	0.0	3	50.8	29.7	40.2	14.2	9 982	17 935	2 713.0
Paraguay	B	8.8	1.5	0.0	3	48.0	28.3	38.1	14.3	3 680	7 097	4 495.5
Peru	D	10.2	2.5	0.0	3	56.0	33.1	44.6	18.4	6 424	11 103	21 238.2
Saint Kitts and Nevis	B	5.9	0.4	1.5	2	68.5	46.0	57.5	13.8	13 658	20 451	39.7
Saint Lucia	B	8.4	0.2	1.6	3	58.0	37.1	47.8	16.1	7 288	10 540	136.9
Saint Vincent and the Grenadines	B	7.3	0.3	0.0	2	56.3	32.2	44.1	13.1	6 349	10 215	81.3
Suriname	B	7.0	1.1	0.0	3	58.6	37.4	48.1	13.5	9 376	15 440	385.8
Trinidad and Tobago	B	6.7	0.3	0.0	2	59.6	37.9	48.9	13.2	17 523	29 594	1 060.2
United States of America	A	9.1	0.5	0.0	2	37.0	24.8	31.1	13.2	51 755	51 755	255 169.9
Uruguay	B	7.2	0.9	0.0	3	51.6	29.9	41.3	12.2	14 728	18 549	2 646.7
Venezuela (Bolivarian Republic of)	B	7.6	1.1	0.0	3	51.6	30.1	40.9	12.9	12 729	17 951	21 317.0

[a] Liters of pure alcohol consumed in one year among people ≥ 15 years old.
[b] Scaled from 1 (least hazardous) to 5 (very hazardous).
[c] Gross domestic product (GDP) per capita in current US dollars (data for Argentina obtained from the International Monetary Fund).
[d] GDP–purchasing power parity (PPP) per capita in current "international" dollars.

TABLE 2. Alcohol consumption characteristics globally, and by World Health Organization subregion (grouped by level of child and adult mortality), Americas, 2012

WHO region/subregion	Beverage type most consumed	Total adult per capita consumption (L)[a]	Unrecorded consumption (% of total alcohol consumed)	HED among current drinkers (%)[b]	Prevalence of drinking (%)			Total adult per capita consumption per drinker (L)[a]	Average pattern of drinking (POD) score[c]
					Men	Women	Total		
Americas subregion A[d]	Beer	9.1	7.2	23.9	75.6	63.7	69.5	13.0	2.0
Americas subregion B[e]	Beer	8.0	19.2	21.4	68.1	46.1	56.7	14.1	2.9
Americas subregion D[f]	Spirits	7.4	29.1	17.5	62.6	39.8	51.0	14.4	3.2
Americas	Beer	8.4	14.7	22.2	70.7	52.7	61.5	13.7	2.5
World	Spirits	6.8	22.8	19.6	47.0	29.1	38.1	17.8	2.6

[a] Liters of pure alcohol consumed in one year among people ≥ 15 years old.
[b] Heavy episodic drinking (consumption of five or more standard international drinks or ≥ 60 g of pure alcohol) on one or more occasion in the past 30 days.
[c] Scaled from 1 (least hazardous) to 5 (very hazardous).
[d] Canada, Cuba, United States of America (very low childhood and very low adult mortality rates).
[e] Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of) (low childhood and low adult mortality rates).
[f] Bolivia (Plurinational State of), Ecuador, Guatemala, Haiti, Nicaragua, Peru (high childhood and high adult mortality).

From 1961 to 2010, the recorded adult per capita consumption of alcohol in the Americas increased 11.43% (from 6.41 L to 7.14 L), mainly due to a 26.90% increase in recorded consumption in Americas subregion B (from 5.11 L to 6.48 L) (Figure A1 of the Supplementary Material). In Americas subregion D, recorded alcohol consumption decreased by 24.24% (from 4.59 L to 3.48 L), but this change did not necessarily indicate a decrease in overall consumption in the region because unrecorded consumption was not taken into account (e.g., if unrecorded consumption increases more than a recorded decrease in recorded alcohol consumption, overall consumption, will increase).

Data on beverage preferences for 2012 (by grams of pure alcohol) indicate that beer was the most popular beverage in the Americas (55.2% of all recorded consumption), followed by spirits (31.0%), and wine (13.4%) (with the remaining 0.4% corresponding to "other" types of alcoholic beverages) (not shown). The popularity of both wine and spirits versus beer has thus decreased since 1961, when the respective percentages recorded for each type of beverage for all recorded consumption of alcohol were 39.4%, 36.6%, and 24.0% (not shown).

Prevalence of alcohol consumption and patterns of drinking

In 2012, 38.5% of all adults (47.3% of adult women and 29.3% of adult men) in the Americas were abstainers at the time of the study ("current abstainers") versus 61.9% of the global adult population (70.9% of adult women and 53.0% of adult men). The prevalence of current abstainers and current drinkers varied greatly in the Americas. Subregionally, Americas subregion A had the lowest prevalence of current abstainers (30.5% of the adult population), whereas Americas subregion D had the highest prevalence (49.0% of the adult population) (Table 2). There was a significant association between the ratio of current drinkers among all men and all women ("prevalence ratios") and the overall prevalence ratio (among the general population region-wide) (r = –0.764; 95% confidence interval (CI): –0.875 to –0.578; $P < 0.001$), indicating that as the prevalence of all current drinkers increased, the gap between the prevalence ratio for men versus women decreased. A similar statistically significant ($P < 0.001$) correlation was found when examining the association between the absolute difference in prevalence ratio of current drinkers among all men versus all women and the overall prevalence of current drinkers.

The consumption of alcohol among current drinkers in the Americas (13.7 L per adult drinker) was less than the global average (17.8 L per adult drinker). Subregionally, Americas subregion D had the highest consumption per drinker (14.4 L) and Americas subregion A had the lowest (13.0 L) (Table 2). A weak and non-significant association was observed between the ratio of alcohol consumption among all female current drinkers to alcohol consumption among all male current drinkers and overall consumption among all current drinkers.

For 2012, HED among current drinkers was more prevalent in the Americas compared to the global average. Within the region, HED was most prevalent in subregion A (Table 2) (23.9% of all adult current drinkers engaged in HED—16.6% of all adult female current drinkers and 30.4% of all adult male current drinkers) and least prevalent in Americas subregion D (17.5% of all adult current drinkers—6.3% of all adult female current drinkers and 25.0% of all adult male current drinkers). A weak and non-significant association was observed between the prevalence ratio of HED among adult female current drinkers to HED among adult male current drinkers and the overall prevalence of HED among all current drinkers.

The POD scores for the countries in the three Americas subregions included in this study ranged from 2 (Argentina, Bahamas, Barbados, Canada, Chile, Cuba, Jamaica, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Trinidad and Tobago, and the United States of America) to 4 (Belize, Grenada, and Guatemala), with an average score for the region of 2.5. The most harmful drinking pattern was observed in subregion D, which had a POD score of 3.2, reflecting the frequency of festive drinking and drinking outside meals in the countries it comprises (Table 2).

Alcohol consumption and development

The level of development of a country, as measured by GDP–PPP per capita, was significantly associated with the adult per capita consumption of alcohol (r = 0.377; CI: 0.050 to 0.631; P = 0.026); prevalence of current abstainers (r = –0.561; CI: –0.753 to –0.279; $P < 0.001$); and the POD (r = –0.562; CI: –0.754 to –0.281; $P < 0.001$).

Alcohol-attributable burden of disease

In 2012, in the Americas, alcohol consumption was responsible for 302 860 deaths (31.7 per 100 000 people) (Table 3) and 18 410 200 DALYs lost (19.2 per 1 000 people) (Table 4), representing 4.7% of all deaths and 6.7% of all DALYs lost. Men in the Americas experienced much more harm from alcohol consumption than women, with alcohol causing 7.3% of all deaths and 10.1% of all DALYs lost among men compared to 1.8% of all deaths and 2.6% of all DALYs lost among women (not shown). There was wide variation by subregion in the number of deaths (per 100 000 people) and DALYs lost (per 1 000 people) attributable to alcohol consumption for 2012 in the Americas, with Venezuela, Guyana, and Brazil experiencing the greatest burden for both variables (51.5, 47.0, and 42.3 deaths per 100 000 people attributable to alcohol consumption and 33.2, 25.7, and 24.8 DALYs lost per 1 000 people attributable to alcohol consumption respectively) (not shown).

Tables 3 and 4 also show the number of deaths and DALYs lost attributable to alcohol consumption by cause. Alcohol-attributable NCDs were the largest contributor to the burden of disease caused by alcohol, accounting for 55.1% of all alcohol-attributable mortality and 61.0% of all alcohol-attributable DALYs lost. For the region as a whole, digestive diseases were the largest NCD contributor to alcohol-attributable mortality, accounting for 25.7% of all alcohol-attributable deaths. In contrast to alcohol-attributable mortality, the largest NCD contributor to alcohol-attributable DALYs lost was mental and behavioral disorders, which accounted for 37.1% of all DALYs lost in the Americas. Alcohol-attributable communicable, maternal, perinatal, and nutritional conditions accounted for 7.4% and 4.1% of alcohol-attributable mortality and DALYs lost in the region respectively (with injuries accounting for the remaining 37.5% and 32.6% respectively) (not shown).

TABLE 3. Alcohol-attributable deaths by cause and World Health Organization subregion (grouped by level of child and adult mortality), Americas, 2012

	Americas									Deaths attributable to alcohol consumption (% of total alcohol deaths)	World		
	Subregion A[a]		Subregion B[b]		Subregion D[c]		Total						
Disease category	Women	Men	Women	Men	Women	Men	Women	Men	Total		Women	Men	Total
Deaths in 100s													
Communicable, maternal, perinatal, and nutritional conditions													
Infectious and parasitic diseases	1.1	4.5	5.3	32.5	2.6	12.2	9.1	49.1	58.2	1.9	205.0	1 100.3	1 305.3
Respiratory infections	19.0	25.5	39.6	56.4	10.4	12.4	68.9	94.3	163.3	5.4	503.6	812.5	1 316.1
Maternal conditions	0.2	0.3	0.8	1.0	0.3	0.4	1.3	1.7	3.0	0.1	15.1	19.4	34.5
Noncommunicable diseases													
Malignant neoplasms	96.8	157.0	72.2	128.1	6.9	7.9	175.9	292.9	468.8	15.5	1 034.7	3 061.2	4 095.9
Mental and behavioral disorders	33.8	92.9	14.2	147.8	1.7	15.5	49.7	256.2	305.9	10.1	211.9	858.3	1070.2
Neurological conditions	1.2	3.1	2.9	10.2	0.7	2.3	4.8	15.7	20.5	0.7	51.3	184.9	236.2
Cardiovascular diseases	1.7	41.8	38.6	120.7	6.4	15.1	46.6	177.6	224.2	7.4	6 287.7	4 995.0	11 282.7
Diabetes[d]	–34.6	–9.7	–68.5	–13.2	–4.4	–0.7	–107.5	–23.6	–131.1	–4.3	–285.4	–20.1	–305.5
Digestive diseases	87.6	165.3	98.9	347.6	27.7	51.6	214.1	564.5	778.7	25.7	1 580.3	3 752.5	5 332.9
Injuries													
Unintentional	19.5	113.5	24.8	345.4	2.8	39.9	47.1	498.8	545.9	18.0	494.3	5 137.4	5 631.6
Intentional	9.5	127.0	11.8	405.8	1.7	35.6	22.9	568.4	591.3	19.5	206.8	2 646.8	2 853.6
Total	235.7	721.1	240.3	1 582.3	56.9	192.1	533.0	2 495.6	3 028.6	100.0	10 305.4	22 548.1	32 853.5
Deaths per 100 000 people	12.8	40.3	9.3	63.7	13.0	44.3	11.0	53.0	31.7		29.4	63.3	46.5

[a] Canada, Cuba, United States of America (very low childhood and very low adult mortality rates).
[b] Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of) (low childhood and low adult mortality rates).
[c] Bolivia (Plurinational State of), Ecuador, Guatemala, Haiti, Nicaragua, Peru (high childhood and high adult mortality).
[d] Negative numbers represent deaths prevented per 100 000 people.

TABLE 4. Alcohol-attributable disability-adjusted life years (DALYs) lost by cause and World Health Organization subregion, Americas, 2012

	Americas									DALYs attributable to alcohol consumption (% of total alcohol DALYs)	World		
	Subregion A[a]		Subregion B[b]		Subregion D[c]		Total						
Disease category	Women	Men	Women	Men	Women	Men	Women	Men	Total		Women	Men	Total
DALYs in 1 000s													
Communicable, maternal, perinatal, and nutritional conditions													
Infectious and parasitic diseases	6.8	26.9	31.7	178.7	14.5	69.0	52.9	274.5	327.5	1.8	981.1	5 165.5	6 146.6
Respiratory infections	35.0	55.2	84.7	158.6	23.3	36.7	143.0	250.5	393.5	2.1	1 135.1	2 178.1	3 313.2
Maternal conditions	2.3	2.9	7.5	10.1	3.0	4.1	12.8	17.1	29.9	0.2	144.6	184.3	328.9
Noncommunicable diseases													
Malignant neoplasms	264.6	425.1	225.8	396.4	21.2	24.2	511.6	845.7	1 357.3	7.4	2 975.7	9 046.9	12 022.6
Mental and behavioral disorders	942.4	2 340.5	656.9	2 349.8	130.9	418.6	1 730.2	5 108.8	6 839.1	37.1	4 986.3	27 021.1	32 007.4
Neurological conditions	22.9	51.0	67.8	166.3	12.5	32.6	103.1	249.9	353.0	1.9	521.2	1 621.2	2 142.4
Cardiovascular diseases	–34.0	87.9	115.5	281.8	12.2	38.6	93.7	408.3	502.0	2.7	11 087.0	11 776.4	22 863.4
Diabetes[d]	–168.8	–40.9	–243.6	–49.5	–20.6	–3.9	–433.0	–94.3	–527.3	–2.9	–1260.6	–90.3	–1 350.8
Digestive diseases	283.0	574.2	303.6	1 272.8	84.4	192.4	671.0	2 039.4	2 710.4	14.7	5 157.4	13 741.9	18 899.3
Injuries													
Unintentional	85.8	588.2	136.7	1 958.0	16.4	234.3	238.9	2 780.5	3 019.4	16.4	2 573.9	25 750.6	28 324.5
Intentional	47.6	682.8	66.7	2 394.9	10.3	203.0	124.7	3 280.7	3 405.4	18.5	927.8	13 385.2	14 313.0
Total	1 487.7	4 793.7	1 453.3	9 118.0	308.1	1 249.5	3 249.1	15 161.1	18 410.2	100.0	29 229.6	109 781.0	139 010.6
DALYs lost per 1 000	8.1	26.8	5.6	36.7	7.0	28.8	6.7	32.2	19.2		8.3	30.8	19.7

[a] Canada, Cuba, United States of America (very low childhood and very low adult mortality rates).
[b] Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of) (low childhood and low adult mortality rates).
[c] Bolivia (Plurinational State of), Ecuador, Guatemala, Haiti, Nicaragua, Peru (high childhood and high adult mortality).
[d] Negative numbers represent deaths prevented per 100 000 people.

DISCUSSION

Harmful alcohol consumption is prevalent in the Americas, and the health harms attributable to alcohol consumption in the region are severe. Therefore, the prevention of alcohol-related harms should be a priority in the Americas (18).

Alcohol consumption and alcohol-attributable burden in the Americas

In the Americas, adult per capita consumption of alcohol is high, and per capita consumption, prevalence of current abstainers, and POD scores are significantly associated with economic development (as measured by GDP–PPP)—findings that corroborate the results of previous analyses (6). In addition, unrecorded consumption varied widely by subregion (subregions B and D had a higher percentage of total consumption comprised of unrecorded alcohol than subregion C). According to a systematic review, the main sources of unrecorded alcohol consumption in the Americas are "surrogate alcohol" (ethanol-containing substances that are not meant for consumption) and artisanal spirits (including home production); however, cross-border shopping and smuggling also affect unrecorded alcohol in Mexico and Canada (19).

The largest contributor to the burden of alcohol-attributable DALYs lost was mental and behavioral disorders, and the majority of this burden came from alcohol use disorders (AUDs). The prevalence of AUDs among adults in the Americas in 2010 was 46.3% higher than the world average (6.0% versus 4.1% globally) (4). For that same year, the prevalence of alcohol dependence among adults and the harmful use of alcohol were much greater in the Americas versus the worldwide averages (3.4% and 2.6% versus 2.3% and 1.8% respectively). The prevalence of AUDs among women in the Americas was particularly high, with 3.2% of all adult women reported to have an AUD versus 2.9% in Europe and 1.3% globally. The prevalence of AUDs among men was also high, with 9.0% of all adult men reported to have an AUD versus 12.6% in Europe and 7.2% globally. Drinking patterns in the Americas also contributed to the large burden of alcohol-attributable disease, especially in the countries of Latin America and the Caribbean (LAC), where they caused the largest burden of alcohol-attributable injuries (3, 4, 20). Therefore, effective interventions are needed to target AUDs in the Americas.

Comparison with previous studies

Although not directly comparable due to difference in methodology, the results of this research are similar to those of Rehm & Monteiro (1), who assessed the burden of alcohol consumption in the Americas for 2000. Like that study, the research reported here found that alcohol consumption is a major health risk in the Americas, and that alcohol-attributable injuries and AUDs accounted for most of the alcohol-attributable burden of disease. However, the methods used by Rehm & Monteiro (1) differed from the ones used in this study (e.g., this study modeled alcohol consumption as a continuous distribution, and used continuous and more up-to-date alcohol relative risk (RR) functions, and different disease categories), and some of the increase in the alcohol-attributable burden in the current study versus the prior study is due to those differences (1, 3, 4). Other differences in this study versus prior studies include the lack of controls for population size and structure (previous analyses that did control for those factors reported an increase in the burden of disease caused by alcohol for LAC and a decrease for North America (high-income countries)) (21). In addition, some previous studies included all subregions of the Americas (versus only three, in the current study); the prior studies found that alcohol was one of the top risk factors for the burden of disease in all subregions (20, 22, 23).

Limitations

The methods used in this report are the best methods for calculating the burden of disease attributable to alcohol consumption and comparing the estimated burden across countries (24). However, as with all burden of disease studies, these methods incur certain limitations in terms of the quality of the exposure and outcome data and the estimation procedures used, including various types of bias and the use of unadjusted data.

To minimize potential survey bias, the survey data on alcohol consumption were triangulated with per capita consumption data. However, survey biases can also affect prevalence results for current drinkers, former drinkers, lifetime abstainers, and current drinkers that engage in HED (6). Currently, there is no way to quantify or correct for these biases. Mortality and disability data can also be affected by accuracy biases, especially in low- and middle-income countries, where the infrastructure for tracking and recording mortality and morbidity is limited or does not exist (25).

The use of cross-sectional estimates of alcohol consumption was another source of potential bias due to the biological latency period between the alcohol consumption and chronic disease development and mortality, as in the case of liver cirrhosis and cancer (10). Despite that inherent limitation, the burden of chronic diseases attributable to alcohol was modeled using cross-sectional estimates for three primary reasons: 1) most surveys only measure alcohol consumption in a cross-sectional manner and do not measure lifetime alcohol consumption history (6); 2) most meta-analyses assessing the relationship between alcohol consumption and chronic diseases use cross-sectional estimates for alcohol consumption (9); and 3) although there is a biological latency period, some of the effects of decreases in alcohol consumption on the burden of chronic diseases can be observed at the population level immediately, such as the effects of the Gorbachev alcohol reforms on liver cirrhosis deaths (26).

Finally, the PAFs used in this study were designed using unadjusted alcohol RR functions (27). The impact of this limitation may have been minimal, however, as alcohol RR functions adjusted for confounding factors, such as smoking status, have been observed to be very similar to unadjusted alcohol RR functions (9). Furthermore, alcohol RR functions are based on the reference category of lifetime abstainers. Although the accuracy of this reference group is questionable, with misclassification of former drinkers as lifetime abstainers potentially creating bias, the absolute risk of a disease related to alcohol consumption among misclassified lifetime abstainers who are in fact former drinkers is likely to be not much higher than the absolute risk of a disease related to alcohol consumption for correctly classified lifetime abstainers (28).

Alcohol policy recommendations

Cost-effective measures to reduce the health, social, and economic burden of alcohol consumption in the Americas (29, 30), taking into consideration statistics on alcohol consumption and alcohol-attributable harms, should focus on the following four areas: 1) reducing per capita consumption of alcohol through measures such as increased taxation, minimum pricing, reduced availability, and alcohol marketing control; 2) decreasing the burden of alcohol-attributable injuries through measures such as lowering the maximum legal blood alcohol content (BAC) while driving, increasing the minimum legal age for the purchase and/or consumption of alcohol, and instituting and/or increasing the frequency of BAC roadside checks; 3) given the high prevalence of AUDs, increasing the identification of people in the general population with these disorders and providing them with evidence-based interventions, treatment, and rehabilitation (taking into consideration the fact that the interventions will require reliable health care systems and are not as cost-effective as other methods, such as increases in alcohol taxation); and 4) introducing new policies, such as restricting the times when alcohol can be sold, restricting sales to intoxicated persons and underage individuals, legislation to improve enforcement and monitoring, and methods of regulating and reducing the unrecorded alcohol market.

Evidence used in determining the optimal measures may require some adjustment for developing countries, as most research on alcohol policies is derived from data collected in high-income countries (18). For example, in developing countries with a large unrecorded alcohol market, increases in taxation and decreases in availability will be less effective without regulations to control the informal and illicit market.

Furthermore, although little has been done in terms of alcohol policy reform in the Americas (3, 4), more countries are now adopting and reforming national alcohol strategies (4), following WHO's Global Strategy and PAHO's Regional Plan of Action for reducing the harmful effects of alcohol (31). Nevertheless, additional action is needed to reduce the burdens created by alcohol, including adopting policy options and implementing national monitoring systems in low- and middle-income countries where these systems do not yet exist.

Conclusions

Harmful consumption of alcohol is prevalent in the Americas, and the resulting health burden is large. Therefore, there is an urgent need for the countries in the Americas to implement cost-effective policies to reduce the harmful consumption of alcohol and the resulting social, economic, and health burdens.

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RESUMEN

El consumo de alcohol y la carga de morbilidad en la Región de las Américas en el 2012: implicaciones para las políticas relacionadas con el consumo de alcohol

Objetivo. Describir el volumen y los modelos de consumo de alcohol hasta el año 2012 incluido, y calcular la carga de morbilidad atribuible al consumo de alcohol medida según el número de defunciones y los años de vida ajustados en función de la discapacidad (AVAD) perdidos en la Región de las Américas en el 2012.

Métodos. Los datos sobre el consumo de alcohol se obtuvieron a partir del Sistema Mundial de Información sobre el Alcohol y la Salud (GISAH, por sus siglas en inglés) de la Organización Mundial de la Salud (OMS). La carga del consumo de alcohol se calculó según la mortalidad y según los AVAD perdidos con base en los datos de mortalidad obtenidos de la OMS, tomando en consideración las fracciones atribuibles al alcohol. La división en subregiones se basó en las clasificaciones de la OMS del año 2004 (según la mortalidad en niños y adultos).

Resultados. Se observaron variaciones regionales en el volumen total de alcohol consumido, la proporción del mercado del alcohol atribuible al consumo de alcohol no registrado, los hábitos de consumo, la prevalencia del consumo y la prevalencia de los episodios de consumo excesivo de alcohol. Los habitantes de la Región de las Américas consumieron más alcohol (8,4 litros de alcohol puro por adulto en el 2012) en comparación con el promedio mundial. La Región también experimentó una alta carga de morbilidad atribuible al consumo de alcohol (4,7% de las defunciones y 6,7% de los AVAD perdidos), especialmente en forma de lesiones atribuibles al consumo de alcohol.

Conclusiones. El alcohol se consume de una manera perjudicial en la Región de las Américas y ello comporta una alta carga de morbilidad, especialmente en forma de lesiones. Con objeto de disminuir el consumo perjudicial de bebidas alcohólicas y la carga de morbilidad resultante, es preciso introducir nuevas políticas en materia de consumo de alcohol que sean eficaces en función de los costos, tales como el incremento de los impuestos sobre el alcohol, el aumento de la edad mínima legal para adquirir alcohol, y la disminución de la concentración máxima legal de alcohol en sangre mientras se conduce.

Palabras clave Etanol; mortalidad; morbilidad; políticas; Américas.

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Web Appendix. Information on alcohol consumption data, and methods used to calculate the alcohol-population-attributable fractions

Methods

Alcohol exposure estimates

Total, recorded, unrecorded and tourist adult *per capita* consumption (in litres of pure alcohol) were obtained by country from 1961 to 2012 (beverage specific data on recorded alcohol consumption was available from 1961 to 2010). Recorded consumption is alcohol that is tracked by governments through production, sales and taxation statistics, market research firms serving the alcoholic beverage industry, and the United Nations Food and Agriculture Organization. Unrecorded consumption is alcohol that is not tracked through the statistics of recorded consumption, and can originate from a variety of sources, including, for example, surrogate alcohol (alcohol not officially intended for consumption) (see (1) for the sources of unrecorded alcohol consumption). Data for unrecorded alcohol consumption are usually obtained from a variety of sources, including government-monitoring data, surveys and expert judgments (2). Tourist *per capita* consumption of alcohol represents both cross-border trade and the amount of alcohol consumed by foreign tourists (accounting for the amount of alcohol consumed by the countries' inhabitants when they travel outside their own country). Data on tourist consumption is estimated using tourist visa data and data from special sales taxes or measures of alcoholic beverages sold to tourists (if implemented in a country).

Prevalence of both current abstainers (made up of both lifetime abstainers (people who have never consumed a standard drink of alcohol) and former drinkers (people who have consumed a standard drink of alcohol but have not done so in the past year) and of current drinkers (those who have consumed alcohol in the past year) were obtained by triangulating survey data with data obtained from a regression analysis of all published survey data found through a systematic review (3).

The pattern of alcohol consumption was measured through the prevalence of heavy episodic drinking and the pattern of drinking (POD) scores. The POD scores capture six different aspects of drinking: (i) the usual quantity of alcohol consumed per drinking occasion; (ii) the prevalence and frequency of festive drinking; (iii) the proportion of drinking events when drinkers become intoxicated; (iv) the proportion of drinkers who drink daily or nearly every day; (v) the frequency of drinking with meals and outside of meals; and (vi) the prevalence of drinking in public places. Data on these variables were collected through a key informant survey, with the POD scores being validated from previous pattern of drinking scores measured at the global level (3). Specifically, the data from the key informant survey are aggregated and scaled from 1 to 5 (1 representing the least risky drinking pattern and 5 representing the most risky drinking pattern) and missing information is then imputed by expert opinion.

Alcohol consumption among current drinkers was modelled by triangulating total adult *per capita* consumption data with survey data to correct for the inconsistent and severe undercoverage of population alcohol consumption when measured by population alcohol surveys (as compared to a more accurate source of adult *per capita* consumption data). The distribution of alcohol consumption was modelled using a Gamma distribution, which Rehm and colleagues and Kehoe and colleagues found best describes the population distribution of alcohol consumption (4, 5). To describe the distribution of alcohol consumption by age and sex, the relative alcohol consumption amounts by age and sex (as obtained from population surveys (3)) were combined with population data and *per capita* consumption of alcohol data to estimate the mean alcohol consumption by age and sex. The standard deviation of the alcohol consumption distribution was modelled according to Rehm and colleagues, who observed that the standard deviation of a population alcohol consumption distribution could be predicted using the mean of the alcohol consumption distribution (4).

Alcohol-attributable burden calculations for 2012

For diseases and injuries where alcohol is a component cause (i.e. alcohol increases the risk for the disease or injury, but is not a necessary cause), the alcohol population-attributable fraction (PAF) combines information on the prevalence of current drinkers, former drinkers and lifetime abstainers, the distribution of alcohol consumption among current drinkers, and the relative risk (RR) for a disease for current drinkers and former drinkers as compared to lifetime abstainers. For most diseases casually related to alcohol, the alcohol PAF is estimated using the formula: (Formula 1)

$$PAF_i = \frac{P_{lifetime\_abstainers} + P_{former\_drinkers} RR_{i-former\ drinkers} \int_{>0}^{150} P(x)_{current\ drinkers} RR_i(x)_{current\_drinkers} dx - 1}{P_{lifetime\_abstainers} + P_{former\_drinkers} RR_{i\_former\ drinkers} \int_{>0}^{150} P(x)_{current\ drinkers} RR_i(x)_{current\_drinkers} dx}$$

where $P_{lifetime\_abstainers}$, $P_{former\_drinkers}$ and $P_{current\_drinkers}$ represent the prevalence of lifetime abstainers, former drinkers and current drinkers respectively, x represents the average daily alcohol consumption in grams of pure alcohol per day, and $RR_{i\_former\ drinkers}$ and $RR_i(x)_{current\_drinkers}$ represent the RR for disease i for former drinkers and current drinkers respectively. For a list of the diseases for which alcohol PAFs were modelled, and for the sources of the RR functions, see Table A1.

Table A1. Sources of Relative Risk functions by ICD-10 Code.*

Conditions	ICD 10 Code	New WHO code	Old WHO code	Sources for Relative Risks
Infectious and parasitic diseases				
Tuberculosis	A15-A19	3	IA1	(6); for causal relationship see: (7)
Human immunodeficiency virus/ Acquired immune deficiency syndrome	B20-B24	10	IA3	(8)
Malignant neoplasms		61	IIA	
Mouth and oropharynx cancers	C00-C14	62	IIA1	(9, 10) (based on Relative Risks from (11))
Esophageal cancer	C15	63	IIA2	

Table A1. Sources of Relative Risk functions by ICD-10 Code.*

Conditions	ICD 10 Code	New WHO code	Old WHO code	Sources for Relative Risks
Liver cancer	C22	66	IIA5	
Laryngeal cancer	C32	78		
Breast cancer	C50	70	IIA9	
Colon cancer	C18	65	IIA4	
Rectal cancer	C20			
Diabetes				
Diabetes mellitus	E10-E14	80	IIC	(12)
Neuro-psychiatric conditions				
Alcoholic psychoses (part of AUD)	F10.0, F10.3-F10.9			100% AAF per definition
Alcohol abuse (part of AUD)	F10.1	86	IIE4	100% AAF per definition
Alcohol dependence (part of AUD)	F10.2			100% AAF per definition
Epilepsy	G40-G41	97	IIF3	(13)
Cardiovascular disease		110	IIH	
Hypertensive disease	I10-I15	112	IIH2	(14)
Ischemic heart disease	I20-I25	113	IIH3	(15) for volume, (16) for pattern
Cardiac arrhythmias	I47-I49	116	IIH6	(17)
Ischemic stroke	I60-I62	114	IIH4	(18)
Hemorrhagic and other non-ischemic stroke	I63-I66	114	IIH4	(18)
Digestive diseases		121	IIJ	
Cirrhosis of the liver	K70, K74	123	IIJ2	(19)
Acute and chronic pancreatitis	K85, K86.1	125		(20)
Respiratory infections				
Pneumonia	J10.0, J11.0, J12-J15, J18	39	IB1	(21)
Conditions arising during the prenatal period				
Low birth weight: as defined by the global burden of disease	P05-P07	50	ID1	(22)
Unintentional injuries		152	IIIA	
Motor vehicle accidents	§	153	IIIA1	(23) for Relative Risk, methodology adopted from (24)
Poisonings	X40-X49	154	IIIA2	
Falls	W00-W19	155	IIIA3	

Table A1. Sources of Relative Risk functions by ICD-10 Code.*

Conditions	ICD 10 Code	New WHO code	Old WHO code	Sources for Relative Risks
Fires	X00-X09	156	IIIA4	
Drowning	W65-W74	157	IIIA5	
Other Unintentional injuries	†Rest of V-series and W20-W64, W 75-W99, X10-X39, X50-X59, Y40-Y86, Y88, and Y89	159	IIIA7	
Intentional injuries		160	IIIB	
Self-inflicted injuries	X60-X84 and Y87.0	161	IIIB1	(23) for Relative Risk, methodology adopted from (24)
Homicide	X85-Y09, Y87.1	162	IIIB2	

§ V021–V029, V031–V039, V041–V049, V092, V093, V123–V129, V133–V139, V143–V149, V194–V196, V203–V209, V213–V219, V223–V229, V233–V239, V243–V249,V253–V259, V263–V269, V273– V279, V283–V289, V294–V299, V304–V309, V314–V319, V324–V329, V334–V339, V344–V349, V354–V359, V364–V369, V374–V379, V384–V389, V394–V399, V404–V409, V414–V419, V424–V429, V434–V439, V444–V449, V454–V459, V464– V469, V474–V479, V484–V489, V494–V499, V504–V509, V514–V519, V524–V529, V534–V539, V544–V549, V554–V559, V564–V569, V574–V579, V584–V589, V594–V599, V604–V609, V614–V619, V624–V629, V634–V639, V644–V649, V654– V659, V664–V669, V674–V679, V684–V689, V694–V699, V704–V709, V714–V719, V724–V729, V734–V739, V744–V749, V754–V759, V764–V769, V774–V779, V784–V789, V794–V799, V803–V805, V811, V821, V830–V833, V840–V843, V850– V853, V860–V863, V870–V878, V892.
†Rest of V = V-series MINUS §.
*For Russia and similar countries, Russia-specific RR functions were used (see (3) for RR function descriptions).

Low birth weight attributable to alcohol consumption

To estimate the mortality and morbidity due to low birth weight attributable to alcohol consumption, we modelled the alcohol consumption of pregnant women who drank the same amount of alcohol as pre-pregnancy and the alcohol consumption of pregnant women who drank less (see (3) for data sources). The alcohol PAFs for low birth weight were calculated as follows:

$$PAF = \frac{P_{abstainer} + \int_{>0}^{150} P_{less}(x)RR(x)dx + \int_{>0}^{150} P_{same}(x)RR(x)dx - 1}{P_{abstainer} + \int_{>0}^{150} P_{less}(x)RR(x)dx + \int_{>0}^{150} P_{same}(x)RR(x)dx}$$

where $P_{abstainer}$ is the prevalence of women who abstained from consuming alcohol while pregnant, P_{same} represents the prevalence of pregnant women who consumed the same amount of alcohol as pre-pregnancy, and P_{less} represents the prevalence of pregnant women who consumed less alcohol than they did pre-pregnancy. RR represents the relative risk for low birth weight given an alcohol consumption amount of (x).

HIV/AIDS deaths attributable to alcohol consumption

HIV/AIDS mortality attributable to alcohol consumption was calculated using methodology outlined by Gmel and colleagues (8). This method estimates the HIV/AIDS mortality as a result of non-adherence to medication due to alcohol consumption by combining HIV/AIDS mortality data, the prevalence of people who require Highly Active Anti-Retroviral Treatment (HAART) and who are also receiving this treatment (obtained from the 2006 Report on the Global AIDS Epidemic (25)), the mortality rate among those individuals who receive HAART and those who do not (26), the rate of deaths for those who adhere to HAART and for those who do not (27), and the hazard of not adhering to HAART if you are a current drinker as compared to a lifetime abstainer (28).

Ischemic heart disease attributable to alcohol consumption

The risk of ischemic heart disease mortality and morbidity is impacted by average volume of alcohol consumption and the patterns of drinking. Thus, data on average alcohol consumption and binge alcohol consumption were used to estimate the alcohol PAF for ischemic heart disease mortality and morbidity attributable to alcohol consumption (29, 30). For modelling the mortality and morbidity from ischemic heart disease that was attributable to alcohol consumption, we used an age dependent RR function ((15); see also (31) or (32) for similar results) for all individuals who did not engage in episodic or chronic heavy drinking. For people with at least one heavy

episodic drinking occasion (defined as drinking occasions where men consume 5 standard drinks or more (the equivalent of consuming 60 grams of pure alcohol or more during one drinking occasion) and where women consume 4 standard drinks or more (the equivalent of consuming 48 grams of pure alcohol or more during one drinking occasion)) per month, we assumed there was no cardio-protective effect (16) and, thus, these people were assigned a relative risk of 1.

Injuries attributable to alcohol consumption

The morbidity from injuries attributable to alcohol consumption was estimated according to methodology outlined by Shield and colleagues (33). This calculation method uses data on alcohol consumption during both normal drinking days and during binge drinking days. For modelling the number of injuries attributable to alcohol consumption, we used data on the prevalence of current drinkers, the prevalence of binge drinkers, and the frequency of binge drinking. The risk relationship between alcohol consumption and injuries was obtained from the meta-analysis performed by Taylor and colleagues (23) and from metabolism data (24) (metabolism data were used to calculate the period of time during a drinking occasion when a person was at risk for an injury).

The alcohol PAFs for intentional and unintentional injuries attributable to alcohol consumption were calculated as follows:

$$PAF = \frac{P_{abstainers} + P_{current(non-binge)}RR_{current(non-binge)} + P_{current(binge)}RR_{current(binge)} - 1}{P_{abstainers} + P_{current(non-binge)}RR_{current(non-binge)} + P_{current(binge)}RR_{current(binge)}}$$

where $P_{abstainer}$ represents the prevalence of current abstainers, and $P_{current(binge)}$ and $P_{current(non-binge)}$ are the prevalence of current drinkers who engage in binge drinking and the prevalence of current drinkers who do not engage in binge drinking, respectively. The RRs for current drinkers who engage in binge drinking and for current drinkers who do not engage in binge drinking were calculated separately as follows:

$$RR_{current(non-binge)} = \left(RR_{average}\left(x_{average-non-binge}\right) - 1\right) * P_{non-binge_{days}} + 1$$

and

$$RR_{current(binge)} = \left(RR_{average}(x_{average-non-binge}) - 1\right) * P_{non-binge\_days} + RR_{binge}(x_{binge}) - 1 * P_{binge\_days}$$

where

$$RR_{average}\left(x_{average-non-binge}\right) = P_{dayatrisk}\left(x_{average-non-binge}\right) * \left(RR_{injury}\left(x_{average-non-binge}\right) - 1\right) + 1$$

and

$$RR_{binge}\left(x_{binge}\right) = P_{dayatrisk}\left(x_{binge}\right) * \left(RR_{injuriy}\left(x_{binge}\right) - 1\right) + 1$$

In the above formulae, $P_{dayatrisk}$ represents the proportion of a day at risk, and RR_{injury} is the relative risk for injury given an amount of alcohol consumed (x_{binge} alcohol consumption during heavy episodic drinking occasions and $x_{average\text{-}non\text{-}binge}$ alcohol consumption during average non-heavy episodic drinking days). $P_{dayatrisk}$ is calculated based on the average rate at which alcohol is metabolized, thereby corresponding to the time during which the blood alcohol level is sufficiently elevated to increase the risk of injury. P_{binge_days} and $P_{non\text{-}binge\_days}$ represent the proportion of heavy episodic drinking days and non-binge drinking days among binge drinkers respectively.

The above-presented alcohol PAFs were determined based on injury RR estimates that were calculated using samples of emergency room patients. In the case of injury mortality alcohol PAFs, the alcohol PAF for morbidity from non-motor vehicle accidents was multiplied by 9/4 and the alcohol PAF for morbidity from motor vehicle accidents was multiplied by 3/2. These multiplication factors were based on two studies that compared blood alcohol levels of emergency room patients with blood alcohol levels obtained from coroners' reports of patients who died from an injury (34, 35).

For women, the alcohol PAF for motor vehicle accidents was calculated by multiplying the alcohol PAF for motor vehicle accidents for men by the product of the *per capita* consumption of alcohol for women divided by the *per capita* consumption of alcohol for men. This imputation method was performed since the RR function for motor vehicle accidents is considered valid for men only (36).

Regions

Table A2. World Health Organization (WHO) sub-regional classification of countries in the Americas according to childhood and adult mortality

WHO sub-region*	Countries
A (Very low childhood and very low adult mortality rates)	Canada, Cuba, United States of America
B (Low childhood and low adult mortality rates)	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of)
D (High childhood and high adult mortality)	Bolivia (Plurinational State of), Ecuador Guatemala, Haiti, Nicaragua, Peru

* Regional subgroups defined by the World Health Organization (37) based on the rates of childhood and adult mortality

Results

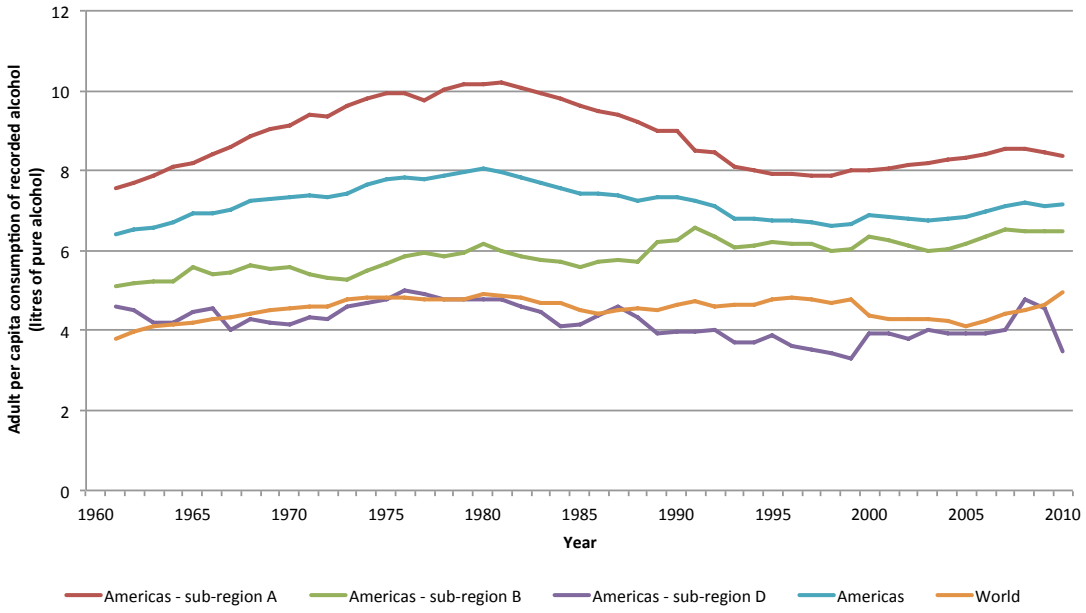

Figure A1. Recorded adult *per capita* consumption of alcohol (litres of pure alcohol) in the Americas for sub-regions A, B, and D from 1961 to 2010

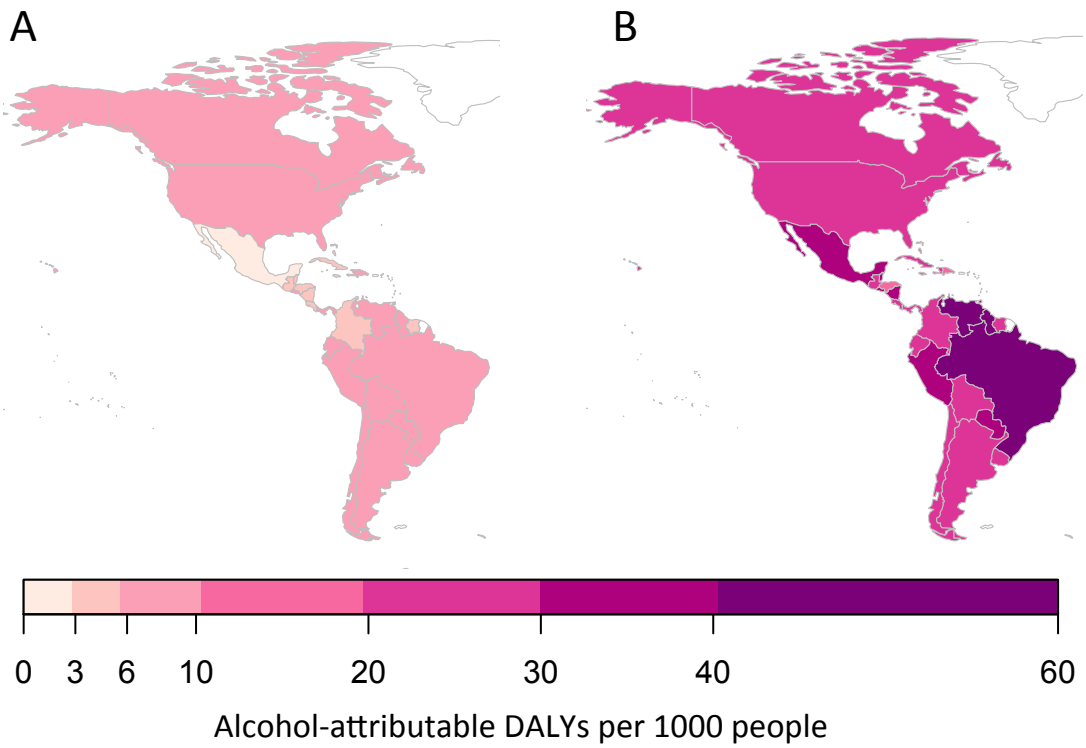

Figure A2. Alcohol-attributable DALYs lost per 1,000 people for (A) women and (B) men in the Americas in 2012

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