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Alcohol-attributable diseases and dose-response curves

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The code that accompanies this vignette can be found in the tobalcepi R package <https://stapm.github.io/tobalcepi/> (Github code repository <https://github.com/STAPM/tobalcepi>).

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Therefore the citation above should be used for the content of this vignette. This vignette differs from the report cited above in being produced by the code within the tobalcepi R package. This vignette therefore presents the risk functions and acts as a means to quality assure the code in the tobalcepi R package.

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1 Introduction

This document presents the list of health conditions related to alcohol which are included in the most recent version (4.0) of the Sheffield Alcohol Policy Model (SAPM). It also presents the corresponding dose-response curves (the mathematical relationships between volume of alcohol consumed and risk of morbidity/mortality) for all included conditions which are not wholly-attributable to alcohol. This is based on recent reviews by Rehm et al. (2017; 2017) and Sherk et al. (2020), as well as previous versions of the Sheffield Model (Meier et al. 2016) supplemented with additional evidence as appropriate. Note that SAPM considers only conditions which affect the drinker and therefore several conditions related to alcohol, such as Foetal Alcohol Spectrum Disorders, are therefore not included.

2 Acknowledgements

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Table 1: List of alcohol-attributable diseases.

Category	Condition	ICD-10 code(s)	Condition type*
Cancer	Oropharyngeal cancer	C00-06, C09-10, C12-C14	Partial chronic
	Oesophageal cancer	C15	
	Colorectal cancer	C18-C20	
	Cancer of the liver and intrahepatic bile ducts	C22	
	Pancreatic cancer	C25	
	Laryngeal cancer	C32	
	Breast cancer	C50	
Cardiovascular	Hypertensive diseases	I10-I14	100% chronic
	Ischaemic heart disease	I20-I25	
	Alcoholic cardiomyopathy	I42.6	
	Cardiac arrhythmias	I47-I49	
	Haemorrhagic stroke	I60-I62	
	Ischaemic stroke	I63-I67	
Digestive	Cirrhosis of the liver (excluding alcoholic liver disease)	K70 (excl. K70.0-K70.4, K70.9), K73-K74	100% chronic
	Alcoholic Gastritis	K29.2	
	Alcoholic liver disease	K70.0-K70.4, K70.9	
	Acute pancreatitis (alcohol induced)	K85.2	
	Acute pancreatitis	K85 (excl. K85.2, K85.3)	
	Chronic pancreatitis (alcohol induced)	K86.0	
	Chronic pancreatitis	K86 (excl. K86.0)	
	Accidental poisoning by exposure to noxious substances	X40-X49 (excl. X45), Y10-Y14, Y16-Y19, T36-T50, T52-T65	Partial acute

Table 1: List of alcohol-attributable diseases. (*continued*)

Category	Condition	ICD-10 code(s)	Condition type*
Poisoning	Excessive Blood Level of Alcohol	R78.0	100% acute
	Toxic effect of alcohol	T51.0, T51.1, T51.8, T51.9	
	Alcohol poisoning	X45, X65, Y15	
	Evidence of alcohol involvement determined by blood alcohol level	Y90	
Injuries	Transport injuries (including road traffic accidents)	V01-V98, Y85.0	Partial acute
	Fall injuries	W00-W19	
	Exposure to mechanical forces (including machinery accidents)	W20-W52	
	Drowning	W65-W74, Y21	
	Fire injuries	X00-X09, Y26	
	Other Unintentional Injuries	W75-W99, X10-X33, Y20, Y22-Y25, Y27-Y29, Y31-Y34	
	Intentional self-harm	X60-X84 (excl. X65), Y87.0	
	Assault	X85-Y09, Y87.1	
Endocrine	Other intentional injuries	Y35	Partial chronic
	Diabetes (Type II)	E11	
	Alcohol-induced pseudo-Cushing's syndrome	E24.4	100% chronic
Mental Health	Acute intoxication	F10.0	100% acute
	Mental and behavioural disorders due to use of alcohol	F10.1-F10.9	
Nervous System	Degeneration	G31.2	100% chronic
	Epilepsy and status epilepticus	G40-G41	Partial chronic
	Alcoholic polyneuropathy	G62.1	100% chronic
	Alcoholic myopathy	G72.1	
Other	Maternal care for (suspected) damage to foetus from alcohol	O35.4	
Respiratory	Tuberculosis	A15-A19	Partial chronic
	Lower respiratory tract infections	J09-J18	

* 100% conditions are those which are wholly-attributable to alcohol (i.e. which would not exist if nobody drank). Partial conditions are those which are partly attributable to alcohol but which would still exist, albeit with reduced prevalence, if nobody drank. Acute conditions are those which are related to intoxication. Chronic conditions are those which are related to chronic alcohol consumption in the longer term.

3 Dose-response curves for partially alcohol attributable chronic conditions

Relative risk of harm for drinkers at consumption level x , measured in grams of ethanol per day, versus lifetime abstainers. Due to small sample sizes, published risk functions are not stable above 150g/day, so we assume $RR(x) = RR(150) \forall x > 150$ for all conditions. All risk functions are applied to both genders and for both mortality and morbidity except where stated otherwise.

3.1 Cancers

3.1.1 Oropharyngeal (C00-06, C09-10, C12-14)

$$\ln(RR(x)) = 0.02474x - 0.00004x^2 \quad (1)$$

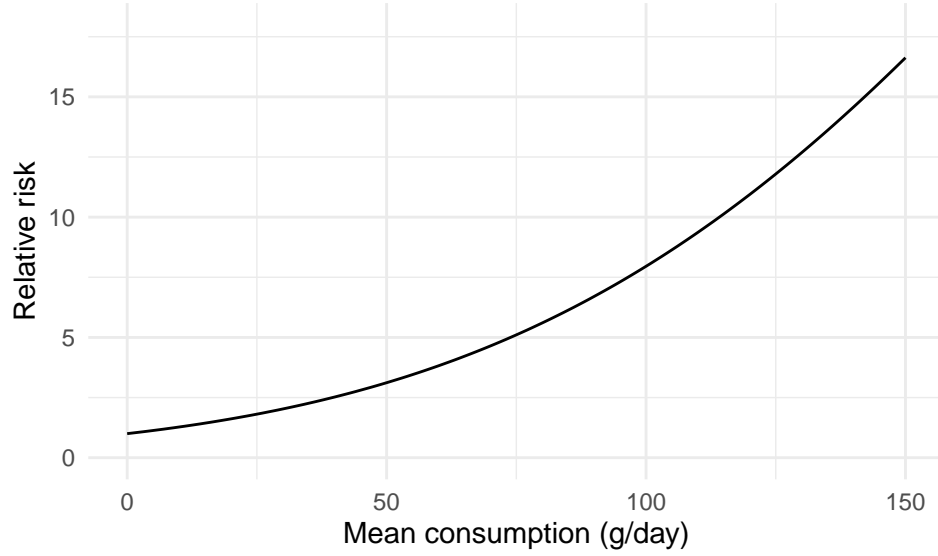


Figure 1: Relative risk for Oropharyngeal cancer by the average daily consumption of alcohol.

Source ([Bagnardi et al. 2015](#))

3.1.2 Oesophageal (C15)

$$\ln(RR(x)) = 0.05593x - 0.00789x \ln(x) \quad (2)$$

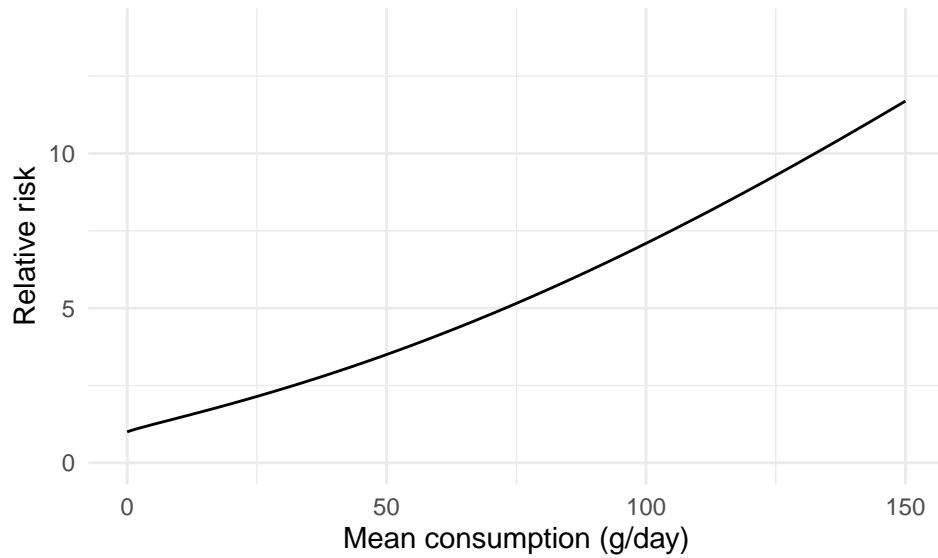


Figure 2: Relative risk for Oesophageal cancer by the average daily consumption of alcohol.

Source ([Bagnardi et al. 2015](#))

Notes: Oesophageal cancer has two main histological types: Squamous Cell Carcinoma (SCC) and Adenocarcinoma (AC). Alcohol is only associated with SCC, not AC ([Bagnardi et al. 2015](#)). The relative prevalence of SCC and AC varies widely between countries and within population subgroups ([Arnold et al. 2015](#)) and it may therefore be necessary to apportion overall oesophageal cancer prevalence between SCC and AC using external data such as that from cancer registries.

3.1.3 Colorectal (C18-C20)

$$\ln(RR(x)) = 0.006279x \quad (3)$$

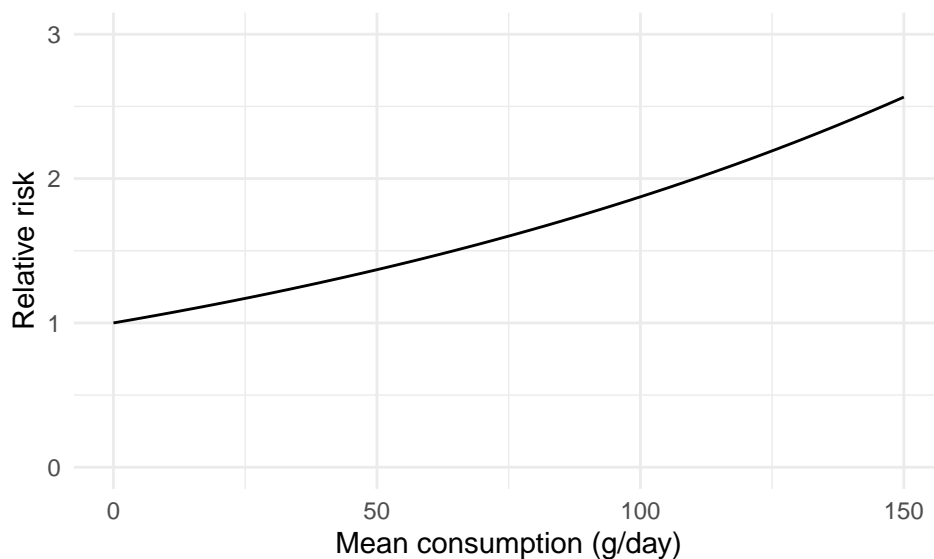


Figure 3: Relative risk for Colorectal cancer by the average daily consumption of alcohol.

3.1.4 Liver and intrahepatic bile ducts (C22)

$$\ln(RR(x)) = 0.4100701(y - 0.6728571429) + 0.6101417(y^2 - 0.4527367347), \quad (4)$$

where

$$y = \frac{x + 12}{100} \quad (5)$$

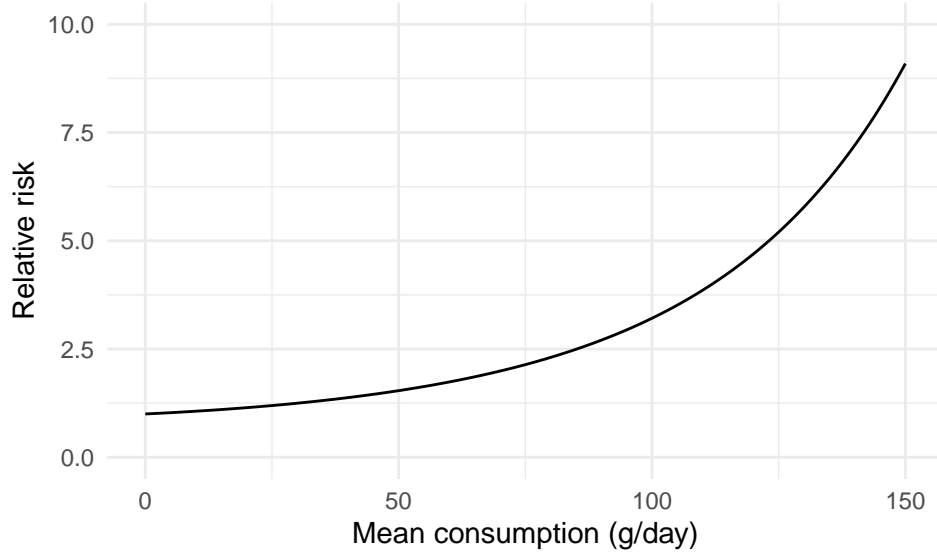


Figure 4: Relative risk for Liver cancer by the average daily consumption of alcohol.

Source ([Chuang et al. 2015](#))

Notes: Bagnardi et al. ([2015](#)), which we use as the source for all other cancer risk curves do provide a curve for liver cancer, however this has extremely high Relative Risks at high levels of consumption (RR=45 at 150g/day), driven by high risks from a small number of case-control studies. Alternative meta-analyses from Chuang et al ([2015](#)) and Turati et al ([2014](#)) have found lower risks at high levels of consumption ([Chuang et al. 2015](#); [Turati et al. 2014](#)), however these risk curves are still quite divergent. It may therefore be advisable to present modelled estimates using several alternative sources to illustrate the impact of this uncertainty.

3.1.5 Pancreatic (C25)

$$\ln(RR(x)) = 0.002089x \quad (6)$$

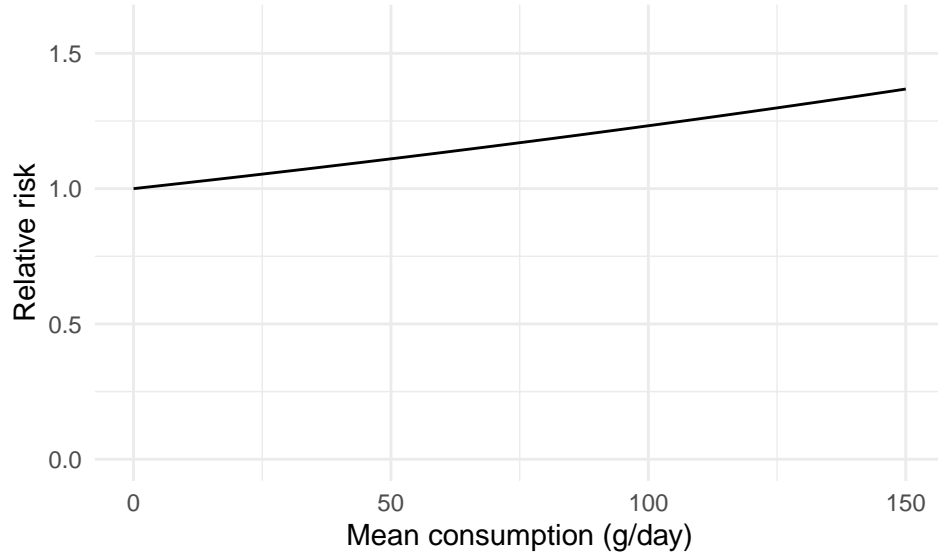


Figure 5: Relative risk for Pancreatic cancer by the average daily consumption of alcohol.

Source ([Bagnardi et al. 2015](#))

3.1.6 Laryngeal (C32)

$$\ln(RR(x)) = 0.01462x - 0.00002x^2 \quad (7)$$

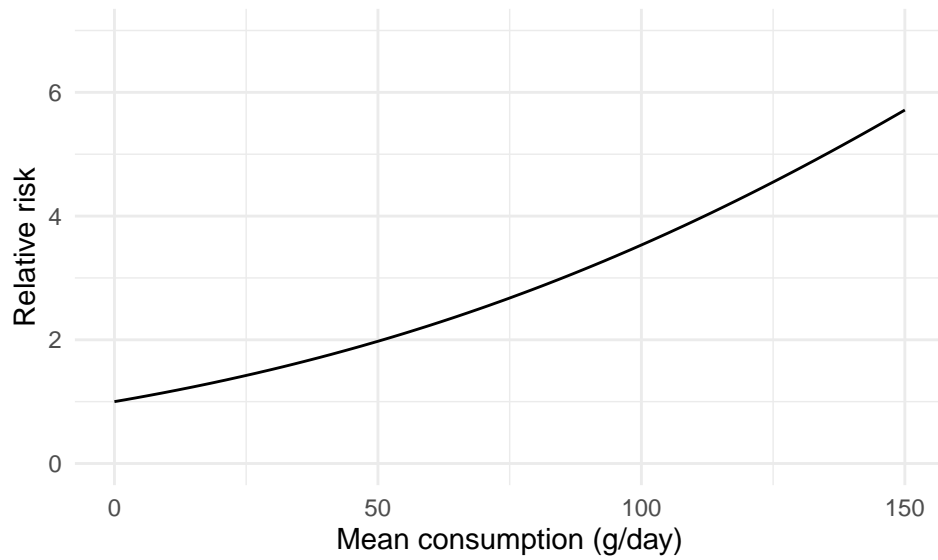


Figure 6: Relative risk for Laryngeal cancer by the average daily consumption of alcohol.

Source ([Bagnardi et al. 2015](#))

3.1.7 Breast (C50)

$$\ln(RR(x)) = 0.01018x \quad (8)$$

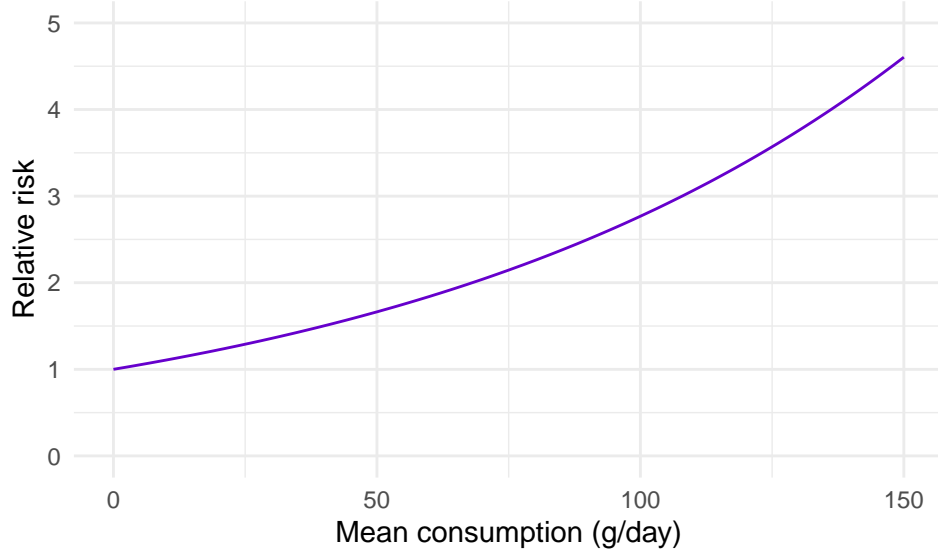


Figure 7: Relative risk for Laryngeal cancer by the average daily consumption of alcohol.

Source ([Bagnardi et al. 2015](#))

3.2 Cardiovascular diseases

3.2.1 Hypertensive diseases (I10-I14)

$$\text{Male } \ln(RR(x)) = \begin{cases} 0.0150537x - 0.0156155 \frac{x^3}{75^2}, & \text{if } 0 \leq x < 21 \\ 0.0150537x - 0.0156155 \frac{x^3 - \frac{(x-21)^3 \times 75}{(75-21)}}{75^2}, & \text{if } 21 \leq x < 75 \\ 0.0150537x - 0.0156155 \frac{x^3 - \frac{(x-10)^3 \times 20 - (x-20)^3 \times 10}{(75-21)}}{75^2}, & \text{if } 75 \leq x \end{cases} \quad (9)$$

$$\text{Female } \ln(RR(x)) = \begin{cases} 0, & \text{if } 0 \leq x < 18.9517 \\ -0.0154196x + 0.0217586 \frac{x^3 - \frac{(x-10)^3 \times 20 - (x-20)^3 \times 10}{(20-10)}}{20^2}, & \text{if } 18.9517 \leq x < 75 \\ 0.9649937, & \text{if } 75 \leq x \end{cases} \quad (10)$$

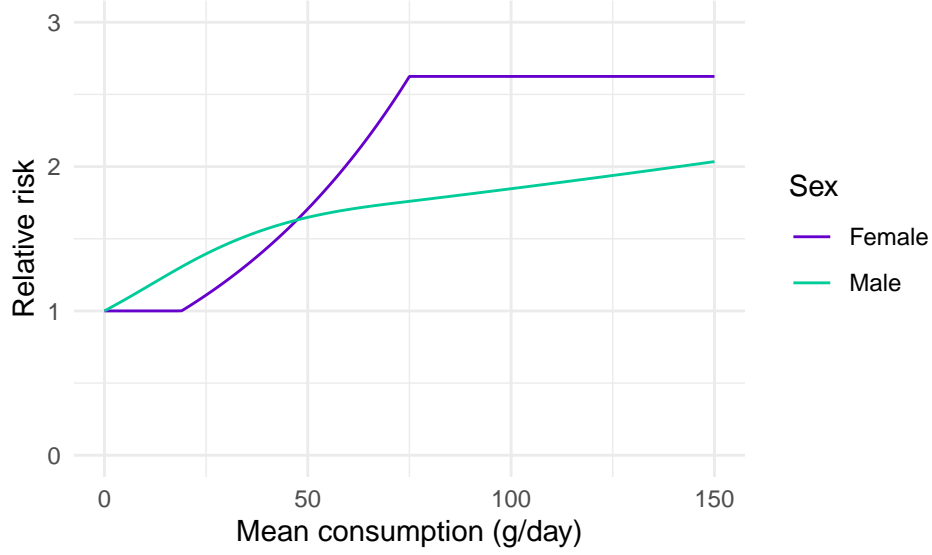


Figure 8: Relative risk for Hypertensive diseases by the average daily consumption of alcohol.

Source ([J. Rehm et al. 2017](#))

3.2.2 Ischaemic heart disease (I20-I25)

3.2.2.1 Mortality

$$\text{Male, 16-34 } \ln(RR(x)) = \begin{cases} 1.111874(-0.4870068\sqrt{y} + 1.550984y^3), & \text{if } 0 \leq x \leq 60 \\ 0, & \text{if } 60 < x < 100 \\ 0.012(x - 100), & \text{if } 100 \leq x \end{cases} \quad (11)$$

$$\text{Male, 35-64 } \ln(RR(x)) = \begin{cases} 1.035623(-0.4870068\sqrt{y} + 1.550984y^3), & \text{if } 0 \leq x \leq 60 \\ 0, & \text{if } 60 < x < 100 \\ 0.012(x - 100), & \text{if } 100 \leq x \end{cases} \quad (12)$$

$$\text{Male, 65+ } \ln(RR(x)) = \begin{cases} 0.757104(-0.4870068\sqrt{y} + 1.550984y^3), & \text{if } 0 \leq x \leq 60 \\ 0, & \text{if } 60 < x < 100 \\ 0.012(x - 100), & \text{if } 100 \leq x \end{cases} \quad (13)$$

$$\text{Female, 16-34 } \ln(RR(x)) = \begin{cases} 1.111874(1.832441y + 1.538557y \ln(y)), & \text{if } 0 \leq x < 30.3814 \\ 0.01(x - 30.3814), & \text{if } 30.3814 \leq x \end{cases} \quad (14)$$

$$\text{Female, 35-64 } \ln(RR(x)) = \begin{cases} 1.035623(1.832441y + 1.538557y \ln(y)), & \text{if } 0 \leq x < 30.3814 \\ 0.0093(x - 30.3814), & \text{if } 30.3814 \leq x \end{cases} \quad (15)$$

$$\text{Female, 65+ } \ln(RR(x)) = \begin{cases} 0.757104(1.832441y + 1.538557y \ln(y)), & \text{if } 0 \leq x < 30.3814 \\ 0.0068(x - 30.3814), & \text{if } 30.3814 \leq x \end{cases} \quad (16)$$

where

$$y = \frac{x + 0.0099999997764826}{100} \quad (17)$$

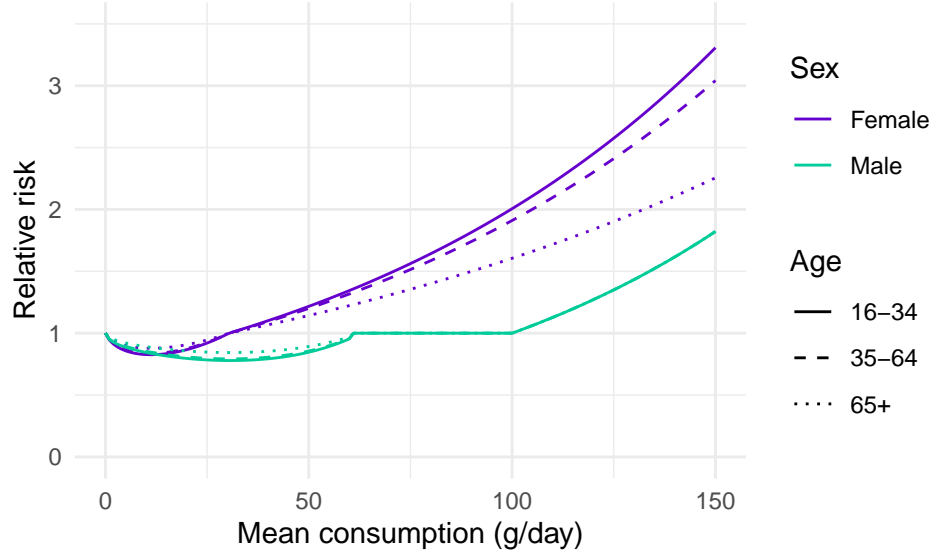


Figure 9: Relative risk for mortality from Ischaemic heart disease by the average daily consumption of alcohol.

Source ([Jürgen Rehm et al. 2016](#))

Notes: All protective effects are removed for drinkers who consume more than 60g in a single drinking occasion at least once per month, as per ([Roerecke and Rehm 2010](#))

3.2.2.2 Morbidity

$$\text{Male } \ln(RR(x)) = \begin{cases} -0.1178113\sqrt{x} + 0.0189\sqrt{x} \ln(x), & \text{if } 0 \leq x < 60 \\ 0, & \text{if } 60 \leq x \end{cases} \quad (18)$$

$$\text{Female } \ln(RR(x)) = -0.296842\sqrt{x} + 0.0392805x \quad (19)$$

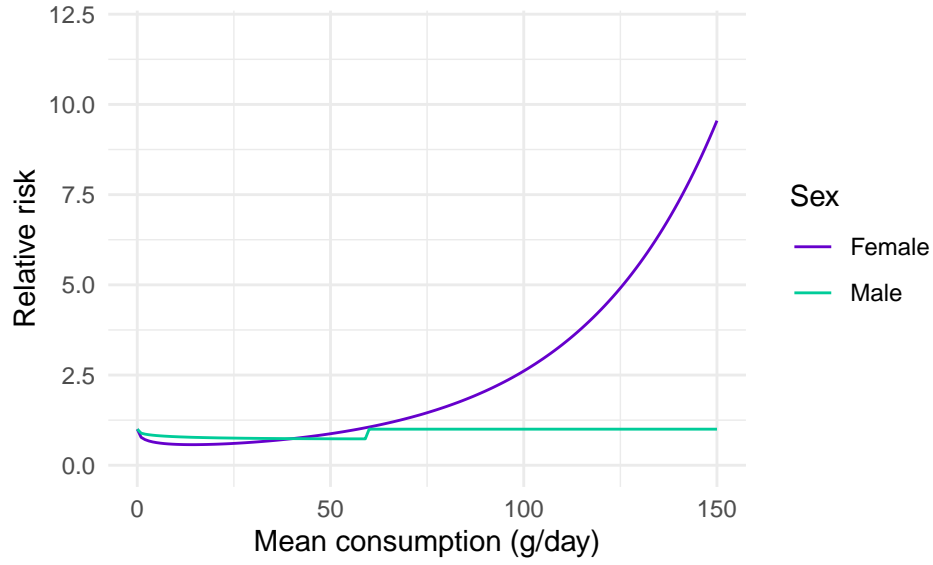


Figure 10: Relative risk for mortality from Ischaemic heart disease by the average daily consumption of alcohol.

Source ([Roerecke and Rehm 2012](#))

Notes: All protective effects are removed for drinkers who consume more than 60g in a single drinking occasion at least once per month, as per ([Roerecke and Rehm 2010](#))

3.2.3 Cardiac arrhythmias (I47-I49)

$$\ln(RR(x)) = 0.0575183 \times \frac{(x + 0.0499992370605469)}{10} \quad (20)$$

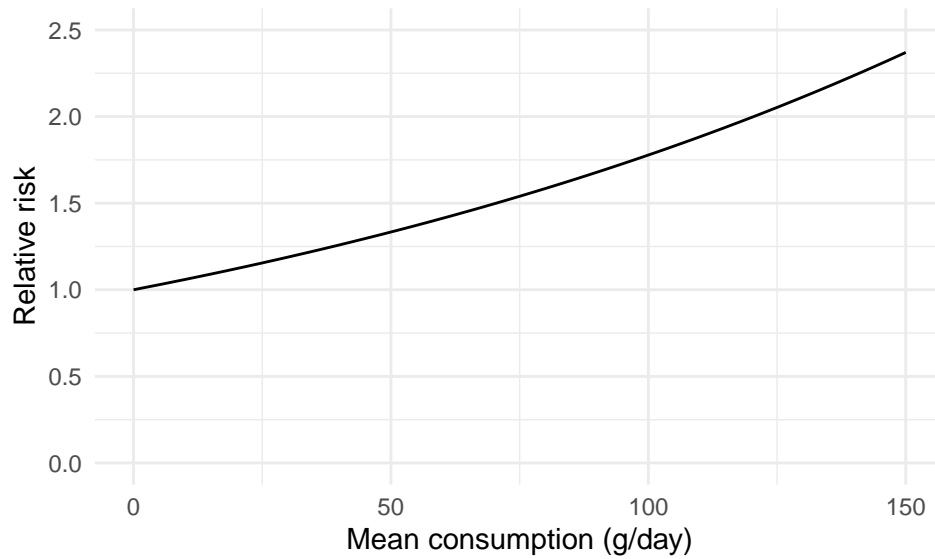


Figure 11: Relative risk for mortality from Cardiac arrhythmias by the average daily consumption of alcohol.

Source ([A. V. Samokhvalov, Irving, and Rehm 2010](#))

3.2.4 Haemorrhagic and other non-ischaemic stroke (I60-I62)

3.2.4.1 Mortality

$$\text{Male } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - 1.006943)), & \text{if } 0 \leq x \leq 1 \\ 0.6898937 \times \frac{x+0.0028572082519531}{100}, & \text{if } x > 1 \end{cases} \quad (21)$$

$$\text{Female } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - 1.014815)), & \text{if } 0 \leq x \leq 1 \\ 1.466406 \times \frac{x+0.0028572082519531}{100}, & \text{if } x > 1 \end{cases} \quad (22)$$

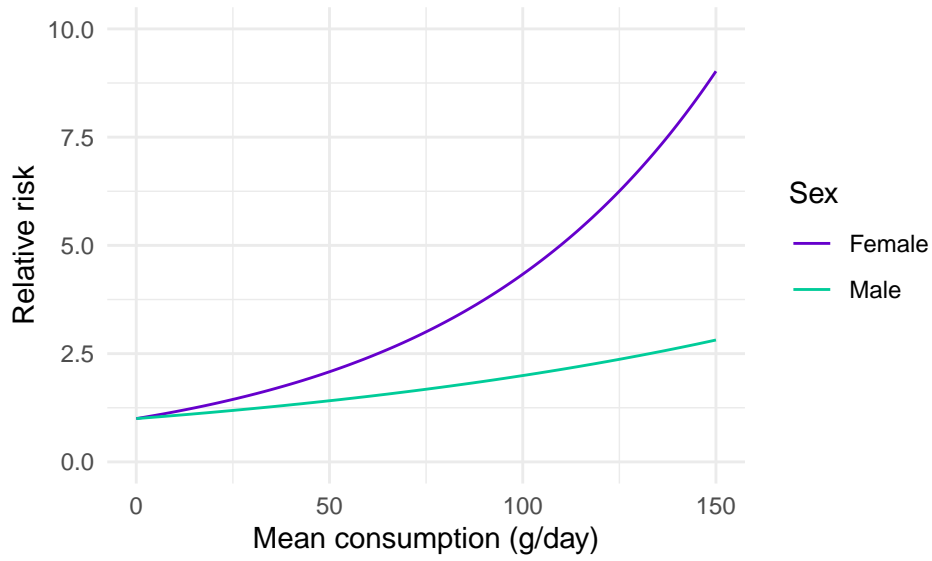


Figure 12: Relative risk for mortality from Haemorrhagic and other non-ischaemic stroke by the average daily consumption of alcohol.

Source ([Patra et al. 2010](#))

3.2.4.2 Morbidity

$$\text{Male } \ln(RR(x)) = 0.007695021x \quad (23)$$

$$\text{Female } \ln(RR(x)) = -0.340861\sqrt{x} + 0.0944208\sqrt{x} \ln(x) \quad (24)$$

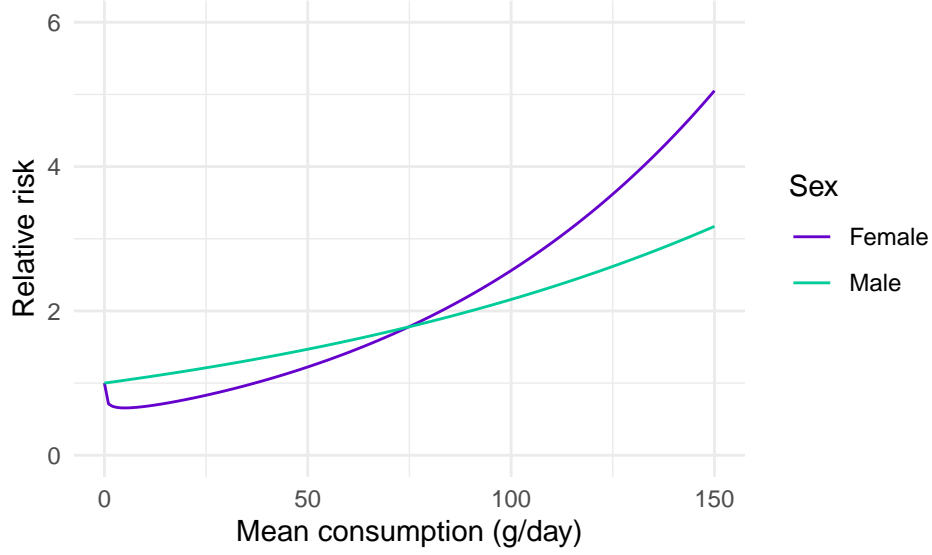


Figure 13: Relative risk for morbidity from Haemorrhagic and other non-ischæmic stroke by the average daily consumption of alcohol.

Source ([Patra et al. 2010](#))

3.2.5 Ischaemic stroke (I63-I67)

3.2.5.1 Mortality

$$\text{Male, 16-34 } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.03521})), & \text{if } 0 \leq x \leq 1 \\ 1.111874 \times (0.4030081\sqrt{y} + 0.3877538\sqrt{y}\ln(y)), & \text{if } x > 1 \end{cases} \quad (25)$$

$$\text{Male, 35-64 } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.03279})), & \text{if } 0 \leq x \leq 1 \\ 1.035623 \times (0.4030081\sqrt{y} + 0.3877538\sqrt{y}\ln(y)), & \text{if } x > 1 \end{cases} \quad (26)$$

$$\text{Male, 65+ } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.02397})), & \text{if } 0 \leq x \leq 1 \\ 0.757104 \times (0.4030081\sqrt{y} + 0.3877538\sqrt{y}\ln(y)), & \text{if } x > 1 \end{cases} \quad (27)$$

$$\text{Female, 16-34 } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.37987})), & \text{if } 0 \leq x \leq 1 \\ 1.111874 \times (-2.48768\sqrt{y} + 3.708724y), & \text{if } x > 1 \end{cases} \quad (28)$$

$$\text{Female, 35-64 } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.35382})), & \text{if } 0 \leq x \leq 1 \\ 1.035623 \times (-2.48768\sqrt{y} + 3.708724y), & \text{if } x > 1 \end{cases} \quad (29)$$

$$\text{Female, 65+ } \ln(RR(x)) = \begin{cases} \ln(1 - x(1 - e^{-0.25866})), & \text{if } 0 \leq x \leq 1 \\ 0.757104 \times (-2.48768\sqrt{y} + 3.708724y), & \text{if } x > 1 \end{cases} \quad (30)$$

where

$$y = \frac{x + 0.0028572082519531}{100} \quad (31)$$

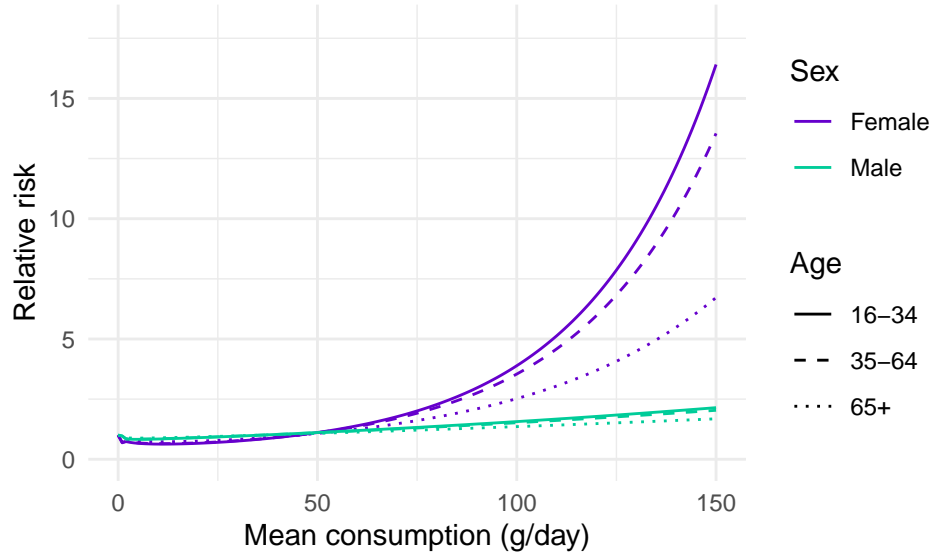


Figure 14: Relative risk for mortality from Ischaemic stroke by the average daily consumption of alcohol.

Source ([Jürgen Rehm et al. 2016](#))

Notes: All protective effects are removed for drinkers who consume more than 60g in a single drinking occasion at least once per month, as per ([Jürgen Rehm et al. 2016](#))

3.2.5.2 Morbidity

$$\text{Male } \ln(RR(x)) = -0.132894\sqrt{x} + 0.03677422\sqrt{x}\ln(x) \quad (32)$$

$$\text{Female } \ln(RR(x)) = -0.114287\sqrt{x} + 0.01680936x \quad (33)$$

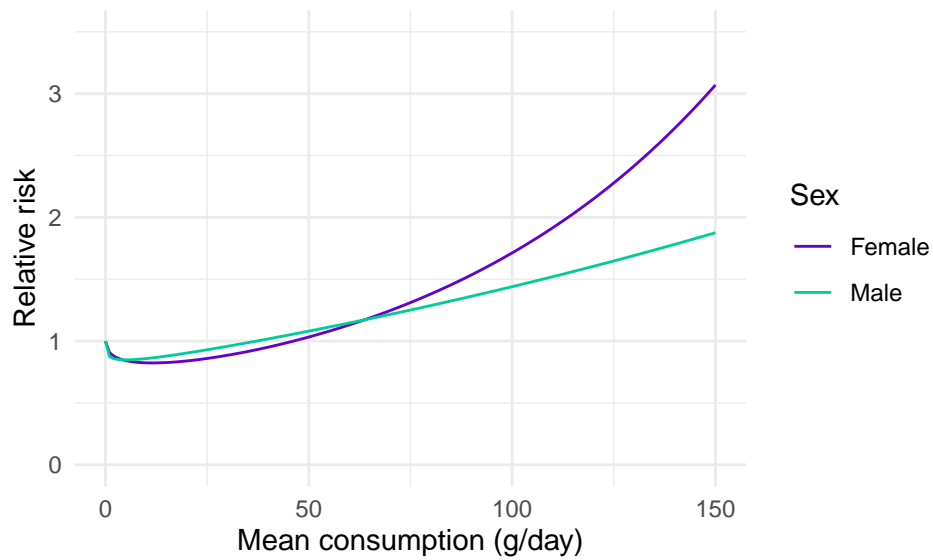


Figure 15: Relative risk for morbidity from Ischaemic stroke by the average daily consumption of alcohol.

Source (Patra et al. 2010)

Notes: All protective effects are removed for drinkers who consume more than 60g in a single drinking occasion at least once per month, as per (Jürgen Rehm et al. 2016)

3.3 Digestive diseases

3.3.1 Cirrhosis of the liver (K70 (excl. K70.0-K70.4, K70.9), K73-K74)

3.3.1.1 Mortality

$$\text{Male } \ln(RR(x)) = \begin{cases} \ln(1 + x(1.033224 - 1)), & \text{if } 0 \leq x \leq 1 \\ 2.793524 \times \frac{x + 0.1699981689453125}{100}, & \text{if } x > 1 \end{cases} \quad (34)$$

$$\text{Female } \ln(RR(x)) = \begin{cases} \ln(1 + x(1.421569 - 1)), & \text{if } 0 \leq x \leq 1 \\ 3.252035 \times \frac{x + 0.1699981689453125}{100}, & \text{if } x > 1 \end{cases} \quad (35)$$

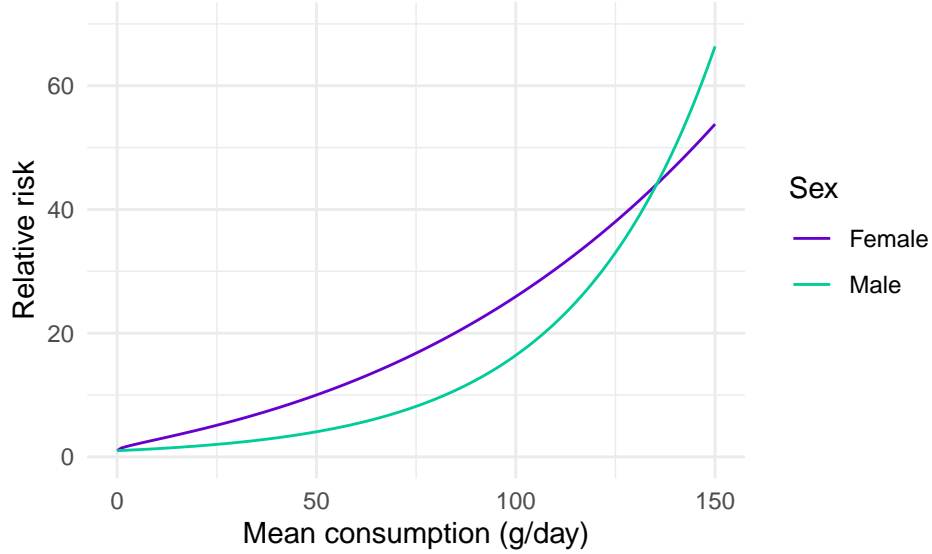


Figure 16: Relative risk for mortality from Cirrhosis of the liver by the average daily consumption of alcohol.

3.3.1.2 Morbidity

$$\text{Male } \ln(RR(x)) = 0.01687111x \quad (36)$$

$$\text{Female } \ln(RR(x)) = 0.2351821\sqrt{x} \quad (37)$$

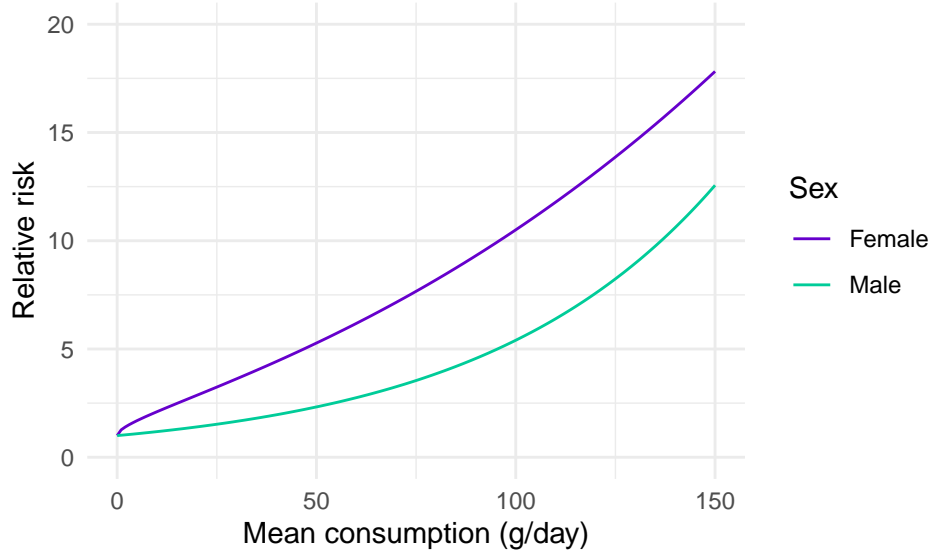


Figure 17: Relative risk for morbidity from Cirrhosis of the liver by the average daily consumption of alcohol.

Source ([Jürgen Rehm et al. 2010](#))

3.3.2 Acute pancreatitis (K85 (excl. K85.2, K85.3))

$$\text{Male } \ln(RR(x)) = 0.013x \quad (38)$$

$$\text{Female } \ln(RR(x)) = \begin{cases} -0.0272886x, & \text{if } 0 \leq x < 3 \\ -0.0272886x + 0.0611466 \times \frac{(x-3)^3}{(40-3)^2}, & \text{if } 3 \leq x < 15 \\ -0.0272886x + 0.0611466 \times \frac{(x-3)^3 - \frac{(x-15)^3 \times (40-3)}{40-15}}{(40-3)^2}, & \text{if } 15 \leq x < 40 \\ -0.0272886x + 0.0611466 \times \frac{(x-3)^3 - \frac{(x-15)^3 \times (40-3) - (x-40)^3 \times (15-3)}{40-15}}{(40-3)^2}, & \text{if } 40 \leq x < 108 \\ 2.327965, & \text{if } 108 \leq x \end{cases} \quad (39)$$

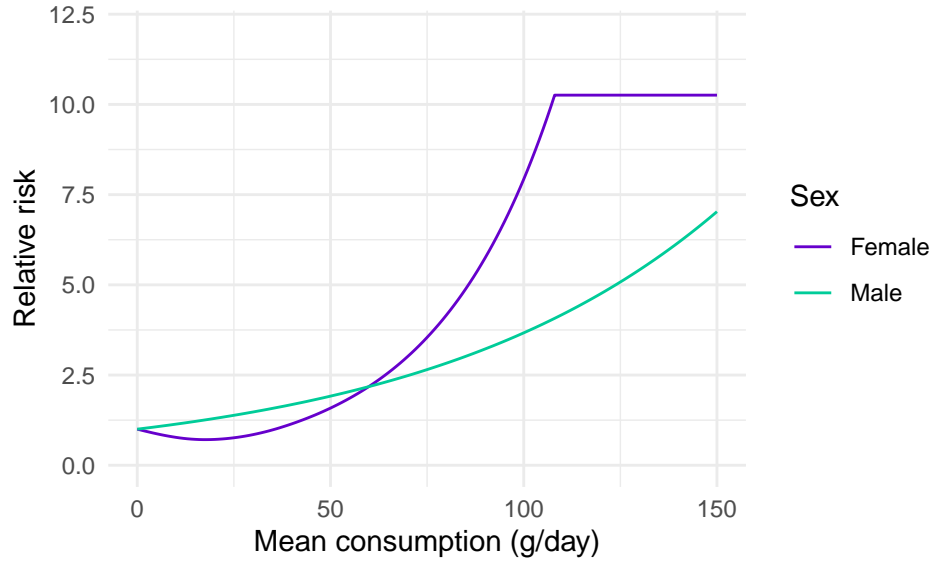


Figure 18: Relative risk for Acute pancreatitis by the average daily consumption of alcohol.

Source ([A. V. Samokhvalov, Rehm, and Roerecke 2015](#))

3.3.3 Chronic pancreatitis (K86 (excl. K86.0))

$$\ln(RR(x)) = 0.018x \quad (40)$$

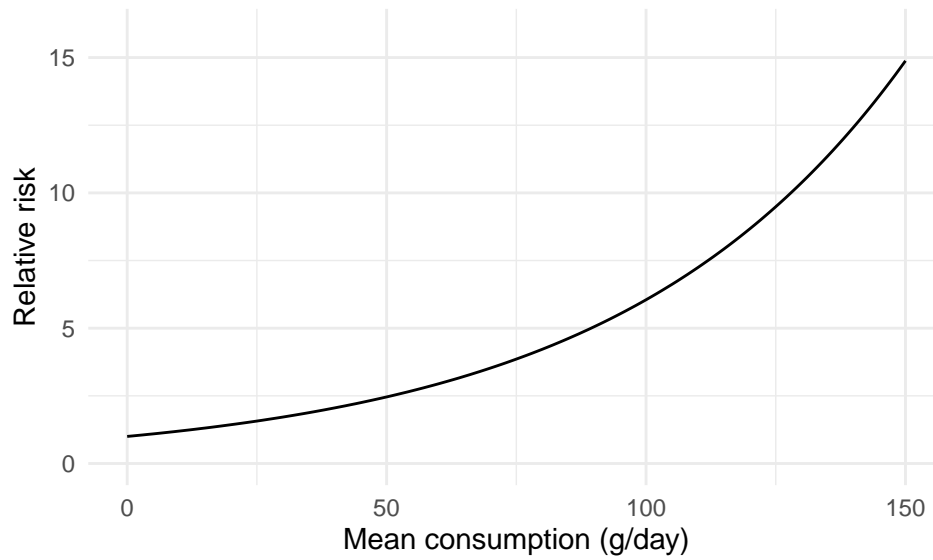


Figure 19: Relative risk for Acute pancreatitis by the average daily consumption of alcohol.

Source ([A. V. Samokhvalov, Rehm, and Roerecke 2015](#))

3.4 Endocrine diseases

3.4.1 Diabetes mellitus (type II) (E11)

$$\text{Male } \ln(RR(x)) = 0.00001763703x^2 - 0.0000000728256x^3 \quad (41)$$

$$\text{Female } \ln(RR(x)) = -0.1313991\sqrt{x} + 0.01014239x \quad (42)$$

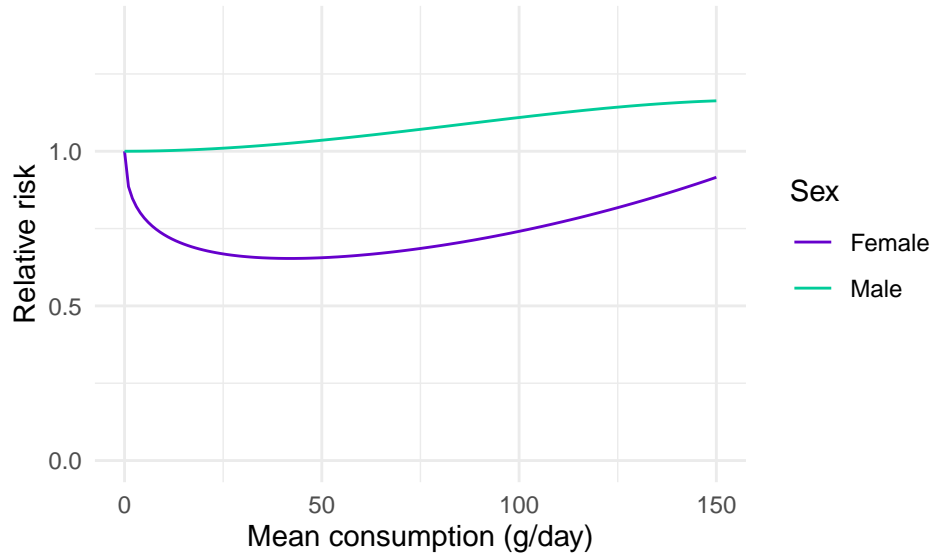


Figure 20: Relative risk for Diabetes mellitus (type II) by the average daily consumption of alcohol.

Source ([Knott, Bell, and Britton 2015](#))

3.5 Diseases of the nervous system

3.5.1 Epilepsy and status epilepticus (G40-G41)

$$\ln(RR(x)) = 1.22861 \times \frac{x + 0.5}{100} \quad (43)$$

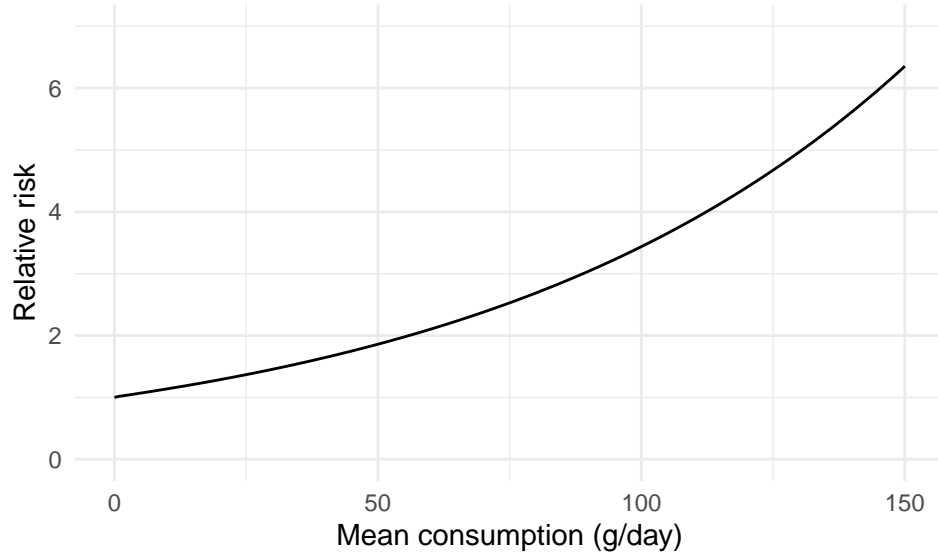


Figure 21: Relative risk for Epilepsy and status epilepticus by the average daily consumption of alcohol.

Source ([A. V. Samokhvalov et al. 2010](#))

3.6 Respiratory diseases

3.6.1 Tuberculosis (A15-A19)

$$\ln(RR(x)) = 0.0179695x \quad (44)$$

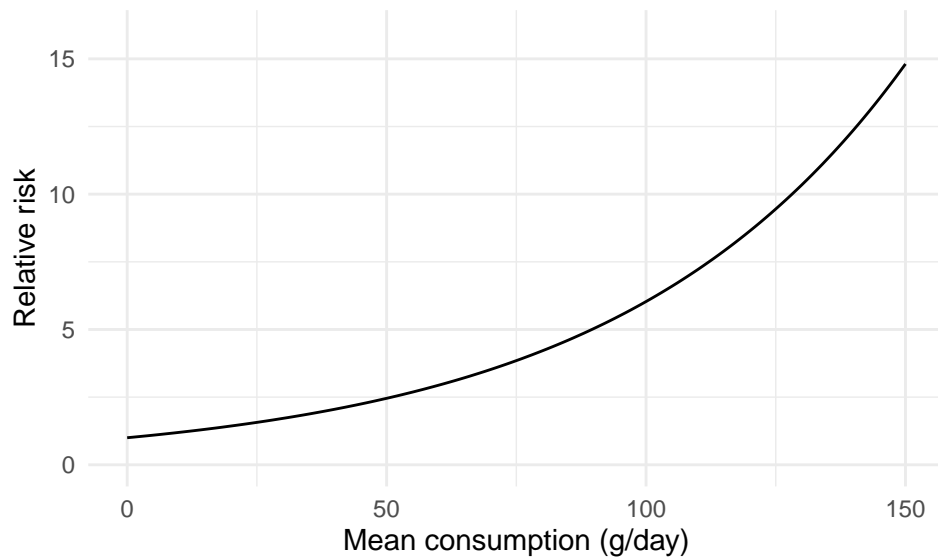


Figure 22: Relative risk for Tuberculosis by the average daily consumption of alcohol.

Source ([Imtiaz et al. 2017](#))

3.6.2 Lower respiratory tract infections (J09-J18)

$$\ln(RR(x)) = 0.4764038 \times \frac{x + 0.0399999618530273}{100} \quad (45)$$

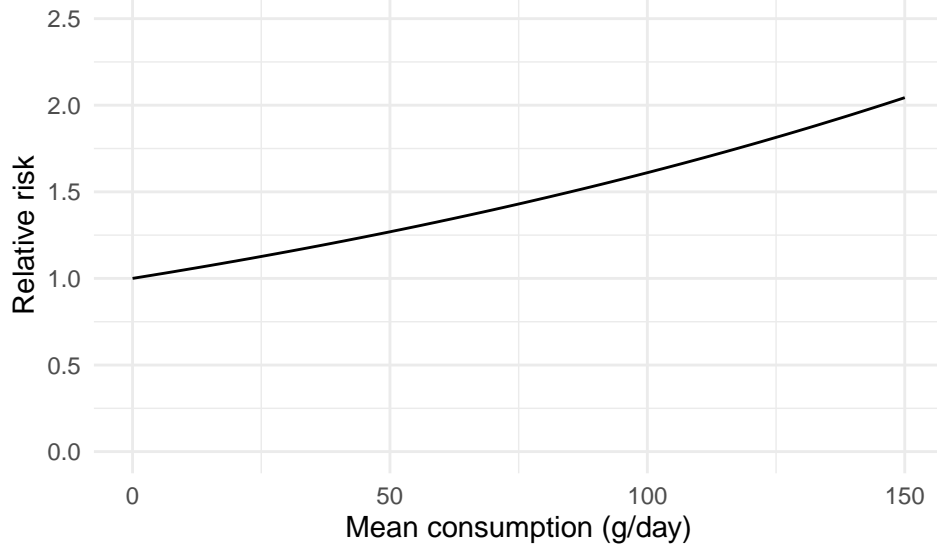


Figure 23: Relative risk for Lower respiratory tract infections by the average daily consumption of alcohol.

Source ([A. Samokhvalov, Irving, and Rehm 2010](#))

4 Dose-response curves for partially alcohol attributable acute conditions

Relative risk of harm for drinkers at consumption level x , measured in grams of ethanol consumed *on a single drinking occasion*, versus non-drinkers. All risk functions are applied to both genders and for both mortality and morbidity except where stated otherwise.

4.1 Transport Injuries (V01-V98, Y85.0)

$$RR(x) = \frac{e^{0.837637 \times (\ln(y) + 3.973538882) + 1.018824 \times (y^3 - 0.00000665184)}}{0.370731 \times (1 + e^{0.837637 \times (\ln(y) + 3.973538882) + 1.018824 \times (y^3 - 0.00000665184)})} \quad (46)$$

where

$$y = \frac{\frac{x}{12.8} + 1}{100} \quad (47)$$

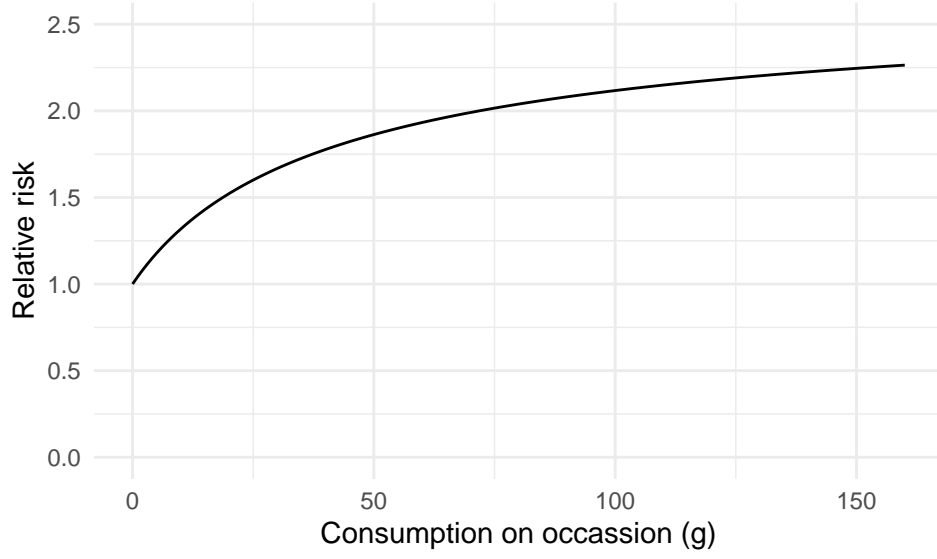


Figure 24: Relative risk for transport injuries by the amount of alcohol consumed on an occasion.

Source ([Cherpitel et al. 2015](#))

4.2 Violent injuries (X85-Y09, Y87.1 & Y35)

$$RR(x) = \frac{e^{-0.42362 \times \left(\frac{1}{\sqrt{y} - 5.084489629} \right) + 0.562549 \times (y^3 - 0.0000578783)}}{0.110872 \times \left(1 + e^{-0.42362 \times \left(\frac{1}{\sqrt{y} - 5.084489629} \right) + 0.562549 \times (y^3 - 0.0000578783)} \right)} \quad (48)$$

where

$$y = \frac{\frac{x}{12.8} + 1}{100} \quad (49)$$

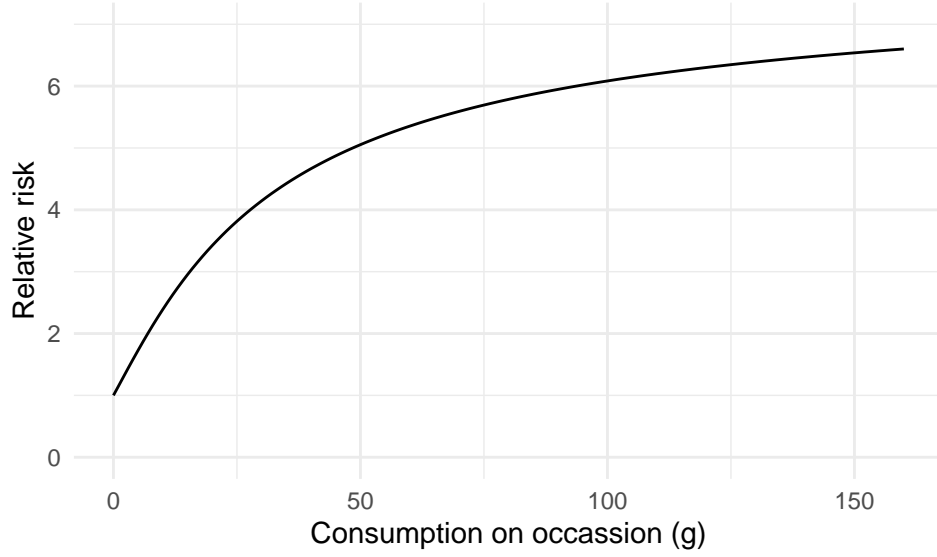


Figure 25: Relative risk for violence by the amount of alcohol consumed on an occasion.

Source ([Cherpitel et al. 2015](#))

4.3 Falls (W00-W19)

$$RR(x) = \frac{e^{17.84434 \times (\sqrt{y} - 0.1398910338) - 17.6229 \times (y - 0.0195695013)}}{0.367446 \times (1 + e^{17.84434 \times (\sqrt{y} - 0.1398910338) - 17.6229 \times (y - 0.0195695013)})} \quad (50)$$

where

$$y = \frac{\frac{x}{12.8} + 1}{100} \quad (51)$$

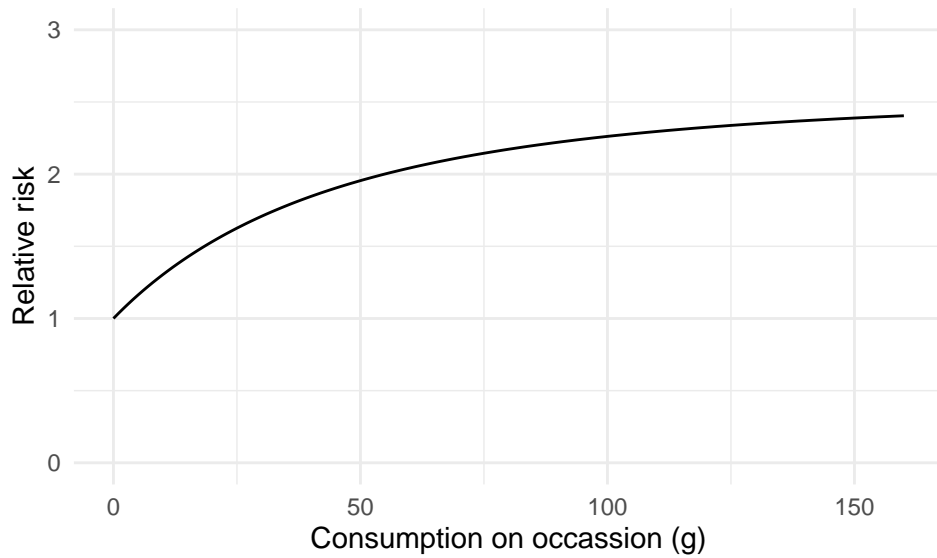


Figure 26: Relative risk for falls by the amount of alcohol consumed on an occasion.

Source (Cherpitel et al. 2015)

4.4 Other injuries (W20-W52, W65-W74, Y21, X00-X09, Y26, W75-W99, X10-X33, Y20, Y22-Y25, Y27-Y29, Y31-Y34, X60-X84 (excl. X65), Y87.0)

$$RR(x) = \frac{e^{-0.28148 \times \left(\frac{1}{\sqrt{y}} - 0.1398910338\right) - 2.00946 \times (y - 0.015761462)}}{0.363279 \times (1 + e^{-0.28148 \times \left(\frac{1}{\sqrt{y}} - 0.1398910338\right) - 2.00946 \times (y - 0.015761462)})} \quad (52)$$

where

$$y = \frac{\frac{x}{12.8} + 1}{100} \quad (53)$$

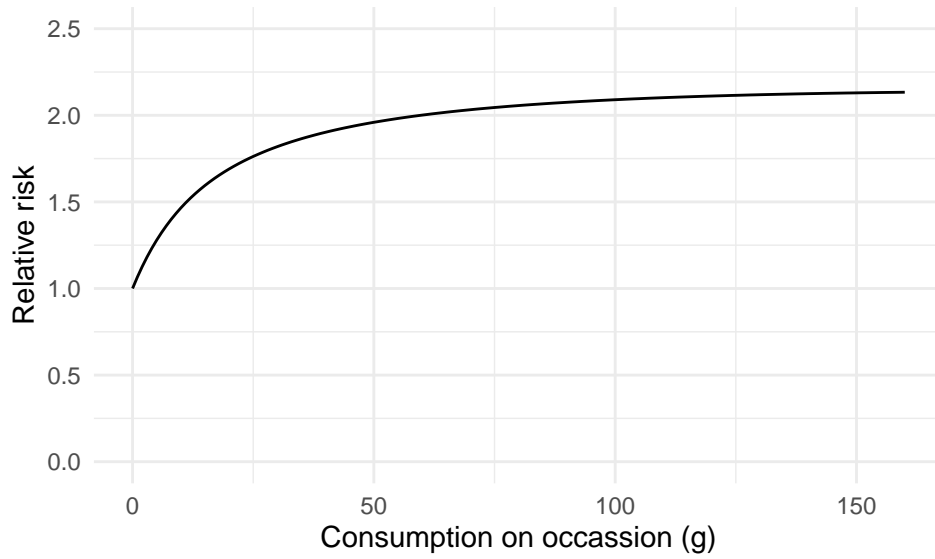


Figure 27: Relative risk for other injuries by the amount of alcohol consumed on an occasion.

Source (Cherpitel et al. 2015)

References

- Arnold, Melina, Isabelle Soerjomataram, Jacques Ferlay, and David Forman. 2015. "Global Incidence of Oesophageal Cancer by Histological Subtype in 2012." *Journal Article. Gut* 64 (3): 381–87.
- Bagnardi, Vincenzo, Matteo Rota, Edoardo Botteri, Irene Tramacere, Farhard Islami, Volodymyr Fedirko, Luciana Scotti, et al. 2015. "Alcohol Consumption and Site-Specific Cancer Risk: A Comprehensive Dose–Response Meta-Analysis." *British Journal of Cancer* 112 (3): 580–93.
- Cherpitel, Cheryl J, Yu Ye, Jason Bond, Guilherme Borges, and Maristela Monteiro. 2015. "Relative Risk of Injury from Acute Alcohol Consumption: Modeling the Dose–Response Relationship in Emergency Department Data from 18 Countries." *Addiction* 110 (2): 279–88.
- Chuang, Shu-Chun, Yuan-Chin Amy Lee, Guo-Jie Wu, Kurt Straif, and Mia Hashibe. 2015. "Alcohol Consumption and Liver Cancer Risk: A Meta-Analysis." *Cancer Causes & Control* 26 (9): 1205–31.
- Imtiaz, Sameer, Kevin D Shield, Michael Roerecke, Andriy V Samokhvalov, Knut Lönnroth, and Jürgen Rehm. 2017. "Alcohol Consumption as a Risk Factor for Tuberculosis: Meta-Analyses and Burden of Disease." *European Respiratory Journal* 50 (1).

- Knott, Craig, Steven Bell, and Annie Britton. 2015. "Alcohol Consumption and the Risk of Type 2 Diabetes: A Systematic Review and Dose-Response Meta-Analysis of More Than 1.9 Million Individuals from 38 Observational Studies." *Diabetes Care* 38 (9): 1804–12.
- Meier, Petra S, John Holmes, Colin Angus, Abdallah K Ally, Yang Meng, and Alan Brennan. 2016. "Estimated Effects of Different Alcohol Taxation and Price Policies on Health Inequalities: A Mathematical Modelling Study." *PLoS Medicine* 13 (2): e1001963.
- Patra, Jayadeep, Benjamin Taylor, Hyacinth Irving, Michael Roerecke, Dolly Baliunas, Satya Mohapatra, and Jürgen Rehm. 2010. "Alcohol Consumption and the Risk of Morbidity and Mortality for Different Stroke Types—a Systematic Review and Meta-Analysis." *BMC Public Health* 10 (1): 1–12.
- Rehm, J, A Sherk, KD Shield, and G Gmel. 2017. *Risk Relations Between Alcohol Use and Non-Injury Causes of Death*. Institute for Mental Health Policy Research. https://www.camh.ca/en/research/news_and_publications/reports_and_books/Documents/CAMH-Risk-relations-between-alcohol-use-and-non-injury-causes-of-death-Sept2017.pdf.
- Rehm, Jürgen, Gerhard E Gmel Sr, Gerrit Gmel, Omer SM Hasan, Sameer Imtiaz, Svetlana Popova, Charlotte Probst, et al. 2017. "The Relationship Between Different Dimensions of Alcohol Use and the Burden of Disease—an Update." *Addiction* 112 (6): 968–1001.
- Rehm, Jürgen, Kevin D Shield, Michael Roerecke, and Gerrit Gmel. 2016. "Modelling the Impact of Alcohol Consumption on Cardiovascular Disease Mortality for Comparative Risk Assessments: An Overview." *BMC Public Health* 16 (1): 1–9.
- Rehm, Jürgen, Benjamin Taylor, Satya Mohapatra, Hyacinth Irving, Dolly Baliunas, Jayadeep Patra, and Michael Roerecke. 2010. "Alcohol as a Risk Factor for Liver Cirrhosis: A Systematic Review and Meta-Analysis." *Drug and Alcohol Review* 29 (4): 437–45.
- Roerecke, Michael, and Jürgen Rehm. 2010. "Irregular Heavy Drinking Occasions and Risk of Ischemic Heart Disease: A Systematic Review and Meta-Analysis." *American Journal of Epidemiology* 171 (6): 633–44.
- . 2012. "The Cardioprotective Association of Average Alcohol Consumption and Ischaemic Heart Disease: A Systematic Review and Meta-Analysis." *Addiction* 107 (7): 1246–60.
- Samokhvalov, Andriy V, Hyacinth M Irving, and Jürgen Rehm. 2010. "Alcohol Consumption as a Risk Factor for Atrial Fibrillation: A Systematic Review and Meta-Analysis." *European Journal of Cardiovascular Prevention & Rehabilitation* 17 (6): 706–12.
- Samokhvalov, Andriy V, Hyacinth Irving, Satya Mohapatra, and Jürgen Rehm. 2010. "Alcohol Consumption, Unprovoked Seizures, and Epilepsy: A Systematic Review and Meta-Analysis." *Epilepsia* 51 (7): 1177–84.
- Samokhvalov, Andriy V, Jürgen Rehm, and Michael Roerecke. 2015. "Alcohol Consumption as a Risk Factor for Acute and Chronic Pancreatitis: A Systematic Review and a Series of Meta-Analyses." *EBioMedicine* 2 (12): 1996–2002.
- Samokhvalov, AV, HM Irving, and J Rehm. 2010. "Alcohol Consumption as a Risk Factor for Pneumonia: A Systematic Review and Meta-Analysis." *Epidemiology & Infection* 138 (12): 1789–95.
- Sherk, Adam, Tim Stockwell, Jürgen Rehm, John Dorocicz, Kevin D Shield, and Samuel Churchill. 2020. "The International Model of Alcohol Harms and Policies: A New Method for Estimating Alcohol Health Harms with Application to Alcohol-Attributable Mortality in Canada." *Journal of Studies on Alcohol and Drugs* 81 (3): 339–51.
- Turati, F, C Galeone, M Rota, Claudio Pelucchi, E Negri, V Bagnardi, G Corrao, P Boffetta, and C La Vecchia. 2014. "Alcohol and Liver Cancer: A Systematic Review and Meta-Analysis of Prospective Studies." *Annals of Oncology* 25 (8): 1526–35.