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Risks and Socioeconomic Costs of Alcohol-Attributable Illnesses

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Contents

List of Tables

I Introduction

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Korea may not be one of the world's biggest alcohol consumers, but the proportion of Koreans binge-drinking and engaging in other forms of high-risk drinking remains persistently high. In 2013, the amount of alcohol consumed per capita per year in South Korea was 8.7 liters, on a par with the OECD average of 9.0 liters (OECD, 2014). However, the rate of alcohol use disorder (AUD) in Korea was 6.2 percent in 2010, higher than the World Health Organization (WHO) average of 4.6 percent (WHO, 2014). As of 2011, one out of every 20 Koreans (4.4 percent or 1.59 million Koreans) were alcoholics (MOHW, 2012).

The medical cost of treating and managing persons with AUD has been on a steady rise. The number of such persons seeking medical care increased 1.5 times from 73,000 to 114,000 over the 10 years from 2003 to 2013, while the total medical costs more than tripled from KRW 120 billion to KRW 375 billion.

The WHO and the governments of various countries have been researching the socioeconomic costs of drinking. The WHO first estimated the global burden of diseases attributable to alcohol in 2003, and concluded that alcohol accounts for 4.0 percent (Rehm et al., 2003). The WHO has been estimating the

attributable (or etiological) fractions of burdens of diseases stemming from alcohol consumption regularly since then.

The Korean government, too, applies the alcohol-attributable fraction (AAF) to estimate these socioeconomic costs, but relies largely upon data available from overseas sources. This study analyzes National Health Insurance (NHI) cohort database (for years 2002~2013) to estimate the risk of illnesses attributable to drinking. The National Health Insurance Service (NHIS)'s NHI Cohort Database specifies the details of medical care provided, of medical costs, and of the data from physical checkups performed on Korean citizens, providing a comprehensive range of information on how alcohol affects these things. Based on the risk of illnesses attributable to alcohol thus estimated, this study calculates the socioeconomic cost of problematic drinking.

II

Illnesses Associated with Alcohol: Literature Survey

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There are two main types of alcohol-related illnesses. The first type includes those that are fully attributable to alcohol consumption. The second type includes those that are partly attributable to alcohol consumption and that affect chronic conditions. The list of illnesses included in each type differs somewhat from study to study. Some studies also include the types of injuries and accidents attributable to alcohol.

Jones et al. (2008) surveyed the literature and provideed lists of illnesses wholly and partly attributable to alcohol consumption as shown in Table 1. The former includes 11 illnesses, while the latter is made up of 42 illnesses.

The illnesses wholly attributable to alcohol include alcohol-induced pseudo-Cushing's syndrome, mental and behavioral disorders due to alcohol use, degeneration of the nervous system due to alcohol, alcoholic polyneuropathy, alcoholic myopathy, alcoholic cardiomyopathy, alcoholic gastritis, alcoholic liver diseases, alcohol-induced chronic pancreatitis, ethanol poisoning, methanol poisoning, unspecified toxic effects of alcohol, and accidental poisoning by and exposure to alcohol.

Rehm et al. (2010) added a few more illnesses to those mentioned above. As Table 2 shows, these additional illnesses in-

clude alcohol-induced acute pancreatitis, maternal care for (suspected) damage to the fetus from alcohol, fetuses and newborns affected by the maternal use of alcohol, and (dysmorphic) fetal alcohol syndrome.

〈Table 1〉 Alcohol-Induced Illnesses

Diagnosis	ICD-10	Source
Wholly attributable conditions		
Alcohol-induced pseudo-Cushing's syndrome	E24.4	
Mental and behavioural disorders due to use of alcohol	F10	
Degeneration of nervous system due to alcohol	G31.2	
Alcoholic polyneuropathy	G62.1	
Alcoholic myopathy	G72.1	
Alcoholic cardiomyopathy	I42.6	
Alcoholic gastritis	K29.2	
Alcoholic liver disease	K70	
Chronic pancreatitis (alcohol induced)	K86.0	
Ethanol poisoning	T51.0	
Methanol poisoning	T51.1	
Toxic effect of alcohol, unspecified	T51.9	
Accidental poisoning by and exposure to alcohol	X45	
Partly attributable – chronic conditions		
Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	Corrao et al., 2004
Malignant neoplasm of oesophagus	C15	Corrao et al., 2004
Malignant neoplasm of colon	C18	Corrao et al., 2004
Malignant neoplasm of rectum	C20	Corrao et al., 2004
Malignant neoplasm of liver and intrahepatic bile ducts	C22	Corrao et al., 2004
Malignant neoplasm of larynx	C32	Corrao et al., 2004
Malignant neoplasm of breast	C50	Hamajima et al., 2002
Diabetes mellitus (type II)	E11	Gutjahr et al., 2001
Epilepsy and Status epilepticus	G40-G41	Rehm et al., 2004
Hypertensive diseases	I10-I15	Corrao et al., 2004

Diagnosis	ICD-10	Source
Ischaemic heart disease	I20-I25	Corrao et al., 2004
Cardiac arrhythmias	I47-I48	Gutjahr et al., 2001
Heart failure	I50-I51	Single et al., 1996
Haemorrhagic stroke	I60-I62, I69.0-I69.2	Corrao et al., 2004
Ischaemic stroke	I63-I66, I69.3-I69.4	Corrao et al., 2004
Oesophageal varices	I85	Corrao et al., 2004
Gastro-oesophageal laceration-haemorrhage syndrome	K22.6	English et al., 1995
Unspecified liver disease	K73, K74	Corrao et al., 2004
Cholelithiasis	K80	Gutjahr et al., 2001
Acute and chronic pancreatitis	K85, K86.1	Corrao et al., 2004
Psoriasis	L40 excluding L40.5	Gutjahr et al., 2001
Spontaneous abortion	O03	Gutjahr et al., 2001
Partly Attributable- acute consequences		
Road traffic accidents - non-pedestrian	V12-V14 (.3 -.9), V19.4-V19.6, V19.9, V20-V28 (.3 -.9), V29-V79 (.4 -.9), V80.3-V80.5, V81.1, V82.1, V82.9, V83-V86 (.0 -.3), V87.0-V87.9, V89.2, V89.3, V89.9	Ridolfo & Stevenson 2001
Pedestrian traffic accidents	V02-V04 (.1, .9), V06.1, V09.2, V09.3	Ridolfo & Stevenson 2001
Water transport accidents	V90-V94	Single et al., 1996
Air/space transport accidents	V95-V97	Single et al., 1996
Fall injuries	W00-W19	Ridolfo & Stevenson 2001
Work/machine injuries	W24-W31	English et al., 1995
Firearm injuries	W32-W34	Single et al., 1996
Drowning	W65-W74	English et al., 1995
Inhalation of gastric contents/Inhalation and	W78, W79	Single et al., 1996

Diagnosis	ICD-10	Source
ingestion of food causing obstruction of the respiratory tract		
Fire injuries	X00-X09	Single et al., 1996
Accidental excessive cold	X31	Single et al., 1996
Intentional self-harm/Event of undetermined intent	X60-X84, Y10-Y34	English et al., 1995
Assault	X85-Y09	Single et al., 1996

Note: English et al. (1995). AAFs are estimated based on the risk of medium/high risk consumption versus low risk consumption.

Source: Jones L., Bellis M., Dedman D. et al. (2008). Alcohol-attributable fractions for England, NorthWest Public Health Observatory Liverpool JMU. Centre for Public Health.

Illnesses partly attributable to alcohol use include seven types of cancer (of the lips, oral cavity and pharynx; of the esophagus; of the colon; of the rectum; of the liver; of the larynx; and of the breast), diabetes mellitus (type-II), epilepsy, hypertensive diseases, ischemic heart diseases, cardiac arrhythmias, heart failure, hemorrhagic stroke, ischemic stroke, esophageal varices, gastro-esophageal laceration-hemorrhage syndrome, unspecified liver diseases, cholelithiasis, acute and chronic pancreatitis, psoriasis, and spontaneous abortion.

〈Table 2〉 Disease Conditions Which Are by Definition Alcohol Attributable (AAF = 100%)

ICD-10	Diagnosis
E24.4	Alcohol-induced pseudo-Cushing's syndrome
F10	Mental and behavioural disorders due to use of alcohol
G31.2	Degeneration of nervous system due to alcohol
G62.1	Alcoholic polyneuropathy
G72.1	Alcoholic myopathy
I42.6	Alcoholic cardiomyopathy
K29.2	Alcoholic gastritis
K70	Alcoholic liver disease
K85.2	Alcohol-induced acute pancreatitis
K86.0	Alcohol-induced chronic pancreatitis
O35.4	Maternal care for (suspected) damage to fetus from alcohol
P04.3	Fetus and newborn affected by maternal use of alcohol
Q86.0	Fetal alcohol syndrome (dysmorphic)
R78.0	Finding of alcohol in blood
T51	Toxic effect of alcohol
X45	Accidental poisoning by and exposure to alcohol
X65	Intentional self-poisoning by and exposure to alcohol
Y15	Poisoning by and exposure to alcohol, undetermined intent
Y90	Evidence of alcohol involvement determined by blood alcohol level

Source: Rehm, Baliunas, Borges et al. (2010). The relation between different dimensions of alcohol consumption and burden of disease: an overview. Addiction 105: 817-843

Table 3 lists the relative risks of alcohol-attributable illnesses that Jones et al. (2008) have estimated for each gender and age group. The fact that the relative risk is greater than one attests to the overall influence that alcohol has on these diseases. In

certain gender and age groups, however, the relative risk remains less than one, suggesting that alcohol is not a direct cause of those diseases. Type-II diabetes, ischemic heart diseases, ischemic stroke, and epilepsy, for instance, show relative risks of alcohol less than one in certain groups.

〈Table 3〉 Estimated Relative Risks of Alcohol on Illnesses in Different Gender & Age Groups

Diagnosis	ICD-10	Male				Female			
	(g/day)	1-19	20-39	40-74	75+	1-19	20-39	40-74	75+
Cancer									
Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	1.43	1.86	3.11	6.45	1.43	1.86	3.11	6.45
Malignant neoplasm of oesophagus	C15	1.20	1.39	1.93	3.59	1.20	1.39	1.93	3.59
Malignant neoplasm of colon	C18	1.03	1.05	1.10	1.21	1.03	1.05	1.10	1.21
Malignant neoplasm of rectum	C20	1.05	1.09	1.19	1.42	1.05	1.09	1.19	1.42
Malignant neoplasm of liver and intrahepatic bile ducts	C22	1.10	1.19	1.40	1.81	1.10	1.19	1.40	1.81
Malignant neoplasm of larynx	C32	1.22	1.43	2.02	3.86	1.22	1.43	2.02	3.86
Malignant neoplasm of breast	C50	-	-	-	-	1.07	1.21	1.35	1.46
Diabetes mellitus (type II)	E11	-	**0.99a**	**0.57**	**0.73**	**0.92**	**0.87**	1.13b	-
Epilepsy and Status epilepticus	G40-G41	-	1.23a	7.52	6.83	1.34	7.22	7.52b	-
Hypertensive diseases	I10-I15	1.15	1.43	2.04	4.15	1.15	1.43	2.04	4.15
Ischaemic heart disease	I20-I25	**0.82**	**0.85**	**0.98**	1.53	**0.85**	**0.90**	1.10	1.87
Cardiac arrhythmias	I47-I48	-	1.51	2.23	2.23	1.51	2.23	2.23	-
Haemorrhagic stroke	I60-I62, I69.0-I69.2	1.10	1.19	1.82	4.70	1.10	1.19	1.82	4.7
Ischaemic stroke	I63-I66, I69.3-I69.4	**0.85**	**0.90**	1.17	4.37	**0.85**	**0.90**	1.17	4.37

Diagnosis	ICD-10	Male				Female			
	(g/day)	1-19	20-39	40-74	75+	1-19	20-39	40-74	75+
Oesophageal varices	I85	1.95	2.90	7.13	26.53	1.95	2.90	7.13	26.53
Unspecified liver disease	K73, K74	1.95	2.90	7.13	26.53	1.95	2.90	7.13	26.53
Cholelithiasis	K80	-	**0.82a**	**0.68**	**0.50**	**0.82**	**0.68**	**0.5b**	-
Acute and chronic pancreatitis	K85, K86.1	1.12	1.34	1.78	3.19	1.12	1.34	1.78	3.19
Psoriasis	L40 excludingL40.5	-	1.58a	1.60	2.20	1.58	1.60	2.20b	-
Spontaneous abortion	O03	-	-	-	-	1.20	1.76	1.79b	-

Note: a 1-30 g/day; b 40+ g/day.

Source: Jones L., Bellis M., Dedman D. et al. (2008). Alcohol-attributable fractions for England, NorthWest Public Health Observatory Liverpool JMU. Centre for Public Health.

Gao et al. (2014) estimate the burden of drinking in Australia by comparing the existing classification of alcohol-attributable illnesses to that used in the survey on the global burden of diseases (BoD) in 2010. The authors retain much of the same classification shown in the tables above, and add a few more illnesses, i.e., human immunodeficiency virus (HIV) infection, acute lower respiratory infections, and tuberculosis.

〈Table 4〉 Classification of Alcohol-Attributable Illnesses & Their Relative Risks

	ICD-10	RR Source	2010 Global BoD ICD-10
Cancers			
Breast cancer	C50	Corrao et al. (2004)	C50, D0.5-D05.9, D48.6
Colon cancer	C18	Corrao et al. (2004)	C18-C21, D01.0-D01.3, D37.3-D37.5 (Colon and Rectum cancer combined and rectum cancer risk is applied in this group)
Larynx cancer	C32	Corrao et al. (2004)	C32, D02.0, D38.0
Liver cancer	C22	Corrao et al. (2004)	C22, D01.5, D37.6
Oesophagus cancer	C15	Corrao et al. (2004)	C15-C159, D00.1
Oral cavity and pharynx cancer	C00-C14	Corrao et al. (2004)	C00-C13
Rectum cancer	C19-21	Corrao et al. (2004)	-
Cardiovascular diseases			
Alcohol cardiomyopathy	I42.6		Not included
Cardiac arrhythmias	I47-I49	Samokhvalov (2010)	I48 (atrial fibrillation and flutter)
Haemorrhagic stroke	I60-I62, I69.0, I69.1, I69.2	Patra(2010)	I60-I62, I69.0-I69.2, I67.4
Hypertensive disease	I10-I15	Taylor(2009)	I11(hypertensive heart disease)
Ischaemic heart disease(IHD)	I20-I25	Roerecke(2012)	I20-I25
Ischaemic stroke	I63-I67, I69.3	Patra(2010)	I63, I65-I67(except I67.4), I69.3
Conditions arising before birth			
Fetal alcohol syndrome	Q86.0		Not included
Fetus and newborn affected by maternal use of alcoho	P04.3		Not included
Maternal care for damage to foetus from alcohol	O35.4		Not included
Low birth weight	P05-P07	Patra(2011)	Not included
Digestive diseases			
Alcoholic gastritis	K29.2		Not included

	ICD-10	RR Source	2010 Global BoD ICD-10
Liver cirrhosis	K70, K73-K74	Rehm(2010)	
Pancreatitis	K85, K86.0, K86.1	Irving(2009)	
Infectious and parasitic diseases			
HIV	B20-B24	Lima(2009) Hendershot (2009)	B20-B24, C46-C46.9, D84.9
Lower respiratory infections	J10-J22	Samokhvalov (2010)	J09-J11, J13, J14, J12.1, J12 (except J12.1), J15-J22, J85, P23
Tuberculosis	A15-A19, B90	Lonnroth (2008)	A15-A19, B90, P37.0

Notes: 1) Corrao, G., et al., A meta-analysis of alcohol consumption and the risk of 15 diseases. Prev Med, 2004. 38(5): p. 613-9.
2) Samokhvalov, A.V., H.M. Irving, and J. Rehm, Alcohol consumption as a risk factor for atrial fibrillation: a systematic review and meta-analysis. Eur J Cardiovasc Prev Rehabil, 2010. 17(6): p. 706-12.
3) Patra, J., et al., Alcohol consumption and the risk of morbidity and mortality for different stroke types—a systematic review and meta-analysis. BMC Public Health, 2010. 10: p. 258.
4) Taylor, B., et al., Alcohol and hypertension: gender differences in dose-response relationships determined through systematic review and meta-analysis. Addiction, 2009. 104(12): p. 1981-90.
5) Roerecke, M. and J. Rehm, The cardioprotective association of average alcohol consumption and ischaemic heart disease: a systematic review and meta-analysis. Addiction, 2012. 107(7): p. 1246-60.
6) Patra, J., et al., Dose-response relationship between alcohol consumption before and during pregnancy and the risks of low birthweight, preterm birth and small for gestational age (SGA)-a systematic review and meta-analyses. BJOG, 2011. 118(12): p. 1411-21.
7) Rehm, J., et al., Alcohol as a risk factor for liver cirrhosis - a systematic review and meta-analysis. Drug Alcohol Rev, 2010.
8) Irving, H.M., A.V. Samokhvalov, and J. Rehm, Alcohol as a risk factor for pancreatitis. A systematic review and meta-analysis. JOP, 2009. 10(4): p. 387-92.
9) Lima, V.D., et al., The combined effect of modern highly active antiretroviral therapy regimens and adherence on mortality over time. J Acquir Immune Defic Syndr, 2009. 50(5): p. 529-36.
10) Hendershot, C.S., et al., Alcohol use and antiretroviral adherence: review and meta-analysis. J Acquir Immune Defic Syndr, 2009. 52(2): p. 180-202.
11) Samokhvalov, A.V., H.M. Irving, and J. Rehm, Alcohol consumption as a risk factor for pneumonia: a systematic review and meta-analysis. Epidemiol Infect, 2010. 138(12): p. 1789-95.
12) Lonnroth, K., et al., Alcohol use as a risk factor for tuberculosis - a systematic review. BMC Public Health, 2008. 8(1): p. 289.

〈Table 4〉 Classification of Alcohol-Attributable Illnesses & Their Relative Risks (Continued)

	ICD-10	RR Source	2010 Global BoD ICD-10
Injuries			
MVA	**	Taylor(2010)	V01-V04, V06, V09, V10-V19, V20-V29, Y85.0, V30-V79, V87.2-V87.3, V80, V82 (road injuries)
Drowning	W65-W74	Taylor(2010)	
Falling	W00-W19	Taylor(2010)	V05, V81, 83-V86, V88.2, V88.3, V91, 93-V98, W00-W19, V90, V92, W65-W74, X00-X19, X46-X47, X48, X40, X43-X44 W32-W34, W24-W31, W45,W46, Y40-Y84, Y88, X20-X29, W53-W64, W21, W39, W44, W49-W52, W75-W99, X50-X58, X70, X76-X77, X72-X74, X68, X71, X75, X78-X83, X60-X67, X69, X93-X95, X99, X85-X92, X96-X98, Y00-Y08, X30-X39, Y36, Y89.1, Y35, Y89.0
Fires	X00-X09	Taylor(2010)	
Poisonings	X40-X44, X46-X49, Y10-Y14, Y16-Y19	Taylor(2010)	
Poisoning and exposure to alcohol (AFF=1)	T51.0, T51.1, T51.8, T51.9, X45, X65, Y15	Taylor(2010)	
Self-inflected injury	X60-X64, X66-X84, Y87.0	Taylor(2010)	
Violence	X85-Y09, Y87.1	Taylor(2010)	
Other unintentional injuries	Rest of V-series and W20-W64, W75-W99, X10-X39, X50-X59, Y40-Y86, Y88, and Y89	Taylor(2010)	
Other intentional injury	Y35	Taylor(2010)	
Other injures with unknown intent	Y20-Y34	Taylor(2010)	
Neuropsychiatric diseases			
Epilepsy	G40-G41	Samokhvalov (2010)	G40-G41
Mental and behavioural disorders due to use of alcohol(AFF=1)	F10		F10, X45, Q86.0
Other alcohol-induced neuropsychiatric conditions(AFF=1)	G62.1, G31.2, E24.4, G72.1		Not included

	ICD-10	RR Source	2010 Global BoD ICD-10
Others			
Excess alcohol blood levels(AFF=1)	R78.0		Not included
Evidence of alcohol involvement determined by blood alcohol level(AFF=1)	Y90		Not included
Problems related to lifestyle alcohol use(AFF=1)	Z72.1		Not included

Notes: **) V02.1-V02.9, V03.1-V03.9, V04.1-V04.9, V09.2, V09.3, V12.3-V12.9, V13.3-V13.9, V14.3-V14.9, V19.4-V19.6, V20.3-V20.9, V21.3-V21.9, V22.3-V22.9, V23.3-V23.9, V24.3-V24.9, V25.3-V25.9, V26.3-V26.9, V27.3- V27.9, V28.3-V28.9, V29.4-V29.9, V30.4-V30.9, V31.4-V31.9, V32.4-V32.9, V33.4-V33.9, V34.4-V34.9, V35.4-V35.9, V36.4-V36.9, V37.4-V37.9, V38.4-V38.9, V39.4-V39.9, V40.4-V40.9, V41.4-V41.9, V42.4-V42.9, V43.4-V43.9, V44.4-V44.9, V45.4-V45.9, V46.4- V46.9, V47.4-V47.9, V48.4-V48.9, V49.4-V49.9, V50.4-V50.9, V51.4-V51.9,V52.4-V52.9, V53.4-V53.9, V54.4-V54.9, V55.4-V55.9, V56.4-V56.9, V57.4-V57.9, V58.4-V58.9, V59.4-V59.9, V60.4-V60.9, V61.4-V61.9,V62.4-V62.9, V63.4-V63.9, V64.4-V64.9, V65.4- V65.9, V66.4-V66.9, V67.4-V67.9, V68.4-V68.9, V69.4-V69.9, V70.4-V70.9, V71.4-V71.9,V72.4-V72.9, V73.4-V73.9, V74.4-V74.9, V75.4-V75.9, V76.4-V76.9, V77.4-V77.9, V78.4-V78.9, V79.4-V79.9, V80.3-V80.5, V81.1, V82.1, V83.0-V83.3, V84.0-V84.3, V85.0- V85.3, V86.0-V86.3, V87.0-V87.8, V89.2

13) Taylor, B., et al., The more you drink, the harder you fall: A systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug and alcohol dependence, 2010. 110(1-2): p. 108-116.

14) Samokhvalov, A.V., et al., Alcohol consumption, unprovoked seizures, and epilepsy: a systematic review and meta-analysis. Epilepsia, 2010. 51(7): p. 1177-84.

Source: Gao C, Ogeil R, Lloyd B. Alcohol's burden of disease in Australia: FARE and VicHealth in collaboration with Turning Point. 2014

Jones et al. (2013) identifies different formulae to capture the ways in which alcohol consumption affects the onset of illnesses and the risk of mortality (Table 5). Alcohol affects different illnesses differently. For example, it bears a linear correla-

tion to liver cancer, and a J-curve correlation to ischemic heart diseases.

That the relationship between alcohol and illnesses is not always straightforward is a major source of controversy today, with some researchers still maintaining that alcohol inevitably affects all illnesses in a linear manner and is always detrimental to health, while others counter that, given the J-curve effect, moderate and healthy drinking could instead reduce the risks of certain illnesses, such as heart disease.

〈Table 5〉 Correlations between Drinking & Alcohol-Attributable Illnesses

Diagnosis	Source	Sex	Level of Exposure	Relative Risk (correlation)	RR (past drinker vs. lifetime non-drinker)
Malignant neoplasm of lip, oral cavity and pharynx	Tramacere et al., 2010		10g/d:1.29(1.25-1.32) 25g/d:1.85(1.74-1.96) 50g/d:3.24(2.89-3.64) 75g/d:5.42(4.58-6.40) 100g/d:8.61(6.91-10.73) 125g/d:13.02(9.87-17.18)	Non-linear.RRfunctionnotreported.(Quadraticapproximation=1.32+-0.001*alc+0.0008*alc^2)	All-cause mortality
Malignant neoplasm of oesophagus	Islami et al., 2011		〈12.5g/d1.38(1.14-1.67) 〉12.5-〈50g/d2.62(2.07-3.31) 〉50g/d5.54(3.92-7.28)	Not reported. Relationship with moderate and high alcohol intakes	All-cause mortality
Malignant neoplasm of colon and rectum	Ferdiko et al., 2011		-	lnRR=0.006992*alc-0.00001*alc^3	All-cause mortality
Malignant neoplasm of liver and intrahepatic bile ducts	Corrao et al., 2004		25g/d:1.19(1.12-1.27) 50g/d:1.4(1.25-1.56) 100g/d:1.81(1.50-2.19)	Linear	All-cause mortality
Malignant neoplasm of larynx	Islami et al.,2010		〈12.5g/d0.88(0.70-1.12) 〈50g/d1.50(1.23-1.83) 〉50g/d2.46(1.88-3.22)	lnRR=0.01625*alc-0.0003*alc^2	All-cause mortality
Malignant neoplasm of breast	CollaborativeGrouponHormonalFactorsinBreastCancer,2002		〈25g/d:1.0725-34g/d:1.2135-44g/d:1.32〉45g/d:1.46(1.33-1.61)	Linear	All-cause mortality

Diagnosis	Source	Sex	Level of Exposure	Relative Risk (correlation)	RR (past drinker vs. lifetime non-drinker)
Diabetes					
Diabetes mellitus (type II)	Baliunas et al., 2009		nadir 22 g/d: 0.87 (0.76-1.00) deleterious >60 g/d: 1.01 (0.71-1.44)	U-shaped. lnRR= $\beta 1$*alc+ $\beta 2$*alc*ln(alc)	1.18 (0.89-1.52)
			nadir 24 g/d: 0.60 (0.52-0.69) deleterious >50 g/d: 1.02 (0.83-1.26)	U-shaped. lnRR= $\beta 1$*alc$^{0.5}$+$\beta 2$*alc^{3}	1.14 (0.99-1.31)
Hypertensive diseases	Taylor et al.,2009	M	25g/d:1.25(1.19-1.32) 50 g/d: 1.62 (1.46-1.81) 100g/d:2.64(2.14-3.26)	Linear	0.94 (0.49-1.39)
		F	<5g/d:0.82(0.73-0.93) 25g/d:1.24(0.87-1.77) 50g/d:1.81(1.13-2.90) 100g/d:2.81(1.56-5.05)	J-shaped (shallow)	0.94 (0.49-1.39)
Ischaemic heart disease	Corrao et al.,2000	-	nadir20g/d:0.80(0.78-0.83) deleterious >89 g/d: 1.05 (1.00-1.11)	J-shaped. lnRR = 0.01110*alc -0.09867*alc$^{0.5}$	
Ischaemic heart disease	Roerecke & Rehm, 2012 (Mortality)	M	<2.5g/d:0.94(0.74-1.21) 2.5-12 g/d: 0.89(0.79-1.00) 12-24g/d:0.86(0.73-1.02) 24-36g/d:0.78(0.63-0.97)	J-shaped. lnRR = $\beta 1$*alc$^{0.5}$ + $\beta 2$*alc$_3$	1.21 (1.12-1.30)
		F	<5g/d:0.82(0.73-0.93) 25g/d:1.24(0.87-1.77) 50g/d:1.81(1.13-2.90) 100g/d:2.81(1.56-5.05)	J-shaped. lnRR = $\beta 1$*alc + $\beta 2$*alc*ln(alc)	1.39 (1.17-1.66)
Ischaemic heart disease	Roerecke & Rehm, 2012 (Morbidity)	M	<2.5 g/d: 0.82 (0.65-1.02) 2.5-12 g/d: 0.77 (0.65-0.92) 12-24 g/d: 0.75 (0.64-0.88) 24 - 36 g/d: 0.74 (0.53-1.02)	J-shaped. lnRR = $\beta 1$*alc$^{0.5}$ + $\beta 2$*ln(alc)*alc$^{0.5}$	0.99 (0.90-1.08)
		F	<2.5 g/d: 0.91 (0.78-1.07) 2.5-12 g/d: 0.54 (0.45-0.65) 12-24 g/d: 0.61 (0.38-0.99) 24 - 36 g/d: 0.40 (0.14-1.13)	J-shaped. lnRR = $\beta 1$*alc$^{0.5}$ + $\beta 2$*alc	1.11 (0.94-1.32)
Cardiac arrhythmias	Kodama et al., 2011	-	-	Linear. lnRR = 0.0074*alc	Not enough data
Haemorrhagic stroke	Patra et al., 2010	M	12 g: 1.09 (1.06-1.12) 36 g: 1.28 (1.18-1.39)	Linear	1.33 (0.91-1.96)

Diagnosis	Source	Sex	Level of Exposure	Relative Risk (correlation)	RR (past drinker vs. lifetime non-drinker)
Haemorrhagic stroke	Patra et al., 2010 (Mortality)		60 g: 1.51 (1.32-1.73) 84 g: 1.79 (1.48-2.15)		
		F	12 g: 0.89 (0.52-1.52) 36 g: 1.52 (1.08-2.14) 60 g: 2.39 (1.61-3.55) 84 g: 3.66 (2.16-6.19)	J-shaped. lnRR = β1*log(alc) + β2*alc	1.15 (0.71-1.92)
		M	12 g: 1.10 (1.06-1.14) 36 g: 1.32 (1.18-1.47) 60 g: 1.59 (1.32-1.91) 84 g: 1.91 (1.47-2.47)	Linear	1.33 (0.91-1.96)
		F	12 g: 0.69 (0.54-0.89) 36 g: 0.99 (0.73-1.33) 60 g: 1.43 (0.99-2.05) 84 g: 2.03 (1.30-3.18)	J-shaped. lnRR = β1*alc$_{0.5}$ + β2*alc$_{0.5}$*log(alc)	1.15 (0.71-1.92)
Ischaemic stroke	Patra et al., 2010 (Mortality)	M	12 g: 0.86 (0.81-0.93) 36 g: 1.00 (0.94-1.07) 60 g: 1.17 (1.09-1.27) 84 g : 1.36 (1.23-1.50)	J-shaped. lnRR = β1*alc$_{0.5}$ + β2*alc$_{0.5}$*log(alc)	1.33 (0.91-1.96)
		F	12 g: 0.66 (0.55-0.79) 36 g: 0.85 (0.73-1.00) 60 g: 1.35 (1.14-1.60) 84 g: 2.31 (1.70-3.13)	J-shaped. lnRR = β1*alc$_{0.5}$ + β2*alc	1.15 (0.71-1.92)
	Patra et al., 2010 (Morbidity)	M	12 g: 0.87 (0.81-0.93) 36 g: 0.99 (0.92-1.07) 60 g: 1.15 (1.05-1.25) 84 g: 1.32 (1.18-1.47)	J-shaped. lnRR = β1*alc$_{0.5}$ + β2*alc$_{0.5}$*log(alc)	1.33 (0.91-1.96)
		F	12 g: 0.82 (0.74-0.92) 36 g: 0.92 (0.81-1.05) 60 g: 1.13 (0.98-1.31) 84 g: 1.44 (1.19-1.74)	J-shaped. lnRR = β1*alc$_{0.5}$ + β2*alc	1.15 (0.71-1.92)
Pneumonia	Samokhvalov et al.,2010	-	24 g: 1.12 (1.02-1.23) 60 g: 1.33 (1.06-1.67) 120 g: 1.76 (1.13-2.77)	Linear	Not enough data
Unspecified liver disease	Rehm et al., 2010 (Mortality)	M	0-12 g/d: 1.0 (0.6-1.6) 12-24 g/d: 1.6 (1.4-2.0) 24-36 g/d: 2.8 (2.3-3.4) 36-48 g/d: 5.6 (4.5-7.0) 48-60 g/d: 7.0 (5.8-8.5) >60 g/d: 14.0 (11.7-16.7)	Non-linear	1.31 (0.67-2.57)
		F	0-12 g/d: 1.9 (1.1-3.1) 12-24 g/d: 5.6 (4.5-6.9) 24-36 g/d: 7.7 (6.3-9.5) 36-48 g/d: 10.1 (7.5-13.5) 48-60 g/d: 14.7 (11.0-19.6) >60 g/d: 22.7 (17.2-30.1)	Non-linear	6.50 (2.21-19.08)

Diagnosis	Source	Sex	Level of Exposure	Relative Risk (correlation)	RR (past drinker vs. lifetime non-drinker)
	Rehm et al., 2010 (Morbidity)	M	0-12 g/d: 0.3 (0.1-0.9) 12-24 g/d: 0.3 (0.2-0.4) 24-36 g/d: 0.7 (0.5-1.0) 36-48 g/d: 2.0 (1.5-2.7) 48-60 g/d: 2.3 (1.7-3.2) >60 g/d: 5.0 (3.9-6.4)	Non-linear	1.31 (0.67-2.57)
		F	0-12 g/d: 0.4 (0.1-1.2) 12-24 g/d: 1.0 (0.5-1.9) 24-36 g/d: 2.4 (1.8-3.2) 36-48 g: 1.9 (1.4-2.6) 48-60 g: 5.9 (3.7-9.3) >60 g: 6.1 (4.6-8.0)	Non-linear	6.50 (2.21-19.08)
Tuberculosis	Lonnroth et al., 2008	-	≥40 g/d: 2.94 (1.89-4.59)	Relationship between risk and consumption not described	M: 1.21 (1.10-1.32) F: 1.44 (1.28-1.61)
Epilepsy and Status epilepticus	Samokhvalov et al., 2010		25 g/d: 1.37 (1.28-1.47) 50 g/d: 1.86 (1.62-2.13) 100 g/d: 3.44 (2.61-4.52)	Non-linear	All-cause mortality
Acute and chronic pancreatitis	Irving et al., 2009	-	<24 g/d: 1.0 (0.8-1.2) 25 g/d: 1.10 (1.08-1.12) 36-48 g/d: 1.2 (1.0-1.5) >48 g/d: 2.5 (2.0-3.1) 50 g/d: 1.46 (1.34-1.59) 100 g/d: 4.50 (3.22-6.31)	Non-linear	All-cause mortality
Low birth weight	Patra et al., 2011	F	12 g: 1.03 (0.96-1.11) 24 g: 1.23 (1.10-1.36) 36 g: 1.50 (1.30-1.73) 48 g: 1.86 (1.54-2.24) 60 g: 2.32 (1.83-2.93) 72 g: 2.91 (2.18-3.88) 84 g: 3.67 (2.60-5.17)	Non-linear. lnRR = $\beta 1^{*}alc_{0.5} + \beta 2^{*}alc$	NA
Motor vehicle accidents	Taylor et al., 2011	-	Categorical estimates not reported	Non-linear	NA
Non-motor vehicle accidents	Taylor et al., 2011	-	Categorical estimates not reported	Non-linear	NA

Source: Jones L, Belis M. Updating england-specific alcohol-attributable fractions. Liverpool John Moores University Centre for public health. 2013.

Gao et al. (2014) present in Table 6 the findings of a meta-analysis on the existing literature that moderate drinking may be beneficial for patients with ischemic heart disease.

〈Table 6〉 Alcohol-Attributable Injuries & Illnesses: A Meta-Analysis

	Literature	Effect of Alcohol
Cancers		
Breast cancer	[20, 53, 57, 58, 61]	Detrimental in females
Colon cancer	[20, 53-55]	Detrimental
Larynx cancer	[20, 53]	Detrimental
Liver cancer	[20, 53]	Detrimental
Oral cavity and pharynx cancer	[20, 53]	Detrimental
Rectum cancer	[20, 53, 54]	Detrimental
Cardiovascular diseases		
Cardiac arrhythmias	[20, 21, 86]	Detrimental
Hypertensive disease	[20, 23, 69]	Detrimental
Ischaemic heart disease (IHD)	[20, 76]	Beneficial in low-moderate amounts, detrimental in higher amounts or where heavy drinking occasions are present
Ischaemic stroke	[20, 22]	Detrimental or beneficial depends on patterns of drinking (similar to IHD)
Haemorrhagic stroke	[20, 22]	Mainly detrimental, except for moderate alcohol consumption
Diabetes		
Diabetes mellitus	[94-96]	Beneficial (low-moderate levels)
Digestive diseases		
Liver cirrhosis	[20, 100, 103, 162]	Detrimental
Pancreatitis	[20, 27]	Detrimental
Infectious and parasitic diseases		
HIV	[115, 163]	Sufficient evidence of causal impact on course of disease but not incidence
Lower respiratory infections		Detrimental

	Literature	Effect of Alcohol
Tuberculosis	[115, 164]	Detrimental
Injuries		
MVA	[2]	Detrimental
NON-MVA	[2, 134]	Detrimental
Neuropsychiatric diseases		
Epilepsy	[33]	Detrimental

Source: Gao C, Ogeil R, Lloyd B. Alcohol's burden of disease in Australia: FARE and VicHealth in collaboration with Turning Point. 2014

Mindful of this controversy, this study analyzes whether alcohol consumption affects alcohol-attributable illnesses in Korea in a linear manner or according to a J-curve. If alcohol consumption affects health only negatively, as does smoking, we will have to revisit the concept of "moderate drinking" altogether. If, on the other hand, there were health benefits of moderate drinking, policy resources should be concentrated on reducing and preventing at-risk drinking only.

In order to estimate the risks of alcohol-attributable illnesses, this study draws upon NHIS cohort data and Cox's proportional hazards model. The results of this analysis were then used to estimate the socioeconomic costs of drinking in Korea.

III

Methods for Estimating the Health Risks & Socioeconomic Costs of Drinking

1. Estimating the Risk of Alcohol-Attributable Illnesses
2. Estimating the Socioeconomic Costs of Alcohol Consumption

III Methods for Estimating the Health Risks & Socioeconomic Costs of Drinking

1. Estimating the Risk of Alcohol-Attributable Illnesses

In order to estimate the risk of alcohol-attributable illnesses, data from the NHIS cohort database were used. The database provides data on the health insurance cohorts from 2002 to 2013 and is a source of wide-ranging information on how drinking affects physical checkup results and the use of medical services, and, accordingly, the medical costs of drinking. A Cox regression model was set up to perform the analysis.

The Cox model supports multivariate analysis or analysis on the multiple variables that simultaneously influence patients' survival or illnesses. It is a non-parametric model because it does not assume any distribution of variables during the survival period. Nevertheless, because it estimates the regression coefficients using a model, it bears some similarities to parametric methods. In other words, the Cox model is a semi-parametric model. As it assumes proportional hazards, it is also known as Cox's proportional hazards model.

The Cox model captures the log-type hazard function at time t in a linear relationship with multiple variables.

$$h_i(t) = h_0(t)\exp(\beta' z_i)$$
$$= h_0(t)\exp(\beta_1 z_{i1} + \beta_2 z_{i2} + \cdots + \beta_m z_{im})$$

Here, $\beta = (\beta_1, \beta_2, \cdots, \beta_m)$ represents the coefficient of the regression model. The positive sign in front of the regression coefficient means an increase in the hazard function: the larger the coefficient, the greater the risk, and the worse the prognosis.

In order to perform this analysis, patients' answers on the levels of drinking they engaged in, during the period of 2002 through 2004 and as indicated in the NHI cohort database, were used as the basis for determining whether alcohol-attributable illnesses occurred in 2005 and afterward. Because Koreans of a certain age undergo government-paid physical checkups every two years, three-year data were used to analyze statistics on patients that received physical checkups.

The NHI cohort database question on drinking asks each participant how frequently they drink and how much, as shown in the box below.

How often do you drink alcohol? ① Rarely ② Two or three times a week ③ Once or twice a week ④ Three or four times a week ⑤ Almost every day How much alcohol do you drink each time? (2 *hop* of soju = 1 bottle of soju) ① Half a bottle or less ② One bottle ③ One bottle and a half ④ Two bottles or more

Note: 2 *hop* of soju = 360 ml of soju.

The tables below summarize Koreans' frequency and intake of alcohol during 2002 through 2004. Those who answered that they drank almost every day made up 2.8 to 3.2 percent of the population, while others who answered that they drank three or four times a week made up another 6.7 to 6.9 percent.

〈Table 7-1〉 Alcohol Consumption by Koreans: Frequency

How often do you drink?	2002		2003		2004	
	N	%	N	%	N	%
Rarely	50,596	45.2	55,452	47.4	66,993	47.7
Two or three times a month	25,436	22.7	24,766	21.2	29,942	21.3
Once or twice a week	25,020	22.4	24,985	21.4	30,283	21.6
Three to four times a week	7,762	6.9	7,978	6.8	9,341	6.7
Almost every day	3,104	2.8	3,739	3.2	3,907	2.8
Total	111,918	100.0	116,920	100.0	140,466	100.0
Missing values	1,723	-	1,838	-	1,815	-

〈Table 7-2〉 Alcohol Consumption by Koreans: Amount

How much alcohol do you drink each time?	2002		2003		2004	
	N	%	N	%	N	%
Half a bottle of soju or less	25,583	38.5	25,951	39.1	29,387	37.2
One bottle of soju	28,289	42.6	27,712	41.7	33,418	42.3
One bottle and a half of soju	8,894	13.4	8,896	13.4	11,315	14.3
Two bottles of soju or more	3,703	5.6	3,868	5.8	4,829	6.1
Total	66,469	100.0	66,427	100.0	78,949	100.0
Missing values	47,172		52,331		63,332	

〈Table 7-3〉 Alcohol Consumption by Koreans: Cross Analysis of Frequency & Amount

	Half a bottle or less	One bottle	One bottle and a half	Two bottles or more	Total
2003					
Rarely	4,631	610	94	40	5,375
Two or three times a month	12,297	9,159	2,224	854	24,534
Once or twice a week	6,388	12,496	4,424	1,559	24,867
Three to four times a week	1,499	3,869	1,672	902	7,942
Almost every day	1,136	1,578	482	513	3,709
Total	25,951	27,712	8,896	3,868	66,427
2004					
Rarely	5,074	786	113	36	6,009
Two or three times a month	14,511	11,169	2,916	1,056	29,652
Once or twice a week	7,344	15,202	5,534	2,052	30,132
Three to four times a week	1,432	4,519	2,195	1,139	9,285
Almost every day	1,026	1,742	557	546	3,871
Total	29,387	33,418	11,315	4,829	78,949

The National Health and Nutrition Survey of 2013 defines the rate of high-risk drinking as the proportion of the adult population drinking seven or more glasses of alcohol each time on average for men (or five or more glasses on average for women) and drinking twice a week or more often. The NHI cohort database, however, defines the amount of alcohol consumption in terms of the number of bottles of soju consumed, and therefore likely neglects the amount of other types of alcohol Koreans

consume. This study thus estimates the risk of illnesses using the frequency of drinking.

2. Estimating the Socioeconomic Costs of Alcohol Consumption

The existing literature was surveyed and reviewed to define the socioeconomic cost of drinking and identify the different types of costs involved. The socioeconomic costs of drinking include direct, indirect, and intangible costs. Direct costs are of those related to the provision of health insurance and benefits, the indirect medical costs incurred by caregiving and transportation, and the financial costs of alcohol-induced car accidents, fires, crimes, and so forth. Indirect costs include the loss of productivity and the loss of future income due to the premature death of patients. Intangible costs refer to the psychological toll on drinkers and their families.

Before estimating the population attributable risk (PAR),[1] the estimates on the relative risk of alcohol-attributable illnesses, explained earlier, were applied to the formula. Given the limitations of the available data and the difficulty of quantifying subjective experiences, this study estimated each type of socio-

1) Population attributable risk = [Pe(Relative risk -1)]/[1+ Pe(relative Risk -1)].
Pe = proportion of the population that is exposed.

economic cost of alcohol-attributable illnesses only, excluding injuries from such events as alcohol-induced car accidents, fires, and crimes.

〈Table 8〉 Types & Scopes of Socioeconomic Cost of Illnesses Due to At-Risk and High-Risk Drinking

Type of Cost		Sources of Costs		Analyzed?
Tangible costs	Direct costs			
	Medical costs	Direct medical costs (illnesses)	Health insurance costs (inpatient care + outpatient care)	Yes
			Insurance benefits (inpatient care + outpatient care)	Yes
			Prescriptions and drugs	Yes
		Direct medical costs (injuries)	Workers' compensation	No
			Car insurance	No
		Indirect medical costs	Cost of caregiving	Yes
			Cost of transportation	Yes
	Prevention and research			No
	Financial losses	Car accidents		No
		Fires		No
	Crime-related	Crimes	Police administrative expenses	No
		Crime prevention	Insurances and alarm devices	No
	Indirect costs			
	Loss of future income due to premature death	Illnesses		Yes
		Injuries		Yes
	Loss of productivity	Absence from work		Yes
		Decline in productivity		Yes
Intangible costs	Compromised quality of life	Pain of drinkers and families Lower quality of life		No

1) Direct Costs

The direct costs of alcohol-attributable illnesses are the sum of the total annual medical costs on treating the illnesses, the cost of transportation due to outpatient care, and the cost of caregiving due to inpatient care.

Direct Costs =

$$\left(\sum_a\sum_j\sum_i\left\{\frac{E_{ij}^a}{(1-\alpha)}+\frac{OE_{ij}^a}{(1-\beta)}\right\}+\sum_a\sum_j\sum_i(O_{ij}^a\times M_j)+\sum_a\sum_j\sum_i(N_{ij}^a\times I)\right)\times PAR$$

Where

i=0, 1, …, n (age), j=1, 2 (sex), a=1, 2, …, n (illness)

α : Co-payment rate for inpatient care,

β : Cco-payment rate for outpatient care

E_{ij}^a : Cost of inpatient care,

OE_{ij}^a : Cost of outpatient care

O_{ij}^a : Number of outpatient visits,

M_j :Average cost of transportation (round-trip)

N_{ij}^a : Number of inpatient days,

I : Daily average cost of caregiving

PAR: Population attributable risk,

RR: Relative risk,, i: Level of drinking (at-risk or high-risk).

2) Indirect Costs

The indirect costs of alcohol-attributable illnesses mainly include the loss of future income due to the premature death of patients and the loss of productivity. This study estimates the former using the gross loss output approach, which involves first estimating the future expected income that patients could have earned had they lived their full life expectancies, and converting patients' total future expected income from labor into the present value.

Loss of productivity due to the need to treat illnesses was estimated on the basis of the number of days or hours for which patients missed work due to inpatient or outpatient care. The following equations were used to estimate these costs.

Loss of future income due to premature death

$$= \sum_{a}\sum_{j}\sum_{i}\left\{F_{ij}^{a} \times \frac{Y_{j}^{t+\tau} \times p_{ij} \times e_{ij}}{(1+r)^{i}}\right\} \times PAR$$

Where

i=0, 1, ⋯, n (age),, j=1, 2 (sex), a=1, 2, ⋯, n (disease),

t : age upon death, τ: number of years;

F_{ij}^{a} : death toll, $Y_{j}^{t+\tau}$: average annual expected income at time t+τ,

p_{ij} : rate of economic participation,

e_{ij} : employment rate,

r : discount rate.

Loss of productivity $= \sum_{a}\sum_{j}\sum_{i}\{(N_{ij}^{a}+\delta \cdot O_{ij}^{a})\times p_{ij}\times e_{ij}\times y_{ij}\}\times PAR$

Where

i=0, 1, …, n (age), j=1, 2 (sex), a=1, 2, …, n (disease)

N_{ij}^{a} : Number of inpatient days,

δ : Loss of productivity due to outpatient care that could have been replaced by inpatient care,

O_{ij}^{a} : Number of outpatient visits,

p_{ij} : rate of economic participation,

e_{ij} : employment rate,

y_{ij} : daily average income.

3) Selecting Alcohol-Attributable Illnesses

Of the diverse cancers, cardiovascular diseases, and digestive system diseases attributable to alcohol, this study focused on illnesses whose relative risks are greater than one. The relative risks of these illnesses were estimated earlier.

A relative risk greater than one indicates that the greater the exposure is to the given risk factor, the greater the likelihood of contracting the given illness. Table 9 below lists illnesses that are 100 percent attributable to drinking and that were subjected to this study's analysis as a result.

In order to estimate the risks of alcohol-attributable illnesses, this study defined at-risk drinkers as those who drink alcohol three to four times a week, and high-risk drinkers as those who drink every day or nearly every day (five to seven times a week). The National Health and Nutrition Survey, however, adopts a slightly different classification of at-risk and high-risk drinkers.

In order to estimate the prevalence of illnesses among at-risk and high-risk drinkers, this study applied the definitions of at-risk and high-risk drinking used in the National Health and Nutrition Survey.

〈Table 9〉 Distribution of Drinking Behavior

Age		20-29	30-39	40-49	50-59	60-69	70+
High-risk drinkers* (%)	Male	2.69	4.14	7.35	10.07	5.18	3.30
	Female	2.10	1.23	1.64	1.13	0.28	0.00
	Total	2.42	2.67	4.46	5.47	2.58	1.27
At-risk drinkers* (%)	Male	15.62	19.12	17.43	9.72	3.75	0.70
	Female	7.20	6.04	2.59	2.88	0.51	0.00
	Total	11.69	12.49	9.91	6.20	2.03	0.27
N	Male	277	392	463	422	390	335
	Female	355	574	618	622	481	520
	Total	632	966	1,081	1,044	871	855

Note: "At-risk drinkers" = men who drink seven glasses of soju or more or women who drink five glasses of soju or more each time, and who drink so two to three times a week.
"High-risk drinkers" = men who drink seven glasses of soju or more or women who drink five glasses of soju or more each time, and who drink so four times a week or more often.
*Determined by assigning weights.

4) Estimating the PARs

This study then sought to estimate the PARs of each chosen illness by applying the formula,

[Pe(RR - 1)]/[1+ Pe(RR - 1)].[2] Because at-risk drinking and high-risk drinking affects different sets of illnesses, this estimation had to be performed twice for each illness.

5) Direct Non-Medical Costs of Drinking

The direct non-medical costs of drinking in this study are made up of the costs of caregiving and transportation associated with the treatment of alcohol-attributable illnesses. In order to estimate the cost of caregiving, the number of per capita inpatient days was multiplied by the daily cost of caregiving. While the amount of time spent on caregiving can differ depending on the severity of the given illness, this study applied KRW 45,000 to each day of inpatient care, the cost for 12 hours of caregiving estimated by the Korea Patient Helper Society.

In order to estimate the cost of transportation attendant upon outpatient care, this study drew upon the data for the National Health and Nutrition Survey of 2005. As the same survey of recent years did not ask questions on the costs of trans-

2) Pe = proportion of the population that is exposed.

portation, the cost estimation formula used in Lee et al. (2011) was applied instead. The cost of single-way transportation was KRW 1,981 in 2005. Applying the consumer price index (CPI) raises this to KRW 2,597 by 2013. This single-way cost was multiplied by two to estimate the round-trip cost.

Ⅳ Results

1. Risks of Alcohol-Attributable Cancers
2. Risks of Alcohol-Attributable Cardiovascular Diseases
3. Risks of Other Alcohol-Attributable Illnesses
4. Socioeconomic Costs of Alcohol Consumption
5. Costs of Alcohol-Attributable Injuries & Suicides

Ⅳ Results

1. Risks of Alcohol-Attributable Cancers

High-risk drinkers were 1.85 times more likely to develop cancer of the lips or of the oral cavity than non-drinkers.

〈Table 10〉 Relative Risk of Cancer of the Lips and of the Oral Cavity Due to High-Risk Drinking, and Model Fitness

	Model 1				Model 2			
	Coefficient	SE	Pr〉Chi Sq	RR	Coefficient	SE	Pr〉Chi Sq	RR
Drinking	0.615	0.165	0.000	1.850	0.616	0.165	0.000	1.852
Male	0.109	0.099	0.274	1.115	0.116	0.100	0.245	1.123
Female	-	.	.	.	-	.	.	.
Age	0.016	0.020	0.424	1.016	0.012	0.020	0.554	1.012
Income (Medicare)					0.299	0.276	0.277	1.349
Income (Q1)					0.047	0.160	0.767	1.048
Income (Q2)					-0.110	0.165	0.504	0.896
Income (Q3)					-0.107	0.151	0.477	0.898
Income (Q4)					-0.060	0.138	0.662	0.942
Income (Q5)					-	.	.	.

Test	Model 1		Model 2	
	Chi-Square	Pr 〉 ChiSq	Chi-Square	Pr 〉 ChiSq
Likelihood Ratio	13.5408	0.0036	16.2377	0.0391
Score	16.0662	0.0011	18.9384	0.0152
Wald	15.6242	0.0014	18.4749	0.0179

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.
N = 72,626.

However, the models were unfit to test the relative risk of cancer of the lips and of the oral cavity in at-risk drinkers.

〈Table 11〉 Relative Risk of Cancer of the Lips and of the Oral Cavity Due to At-risk Drinking, and Model Fitness

	Model 1				Model 2			
	Coefficient	SE	Pr〉Chi Sq	RR	Coefficient	SE	Pr〉Chi Sq	RR
Drinking	-0.642	0.211	0.002	0.526	-0.641	0.211	0.002	0.527
Male	0.093	0.102	0.362	1.097	0.099	0.102	0.328	1.105
Female	0.000	.	.	.	0.000	.	.	.
Age	0.007	0.021	0.745	1.007	0.003	0.021	0.905	1.003
Income (Medicare)					0.385	0.277	0.164	1.469
Income (Q1)					0.025	0.168	0.883	1.025
Income (Q2)					0.060	0.161	0.710	1.062
Income (Q3)					-0.095	0.156	0.544	0.910
Income (Q4)					-0.037	0.141	0.792	0.963
Income (Q5)					0.000	.	.	.

Test	Model 1		Model 2	
	Chi-Square	Pr 〉 ChiSq	Chi-Square	Pr 〉 ChiSq
Likelihood Ratio	12.140	0.007	14.987	0.059
Score	10.502	0.015	13.612	0.093
Wald	10.177	0.017	13.253	0.103

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.
N = 72,626.

High-risk drinking was shown to increase the risk of all types of alcohol-attributable cancer.

〈Table 12〉 Relative Risk of Alcohol-Attributable Cancers Due to At-Risk & High-Risk Drinking

Cancer Location	High-risk Drinking		At-risk Drinking	
	Model 1	Model 2	Model 1	Model 2
Oral cavity	1.850**	1.852**	0.526†	0.527†
Esophagus	6.067**	6.010**	2.923**	2.919**
Colon	2.131**	2.131**	1.300**	1.300**†
Rectum	2.463**	2.463**	0.931†	0.931†
Liver	2.928**	2.913**	1.533**	1.534**
Larynx	5.144**	5.213**	2.864**	2.871**
Prostate	2.187**	2.226**	1.417	1.420
Stomach	2.488**	2.474**	1.387**	1.386**

Note: **Significant at 〈 0.05. †Models unfit.
At-risk-drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.
N = 72,626.

2. Risks of Alcohol-Attributable Cardiovascular Diseases

High-risk drinkers are 1.714 times more likely than non-drinkers to suffer from hypertensive diseases.

〈Table 13〉 Relative Risk of Hypertensive Diseases Due to High-Risk Drinking, and Model Fitness

	Model 1				Model 2			
	Coefficient	SE	Pr〉Chi Sq	RR	Coefficient	SE	Pr〉Chi Sq	RR
Drinking	0.539	0.028	〈.0001	1.714	0.539	0.028	〈.0001	1.714
Male	-0.024	0.016	0.137	0.976	-0.024	0.016	0.132	0.976
Female	-	.	.	.	-	.	.	.
Age	-0.004	0.003	0.142	0.996	-0.005	0.003	0.143	0.996
Income (Medicare)					0.109	0.054	0.042	1.115
Income (Q1)					-0.013	0.028	0.645	0.987
Income (Q2)					0.029	0.026	0.269	1.029
Income (Q3)					0.039	0.024	0.100	1.040
Income (Q4)					0.016	0.022	0.467	1.016
Income (Q5)					-	.	.	.

Test	Model 1		Model 2	
	Chi-Square	Pr 〉 ChiSq	Chi-Square	Pr 〉 ChiSq
Likelihood Ratio	323.137	〈.0001	331.021	〈.0001
Score	382.165	〈.0001	390.116	〈.0001
Wald	373.190	〈.0001	381.137	〈.0001

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk-drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.

At-risk drinkers are 1.282 times more likely than non-drinkers to suffer from hypertensive diseases.

〈Table 14〉 Relative Risk of Hypertensive Diseases Due to At-Risk Drinking, and Model Fitness

	Model 1				Model 2			
	Coefficient	SE	Pr〉Chi Sq	RR	Coefficient	SE	Pr〉Chi Sq	RR
Drinking	0.248	0.023	〈.0001	1.282	0.248	0.023	〈.0001	1.282
Male	-0.012	0.016	0.438	0.988	-0.012	0.016	0.447	0.988
Female	-	.	.	.	-	.	.	.
Age	-0.005	0.003	0.112	0.995	-0.005	0.003	0.102	0.995
Income (Medicare)					0.121	0.052	0.021	1.129
Income (Q1)					0.003	0.027	0.905	1.003
Income (Q2)					0.048	0.025	0.059	1.049
Income (Q3)					0.032	0.023	0.169	1.032
Income (Q4)					0.021	0.022	0.338	1.021
Income (Q5)					-	.	.	.

Test	Model 1		Model 2	
	Chi-Square	Pr 〉 ChiSq	Chi-Square	Pr 〉 ChiSq
Likelihood Ratio	115.940	〈.0001	124.581	〈.0001
Score	123.600	〈.0001	132.329	〈.0001
Wald	123.222	〈.0001	131.947	〈.0001

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.

High-risk drinking acts as a risk factor for all types of cardiovascular disease. At-risk drinking, too, increases the risk of hypertensive diseases. The models used in this study, however, were not fit to test whether at-risk drinking raised the risk of other types of cardiovascular disease, such as arrhythmia, heart failure, cerebral hemorrhage, and ischemic heart disease.

〈Table 15〉 Relative Risk of Cardiovascular Disease Due to High-Risk & At-Risk Drinking

	High-risk Drinking		At-risk Drinking	
	Model 1	Model 2	Model 1	Model 2
Arrhythmia	1.237**	1.238**	0.887†	0.887†
Cerebral hemorrhage	1.897**	1.900**	1.178†	1.178†
Hypertensive diseases	1.714**	1.714**	1.282**	1.282**
Ischemic heart diseases	1.337**	1.337**	0.985†	0.985†
Cerebral ischemia	1.481**	1.479**	0.833**(†)	0.832**(†)

Note: ** Significant at 〈 0.05. †Models unfit. (†) Interpretive caution required.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.
N = 72,626.
Model 1=$\alpha+\beta$*sex+β*age+ε
Model 2=$\alpha+\beta$*sex+β*age+β*income+ε

The exact nature of alcohol's influence on cerebral ischemia is a subject of ongoing controversy today. The models used in this study fail to reflect variations in the frequency of drinking and in alcohol intake over time. More in-depth analysis will

thus be needed to determine the relative risk of cerebral ischemia related to different drinking patterns.

Note that low-risk drinking (intake of less than 21 grams of alcohol per day) appears to reduce the relative risk (0.61) of ischemic heart diseases. At-risk drinking (intake of 60 grams or more of alcohol per day), on the other hand, could raise the relative risk to 1.69. These results, however, may reflect errors with the classification of specific diseases making up the category of ischemic heart diseases, the idiosyncratic characteristics of the patient groups compared, and confounding (Emberson and Bennett, 2006).

3. Risks of Other Alcohol-Attributable Illnesses

This study also analyzed the relative risk of other alcohol-attributable illnesses, i.e., diabetes, epilepsy, liver disease, and pancreatic disease.

High-risk drinking increases the risk of diabetes, epilepsy, liver disease, and pancreatic disease. The models used, however, were not fit to test the effect of at-risk drinking on epilepsy.

〈Table 16〉 Relative Risk of Diabetes, Liver Disease & Other Illnesses Due to Drinking

	High-risk Drinking		At-risk Drinking	
	Model 1	Model 2	Model 1	Model 2
Diabetes	1.571**	1.570**	1.151**	1.151**
Liver disease	3.026**	3.024**	2.330**	2.330**
Pancreatic disease	3.029**	3.010**	1.605**	1.604**
Epilepsy	1.480**	1.477**	1.116†	1.116†

Note: ** Significant at 〈 0.05. †Models unfit.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.

4. Socioeconomic Costs of Alcohol Consumption

The socioeconomic costs of alcohol consumption were estimated with respect to alcohol-attributable illnesses, including cancers, cardiovascular disease, and digestive system diseases, whose relative risks were greater than one. A relative risk greater than one indicates a proportional relationship between exposure to a given risk factor and the likelihood of contracting or developing the given illness. The socioeconomic costs were thus estimated with respect to illnesses whose alcohol-related relative risks were greater than one, including illnesses fully attributable to alcohol.

〈Table 17〉 Relative Risk of Alcohol-Attributable Illnesses

Diagnosis		High-risk Drinking	At-risk Drinking
Cancer location	Oral cavity	1.850	-
	Esophagus	6.067	2.923
	Colon	2.131	-
	Rectum	2.463	-
	Liver	2.928	1.533
	Larynx	5.144	2.864
	Prostate	2.187	-
	Stomach	2.488	1.387
Cardiovascular disease	Heart disease	1.335	-
	Stroke	1.482	-
	Arrhythmia	1.237	-
	Cerebral hemorrhage	1.897	-
	Hypertensive diseases	1.714	1.282
	Ischemic heart disease	1.337	-
	Cerebral ischemia	1.481	-
Other	Diabetes	1.571	1.151
	Liver disease	3.026	2.330
	Pancreatic disease	3.029	1.605
	Epilepsy	1.480	-

Note: Relative risk = risk of disease or death in the exposed population / risk of disease or death in the unexposed population.
The relative risk estimates are based upon the NHI cohort database.

〈Table 18〉 Illnesses Fully Attributable to Alcohol (AAF=100%)

Diagnosis	ICD-10
Alcohol-induced pseudo-Cushing's syndrome	E24.4
Mental and behavioural disorders due to use of alcohol	F10
Degeneration of nervous system due to alcohol	G31.2
Alcoholic polyneuropathy	G62.1
Alcoholic myopathy	G72.1
Alcoholic cardiomyopathy	I42.6
Alcoholic gastritis	K29.2
Alcoholic liver disease	K70
Alcohol-induced acute pancreatitis	K85.2
Chronic pancreatitis (alcohol induced)	K86.0
Maternal care for (suspected) damage to fetus from alcohol	O35.4
Fetus and newborn affected by maternal use of alcohol	P04.3
Fetal alcohol syndrome (dysmorphic)	Q86.0
Finding of alcohol in blood	R78.0
Ethanol poisoning	T51.0
Methanol poisoning	T51.1
Toxic effect of alcohol, unspecified	T51.9
Accidental poisoning by and exposure to alcohol	X45
Intentional self-poisoning by and exposure to alcohol	X65
Poisoning by and exposure to alcohol, undetermined intent	Y15
Evidence of alcohol involvement determined by blood alcohol level	Y90

Tables 20 and below list the estimated socioeconomic costs of alcohol-attributable illnesses, which amount to KRW 4.6394 trillion.

The NHIS provides billing data, but the data lack information on the costs of illnesses not covered by the NHI. It was thus necessary to refer, additionally, to the NHIS Survey on the Co-Payments by NHI Participants 2013 (2014). The rates of

co-payment on inpatient care, outpatient care and prescriptions were used to ensure that the socioeconomic cost estimates reflect the cost of co-payments as well.

〈Table 19〉 Rates of Co-payment

	20-44	45-64	65-74	75+
Inpatient care	0.294	0.235	0.189	0.148
Outpatient care	0.294	0.262	0.195	0.148
Prescriptions	0.036	0.035	0.024	0.023

Source: NHIS (2014). Survey on the co-payments by NHI participants 2013.

The analysis shows that alcohol consumption generated total direct medical costs of KRW 1.0382 trillion in 2013.

〈Table 20〉 Direct Medical Costs of Alcohol-Attributable Illnesses (2013)

(Unit: KRW million)

		20-29	30-39	40-49	50-59	60-69	70+	Total
AAF=100%								
	Alcoholic mental and behavioral disorders	4,968	34,826	110,587	164,798	86,271	40,926	442,376
	Alcoholic liver disease	1,260	9,222	32,584	50,642	23,179	10,315	127,202
AAF=Partial								
	Oral cancer	37	130	689	1,836	959	435	4,086
	Esophageal cancer	8	28	1,247	7,819	6,427	3,901	19,430

		20-29	30-39	40-49	50-59	60-69	70+	Total
	Gastric cancer	193	1,669	7,388	18,436	9,760	5,657	43,103
	Colon cancer	93	600	2,537	7,191	4,356	2,814	17,591
	Rectal cancer	30	351	2,355	7,684	4,325	2,656	17,401
	Liver cancer	103	1,489	11,989	37,055	15,728	5,718	72,082
	Laryngeal cancer	3	40	437	2,881	2,527	1,497	7,385
	Prostate cancer	0	3	76	1,323	2,525	3,988	7,915
	Diabetes	425	2,018	9,333	20,065	8,512	4,244	44,597
	Epilepsy	295	328	572	719	222	138	2,274
	Hypertension	284	3,415	19,503	40,591	15,902	8,316	88,011
	Heart disease	14	183	1,771	6,351	3,755	2,480	14,554
	Arrhythmia	57	112	366	861	435	363	2,194
	Stroke	171	730	4,403	13,201	7,581	7,981	34,067
	Liver disease	2,905	8,760	24,518	34,583	9,081	2,403	82,250
	Pancreatic disease	458	1,777	3,918	4,069	1,021	450	11,693
	Total	11,305	65,681	234,272	420,105	202,566	104,282	1,038,211

Note: Direct medical cost = inpatient care cost + outpatient care cost + prescription cost, including the costs incurred by at-risk and high-risk drinkers.

The direct costs of drinking include the direct medical costs for treating patients and the direct non-medical costs generated by the need to obtain care, i.e., the costs of caregiving and transportation. In order to estimate the cost of caregiving, the number of inpatient days was multiplied by the cost of caregiving per day. While the period of time spent on care-

giving varies depending on the severity of illnesses, this study applies the standard caregiving cost of KRW 45,000 per day (12 hours of caregiving, determined by the Korea Patient Helper Society). The total cost of caregiving thus amounted to KRW 190.1 billion.

This study used data from the National Health and Nutrition Survey of 2005 to estimate the cost of transportation associated with outpatient care. As the same survey of recent years did not ask questions on the costs of transportation, the cost estimation formula used in Lee et al. (2011) was applied instead. The cost of single-way transportation was KRW 1,981 in 2005. Applying the CPI raises this to KRW 2,597 by 2013. This single-way cost was multiplied by two to estimate the round-trip cost.

〈Table 21〉 CPI: Transportation

	2005	2006	2007	2008	2009	2010	2011	2012	2013
CPI	83.82	87.70	90.82	98.81	95.31	100.00	107.00	110.45	109.87

Source: NHIS (2014).

The total cost of transportation associated with alcohol-attributable illnesses thus amounted to KRW 16.6 billion.

Loss of future income due to alcohol-attributable premature death involves estimating the total amount of income one could have earned had one lived to the full extent of one's healthy life expectancy without dying prematurely due to an alcohol-attributable illness. In estimating this loss, this study assumed no income would be generated from labor for patients

at age 70 and older.

Loss of future income due to alcohol-attributable premature death was estimated to be KRW 2.9387 trillion. The loss was most acute among patients in their 40s, amounting to KRW 1.2396 trillion.

〈Table 22〉 Loss of Future Income Due to Alcohol-Attributable Premature Death (2013)

(Unit: KRW million)

	20-29	30-39	40-49	50-59	60-69	70+	Total
AAF=100%							
Alcoholic mental and behavioral disorders	3,708	43,965	127,183	118,451	14,009	0	307,317
Alcoholic liver disease	12,710	162,766	702,799	563,238	74,019	0	1,515,532
Other	0	2,406	19,295	11,662	545	0	33,909
AAF=Partial							
Oral cancer	273	674	2,729	5,577	982	0	10,236
Esophageal cancer	0	719	14,503	43,679	9,247	0	68,148
Gastric cancer	2,929	17,649	56,243	76,808	11,425	0	165,054
Colon cancer	1,356	5,959	14,815	18,115	3,751	0	43,997
Rectal cancer	215	1,535	10,483	19,358	3,486	0	35,077
Liver cancer	1,614	26,434	145,129	204,130	25,381	0	402,689
Laryngeal cancer	0	0	1,217	8,270	1,897	0	11,384
Prostate cancer	0	129	532	2,385	1,111	0	4,156
Diabetes	277	2,573	11,582	21,682	3,335	0	39,449
Epilepsy	411	572	854	1,271	103	0	3,210

	20-29	30-39	40-49	50-59	60-69	70+	Total
Hypertension	0	413	2,690	3,392	777	0	7,272
Heart disease	243	2,043	9,869	15,302	2,143	0	29,600
Arrhythmia	396	1,348	4,526	4,815	615	0	11,701
Stroke	767	3,814	18,342	25,343	4,430	0	52,696
Liver disease	1,984	14,678	87,045	69,443	5,939	0	179,090
Pancreatic disease	203	1,891	9,759	5,946	386	0	18,185
Total	27,090	289,567	1,239,596	1,218,867	163,582	0	2,938,702

Loss of productivity refers to the financial cost of decline in productivity as patients absent themselves from work due to the need to receive either inpatient or outpatient care for their alcohol-attributable illnesses. Alcohol-attributable illnesses were estimated to cause a loss of productivity totaling KRW 455.7 billion.

〈Table 23〉 Loss of Productivity Due to Alcohol-Attributable Illnesses (2013)

(Unit: KRW million)

	20-29	30-39	40-49	50-59	60-69	70+	Total
AAF=100%							
Alcoholic mental and behavioral disorders	1,659	25,018	83,980	115,326	30,844	18,391	275,216
Alcoholic liver disease	242	3,129	12,932	19,205	4,011	2,342	41,861
Other	0	0	0	0	0	0	0
AAF=Partial							
Oral cancer	2	22	144	410	89	52	719
Esophageal cancer	0	5	324	1,939	673	471	3,412
Gastric cancer	18	316	1,807	4,401	952	751	8,246
Colon cancer	7	111	601	1,681	412	350	3,163
Rectal cancer	3	58	525	1,821	409	318	3,134
Liver cancer	7	240	2,297	6,378	1,214	645	10,781
Laryngeal cancer	0	8	111	671	272	205	1,266
Prostate cancer	0	1	25	296	218	451	990
Diabetes	57	748	4,600	9,008	1,596	1,007	17,015
Epilepsy	21	64	145	195	33	21	479
Hypertension	61	1,771	12,733	23,364	3,699	2,231	43,859
Heart disease	1	26	287	939	229	187	1,669
Arrhythmia	3	14	69	175	40	43	344
Stroke	21	216	1,690	5,762	1,548	1,991	11,228
Liver disease	541	3,381	10,265	12,505	1,444	467	28,603
Pancreatic disease	58	557	1,499	1,428	136	65	3,742
Total	2,701	35,686	134,035	205,502	47,819	29,985	455,728

Table 24 lists all types of the total socioeconomic costs of alcohol-attributable illnesses in Korea. The grand total cost reaches KRW 4.6394 trillion.

〈Table 24〉 Socioeconomic Costs of Illnesses Attributable to At-Risk & High-Risk Drinking (2013)

(Unit: KRW million)

Age Group	20-29	30-39	40-49	50-59	60-69	70+	Total
Medical cost	11,305	65,681	234,272	420,105	202,566	104,282	1,038,211
Caregiving cost	2,126	14,017	39,369	64,398	42,711	27,525	190,146
Transportation cost	278	1,042	3,567	6,958	3,166	1,612	16,623
Loss of income due to premature death	27,090	289,567	1,239,596	1,218,867	163,582	-	2,938,702
Loss of productivity	2,701	35,686	134,035	205,502	47,819	29,985	455,728
Total	43,500	405,993	1,650,839	1,915,830	459,844	163,404	4,639,410

5. Costs of Alcohol-Attributable Injuries & Suicides

1) Risk of Death Due to Poisoning from At-Risk Drinking

The NHI cohort data of 2011 through 2013 were pooled to analyze the risk of death and suicide due to poisoning from at-risk drinking. Cox's proportional hazards model was applied.

High-risk drinkers were 3.364 times more likely than

non-drinkers to die from alcohol poisoning (toxic effect of non-medical substances, Mortal Cause Codes T51 through T65). At-risk drinkers were 1.462 times more likely than non-drinkers.

〈Table 25〉 Relative Risks of Death Due to Poisoning from At-Risk Drinking: Model 1

	High-risk Drinking				At-risk Drinking			
	Coefficient	SE	Pr〉ChiSq	RR	Coefficient	SE	Pr〉ChiSq	RR
Drinking	1.213	0.419	0.004	3.364	0.380	0.549	0.489	1.462
Male	0.712	0.396	0.072	2.038	0.146	0.412	0.723	1.157
Age	0.063	0.064	0.319	1.066	-0.010	0.074	0.891	0.990

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.

Income variables were added to the analysis. The relative risk of death from poisoning from at-risk drinking did not vary significantly according to income in the cases of high-risk and at-risk drinkers. Income did not exert a significant effect.

〈Table 26〉 Relative Risk of Death Due to Poisoning from At-Risk Drinking: Model 2

	High-risk Drinking				At-risk Drinking			
	Coefficient	SE	Pr〉ChiSq	RR	Coefficient	SE	Pr〉ChiSq	RR
Drinking	1.073	0.424	0.012	2.923	0.338	0.550	0.539	1.402
Male	0.696	0.397	0.079	2.007	0.141	0.412	0.732	1.152
Age	0.078	0.066	0.240	1.081	-0.015	0.076	0.848	0.986
Income (Medicare)	0.085	1.075	0.937	1.089	0.057	1.073	0.958	1.059
Income (Q1)	-0.378	0.803	0.638	0.685	-0.578	0.791	0.465	0.561
Income (Q2)	0.935	0.515	0.069	2.547	0.470	0.544	0.388	1.599
Income (Q3)	0.242	0.592	0.683	1.274	-0.076	0.615	0.901	0.927
Income (Q4)	-0.236	0.629	0.707	0.789	-0.713	0.680	0.294	0.490
Income (Q5)	-	.	.	.	-	.	.	.

2) Risk of Suicide Due to At-Risk Drinking

High-risk drinkers were 1.958 times more likely to commit suicide than non-drinkers. At-Risk drinkers were 1.93 times more likely.

〈Table 27〉 Relative Risk of Suicide Due to Risk Drinking: Model 1

	High-risk Drinking				At-risk Drinking			
	Coefficient	SE	Pr〉ChiSq	RR	Coefficient	SE	Pr〉ChiSq	RR
Dringking	0.672	0.298	0.024	1.958	0.658	0.290	0.024	1.930
Male	-0.074	0.237	0.755	0.929	-0.155	0.236	0.510	0.856
Age	0.033	0.040	0.415	1.034	0.030	0.041	0.459	1.031

No-risk drinking: Drinking rarely or two to three times a month.
Moderate-risk drinking: Drinking once or twice a week.
At-risk drinking: Drinking three to four times a week.
High-risk drinking: Drinking almost every day.
Age groups of five years (starting at 30 years old) used as continuous variables.

Income variables were added to the analysis. The relative risk of suicide due to at-risk drinking did not vary significantly according to income in the cases of high-risk and at-risk drinkers. Income did not exert a significant effect.

〈Table 28〉 Relative Risk of Suicide Due to At-Risk Drinking: Model 1

	High-risk Drinking				At-risk Drinking			
	Coefficient	SE	Pr〉ChiSq	RR	Coefficient	SE	Pr〉ChiSq	RR
Drinking	0.655	0.301	0.030	1.924	0.660	0.291	0.023	1.935
Male	-0.091	0.238	0.702	0.913	-0.160	0.236	0.498	0.852
Female	-	.	.	.	-	.	.	.
Age	0.042	0.041	0.309	1.043	0.038	0.042	0.366	1.039
Income (Medicare)	-0.236	0.750	0.754	0.790	-0.332	0.748	0.657	0.717
Income (Q1)	0.234	0.396	0.554	1.264	0.305	0.366	0.404	1.357
Income (Q2)	0.474	0.361	0.189	1.607	0.210	0.377	0.577	1.234
Income (Q3)	-0.027	0.399	0.946	0.973	-0.048	0.389	0.901	0.953
Income (Q4)	0.317	0.335	0.344	1.373	0.220	0.327	0.500	1.247
Income (Q5)	-	.	.	.	-	.	.	.

3) Loss of Future Income Due to Alcohol-Attributable Premature Death: from Poisoning or Suicide

The total loss of future income due to alcohol-attributable premature death from poisoning amounted to KRW 367.5 billion, while the total loss of future income due to alcohol-attributable suicide amounted to KRW 1.1691 trillion.

〈Table 29〉 Loss of Future Income Due to Alcohol-Attributable Premature Death: from Poisoning or Suicide (2013)

(Unit: KRW million)

		20-29	30-39	40-49	50-59	60-69	Total
Poisoning	Male	35,716	118,809	129,945	64,118	5,256	353,845
	Female	4,701	4,990	2,822	1,096	67	13,675
	Total	40,417	123,799	132,767	65,214	5,323	367,519
Suicide	Male	165,152	363,072	381,345	168,050	11,598	1,089,216
	Female	30,163	32,443	11,978	5,166	166	79,916
	Total	195,315	395,515	393,323	173,216	11,763	1,169,132

V Conclusion

V Conclusion

This study estimates the relative risks of alcohol-attributable illnesses due to at-risk drinking and the socioeconomic costs of at-risk drinking in general.

We find that high-risk drinking significantly increases the relative risk of all alcohol-attributable illnesses. At-risk drinking, in the meantime, did not show such a statistically significant effect on the relative risk of certain illnesses, some of which may have to do with the unfitness of the test models. High-risk drinking emerged as a risk factor of cardiovascular disease of all types. The relative risk of cardiovascular disease due to at-risk drinking, on the contrary, ranged between 0.9 and 1.0, but the models were unfit.

The total socioeconomic costs of alcohol-attributable illnesses amount to KRW 4.6942 trillion. High-risk drinkers and at-risk drinkers are 3.364 times and 1.462 times more likely, respectively, than no-risk drinkers to die from alcohol poisoning.

Policy intervention is necessary to reduce and eliminate the alcohol-induced damage to public health and society. This study was conducted with the aim of providing information necessary for effective policymaking on anti-alcohol intervention. More in-depth and expert-based research should

be conducted in the future to establish empirically-based policies against socioeconomic damage caused by alcohol consumption.

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