Journal of Public Health | Vol. 36, No. 2, pp. 225–234 | doi:10.1093/pubmed/fdt056 | Advance Access Publication 11 June 2013

Burden of disease in Korea during 2000–10

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ABSTRACT

Background This study estimates the burden of disease in Korea during 2000–10, using disability-adjusted life years (DALYs).

Methods DALYs are the sum of years of life lost from mortality and years of life lost from disability. DALYs for 24 major diseases in 2000, 2005 and 2010 Korea were calculated based on the Global Burden of Disease Study method.

Results As in other advanced nations, the burden of disease in Korea is characterized by an increasing importance of cancer, unipolar depression and ischemic heart disease (1681, 1508 and 562 person-years for Year 2010 in terms of DALYs per 10 0000, respectively). At the same time, unipolar depression, liver cirrhosis and mental and behavioral disorder due to alcohol use (1508, 323 and 535 person-years for 2010, respectively) became much more common in Korea than in other advanced nations.

Conclusions The burden of disease in Korea follows the pattern of other advanced nations in general but also registers some unique characteristics affected by the nation's distinctive epidemiological and sociocultural contexts, e.g. rapid economic growth and dramatic social transition without appropriate policy response. Korea's health and welfare policy might need to incorporate these special conditions for the effective reduction of its disease burden.

Keywords burden of disease, disability-adjusted life years, incidence, mortality, prevention

Introduction

In the past four decades, South Korea (hereafter Korea) achieved a rapid economic growth, experiencing the dramatic rise of chronic diseases.[1,2] The incidence of cancer registered a rapid expansion in Korea, with an annual growth of 3.1% from 1999 to 2008,[1] while the prevalence of diabetes in the nation has increased from 1.5% in 1970 to 9.9% during 2007–09.[2] As chronic diseases are getting more common in Korea, it is becoming more essential to use a single measure of population health combining morbidity with mortality and reflecting the quality of patient life in the nation. Also, midst Korea's sudden epidemiological and sociocultural transitions addressed above, the reliable estimation of its disease burden is getting more important for setting up its proprieties regarding disease control and prevention. But existing research on the burden of disease centers on either incidence or mortality, which fails to reflect the quality of life and the burden of disease as a single collective measure.

Anticipating these issues, the World Health Organization and the Global Burden of Disease (GBD) Study Group have since 1993 introduced disability-adjusted life years (DALYs), a single measure of population health incorporating both mortality and morbidity.[3,4] DALYs combines the years of life lost (YLLs: the quantity of premature death or fatal health outcomes) and the years lived with disability (YLDs: the quality of disabled life or non-fatal health outcomes). This measure shows comparability across nations and regions, a characteristic that conventional qualitative indicators, such as the SF-36 (i.e. a short-form survey measure of patient health introduced by the RAND Corporation to reflect the quality of patient life), are currently lacking. Also, it can serve as a basis

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of cost-effectiveness analysis, aiding in the rational, efficient utilization of limited healthcare resources.[3,4]

Based on national health insurance claims data, the Korea Ministry of Health and Welfare[5] and Yoon[6] replicated the GBD analysis in a Korean context, estimating and ranking the DALYs of major diseases in Korea for Year 2002 (or Y2002 hereafter) (e.g. cancer, diabetes mellitus and cerebrovascular disease as top three diseases). Yoon's follow-up study[7] updated his old results, reaching a similar conclusion on three leading diseases in Korea for Y2007 (i.e. cancer, cerebrovascular disease and diabetes mellitus). As these studies admit, however, the reliability of national health insurance claims data is questionable for physicians' over-report, and the existing results might need a cross-examination from the national survey data on patients. Moreover, these studies might underestimate the incidence and prevalence of mental disorder, whose accurate estimation requires direct interviews. In fact, mental diseases prevalent in developed countries, e.g. unipolar depression, are becoming more common in Korea, a nation characterized by rapid, constant westernization in demographic, socioeconomic, health-behavioral and medical–technological aspects in the past four decades.[8,9] The prevalence of depressive symptoms for elders in Korea registered a jump from 9.1% in 1989 to 16.6% in 2005,[8] whereas the nation's incidence of suicide showed an annual growth of 8.0% from 1995 to 2006.[9] In this context, calculating the burden of mental disorder might need reliable data from direct interviews, and a new calculation is required on the burden of disease in Korea during the period 2000–10. For this reason, this research involves the estimation of DALYs for major diseases in Korea during 2000–10.

Methods

For estimating DALYs for 24 major diseases (Table 1) in Korea during 2000–10, this study improves the GBD method with the incidence–prevalence–mortality (IPM) model.[10,11] The estimation of YLDs for a disease requires estimating the average age of onset and the expected duration of disability based on the DisModII program,[12] which in turn requires the estimation of mortality, incidence and prevalence (DisModII, based on a set of differential equations, and the IPM model, based on a set of difference equations, both are designed to test data consistency and supplement incomplete data on the mortality, incidence and prevalence of a disease). Usually, however, only mortality and prevalence data are available in reality. In order to calculate the YLDs of a disease without incidence data, the GBD Study Group normally uses the YLLs values from the mortality data, assuming that the YLDs/YLLs ratio stays constant during the study period. However, empirical results show that the YLDs/YLLs ratio for a major disease (such as cancer) is rising over time.[13] It might be better to estimate the incidence from the prevalence (and mortality) based on a reliable method (e.g. the IPM model) then to estimate the average age of onset, the expected duration of disability, and the YLDs. In this context, this work calculates the YLDs of a major disease by (i) calculating the disease-specific prevalence rate for missing data from existing literature, (iii) deriving the disease-specific incidence rate based on the IPM model and (iii) calculating the average age at onset and the expected duration of disability based on DisModII.

Table 1 shows diseases, data sources and years of prevalence data available. Twenty-four diseases listed in the table were chosen for (i) their great incidence, prevalence or DALYs in Korea for Y2002/Y2007 (compared with Australia for Y2003,

Table 1 Diseases, data sources and years of prevalence data available

Disease	*ICD-10 code*	*Data source*	*Years of prevalence data available*
Cancer	C00–C96	13	2000–10
Tuberculosis	A15–A19	37	2000–10 (incidence data instead)
Viral hepatitis	B15–B19	17	2001, 2005, 2007–10
Anemia	D50	17	2001, 2005, 2007–10
Diabetes mellitus	E10–E14	17,38	2000–02, 2005, 2007–10
MBDA	F10	18,19	2006, 2010
Schizophrenia	F20–F29	18,19	2006, 2010
U. depression	F30–F39	18,19	2006, 2010
Parkinson	G20	38,39	2000–02, 2007
Alzheimer	G30	20,38	2000–02, 2005
Multiple sclerosis	G35	38,40	2000–02, 2005
Epilepsy	G40–G41	38,41	2000–02, 2007
Cataract	H25–H28	17	2001, 2007
Glaucoma	H40–H42	38,42	2000–02, 2009
Otitis media	H65–H75	17,38	2000–02, 2007, 2009–10
IHD	I20–I25	17	2001, 2008–10
CVD	I60–I69	17	2001, 2005, 2007–10
AURI	J00–J06	17	2001, 2008–10
COPD	J40–J44	17	2001, 2007–10
Peptic ulcer	K25–K27	17	2001, 2009
Liver cirrhosis	K70	17	2007–10
Arthrosis	M05–M19	17	2001, 2005, 2007–08, 2010
Glomerular disease	N00–N08	43	2000–02, 2006
Renal failure	N17–N19	43	2000–02, 2006

AURI, acute upper respiratory infection; CVD, cerebrovascular disease; IHD, ischemic heart disease; U. depression, unipolar depression; COPD, chronic obstructive pulmonary disease; MBDA, mental and behavioral disorder due to alcohol use.

Spain for Y2008 and a high-income nation on average for Y2004)[5–7,14–16] and (ii) the stability of their prevalence data available (given that the incidence was estimated from the prevalence (and mortality) data based on a method addressed below). The Korea National Health and Nutrition Examination Survey (KNHANES) data[17] are considered to be a gold standard for Korea's prevalence data. The survey involves a clustered random sampling with a proportional allocation in each of 30 clusters across the nation so that the population and the sample are consistent with each other in demographic composition. The survey on an item of 'morbidity' was done by direct interviews in a traveling check-up center for 24 871 participants (with the participation rate of 78.4% and the non-response rate of 0.79% during 2007–09). The survey allowed this study to estimate the incidence of a disease from its prevalence and mortality, an advantage over the previous studies on Australia for Y2003, Spain for Y2008 and the world for Y2004 (which estimated the incidence/YLDs of a disease only from its mortality/YLLs with a simple assumption on the (constant) ratio of incidence to mortality or YLDs to YLLs). But the survey information is missing for some diseases. For this reason, other reliable sources listed in the table were used when the KNHANES data were not available for certain diseases. Indeed, the data from Cho's studies of mentor diseases (e.g. mental and behavioral disorder due to alcohol, schizophrenia, unipolar depression and Alzheimer)[18–20] were used in this study, given that his studies were designed specifically for mental diseases and his interviews were more focused and intensive than the KNHANES). To estimate the YLLs of the major diseases in Korea for Y2000, Y2005 and Y2010, this study used the GBD methods. YLLs are years of life lost because of premature death from a specific disease. The basic formula is YLL $= m \times l$ where m is the number of death from a particular disease and l the standard life expectancy at the age of death (this formula is modified by social values including the discount rate (r)/age-weighting constants (β, K and C) so that YLLs are greater and the state of health is valued more for the present/the young than for the future/the old).[21] The average age of death for an age cohort by gender was assumed to be an average age of that cohort, e.g. 2, 7, . . ., 77 for the 0–4, 5–9, . . ., 75– cohort, respectively. The discount rate (r) and the age-weighting constants (β, K and C) took the GBD values, i.e. 0.03, 0.04, 1.00 and 0.1658, respectively. The data on standard life expectancies at the age of death and disease-specific mortality rates for each age cohort by gender in 2000, 2005 and 2010 came from Statistics Korea, 'the cause of death' denoting 'the first cause of death' here.[22]

For estimating the YLDs of the major diseases in Korea for Y2000, Y2005 and Y2010, this research improved the GBD approach with the IPM model. YLDs are years of life lived with disability from a specific disease. The basic formula is YLD $= i \times w \times l$ where i is the number of incidence for a particular disease, w a disability weight/severity and l the expected duration of disability from onset to remission/death (this formula is modified by social values including the discount rate (r)/age-weighting constants (β, K and C) so that YLDs are greater and the state of health is valued more for the present/the young than for the future/the old).[21] The average age at onset for each age cohort by gender in 2000, 2005 or 2010 was estimated based on DisModII after (i) data on disease-specific mortality rates, population sizes and total mortality rates for each age cohort by gender during 2000–10 were collected from Statistics Korea,[22] (ii) data on disease-specific prevalence rates for each age cohort by gender were gathered from the data sources listed in Table 1, (iii) disease-specific prevalence rates for each age cohort by gender missing in some years were estimated based on the available data with an assumption of linear relationship between the logarithm of the prevalence rate and time[23] and (iv) a disease-specific incidence rate for each age cohort by gender in a given year (i_{t-1}) (during the period 2000–10) was derived from the disease-specific mortality and prevalence rates in the same year (m_{t-1}, p_{t-1}) and the disease-specific prevalence rate in the following year (p_t) (IPM model: $i_{t-1} = [(p_t - p_{t-1}) + (1 - p_t)m_{t-1}]/(1 - p_{t-1})$. The discount rate ($r$) and the age-weighting constants (β, K and C) took the GBD values, i.e. 0.03, 0.04, 1.00, 0.1658, respectively. The expected duration of disability for each age cohort by gender in 2000, 2005 or 2010 was also estimated based on DisModII. Disability weights for major diseases were from Do's 2004 results.[24] Once YLLs and YLDs were estimated based on the methods above, DALYs were calculated as the sum of the two measures. Indeed, the YLLs, YLDs and DALYs of cancer in Korea for Y2000, Y2005 and Y2010, respectively, came from Park's 2013 outcomes.[13]

Results

Table 2 describes the trends of prevalence, mortality and incidence (per 10 0000) for 10 major diseases of Korean men and women in 2010 values during 2000–10. Table 3 presents the trends of YLLs, YLDs and DALYs (per 10 0000) for 10 or all major diseases of Korean men and women in 2010 values during the period. Indeed, Fig. 1 displays the trend of DALYs (per 10 0000) for 10 major diseases of the entire Korean population in 2010 values during the period. The rank order in YLLs (e.g. cancer, cerebrovascular disease and ischemic heart disease) was almost identical to that in mortality for both Korean men and women during 2000–10. Relative falls of cerebrovascular disease, diabetes mellitus and

Table 2 Incidence, prevalence and mortality per 100 000 for Korean men and women in years 2000, 2005 and 2010 (estimated values for missing data)

2010	*Men*				*Women*			
Rank	*Disease*	*2000*	*2005*	*2010*	*Disease*	*2000*	*2005*	*2010*
Incidence								
1	Cataract	177	763	1065	AURI	747	1244	625
2	Peptic ulcer	323	467	679	Cancer	174	261	362
3	Cancer	232	311	392	Arthrosis	503	368	331
4	Glaucoma	32	73	140	U. depression	168	225	303
5	IHD	97	215	97	Cataract	297	482	224
6	COPD	91	309	90	COPD	131	119	108
7	Tuberculosis	79	81	84	IHD	98	180	106
8	Liver cirrhosis	13	44	82	Alzheimer	4	16	73
9	Parkinson	2	20	61	Diabetes mellitus	111	32	66
10	U. depression	43	48	54	Tuberculosis	58	54	65
Prevalence								
1	AURI	4527	13 935	33 400	AURI	4129	12 575	31 600
2	COPD	1173	5898	19 600	Arthrosis	11 255	17 500	25 800
3	Diabetes mellitus	2712	7100	11 300	Cataract	1022	3985	13 300
4	Peptic ulcer	4265	6049	8579	Anemia	2946	9500	12 600
5	Cataract	591	2343	8200	Diabetes mellitus	2439	5800	9000
6	Arthrosis	3521	6000	6600	COPD	1015	3174	7000
7	CVD	4575	5000	3700	Peptic ulcer	6338	5494	4762
8	MBDA	5104	4166	3400	U. depression	2054	2972	4300
9	Viral hepatitis	1526	4400	2700	Otitis media	431	1218	3800
10	Otitis media	503	1224	2600	Viral hepatitis	692	3000	3200
Mortality								
1	Cancer	150	164	173	Cancer	83	94	100
2	CVD	70	62	52	CVD	78	68	55
3	IHD	24	29	29	IHD	19	27	25
4	Diabetes Mellitus	23	25	21	Diabetes mellitus	23	24	21
5	COPD	9	14	14	Renal failure	5	5	8
6	Liver cirrhosis	6	14	13	COPD	5	7	6
7	Renal failure	5	6	8	Parkinson	1	3	4
8	Tuberculosis	10	8	6	Tuberculosis	4	4	3
9	Parkinson	1	2	4	Viral hepatitis	1	1	2
10	MBDA	5	4	3	Liver cirrhosis	0	1	1

AURI, acute upper respiratory infection; CVD, cerebrovascular disease; IHD, ischemic heart disease; U. depression, unipolar depression; COPD, chronic obstructive pulmonary disease; MBDA, mental and behavioral disorder due to alcohol use.

tuberculosis (e.g. from 559/70, 205/23 and 106/10 to 391/52, 173/21 and 59/6 in men's YLLs/mortality), respectively, were contrasted with the opposite movements of cancer, liver cirrhosis and viral hepatitis (e.g. from 1220/150, 83/6 and 15/1 to 1377/173, 192/13 and 35/3 in men's YLLs/mortality), respectively, in both measures for both groups during the period. The pattern of YLDs followed that of incidence for both Korean men and women during 2000–10, albeit with some gaps in rank order between the two indicators. Acute upper respiratory infection, cataract, peptic ulcer and arthrosis (top five diseases in incidence for either Korean men or women during 2000–10) moved down or entirely disappeared in the top-10 list in YLDs during the period. On the contrary, unipolar depression, ischemic heart disease and mental and behavioral disorder due to alcohol use (MBDA), which occupied the lower echelon of the top-10 list in incidence or did not make the list at all during 2000–10, emerged to constitute the core of top five diseases in YLDs together with cancer in the latest year. In terms of DALYs (per 10 0000) for the entire population during 2000–10, unipolar

Table 3 YLL, YLD and DALY per 100 000 for Korean men and women in years 2000, 2005 and 2010

2010	Men				Women			
Rank	Disease	2000	2005	2010	Disease	2000	2005	2010
YLL								
1	Cancer	1220	1375	1377	Cancer	802	846	863
2	CVD	559	480	391	CVD	543	457	372
3	IHD	234	259	246	IHD	134	169	157
4	Liver cirrhosis	83	199	192	Diabetes mellitus	164	175	137
5	Diabetes mellitus	205	220	173	Renal failure	42	43	58
6	COPD	50	74	77	COPD	28	36	33
7	Renal failure	46	50	59	Parkinson	8	15	26
8	Tuberculosis	106	81	59	Liver cirrhosis	5	20	25
9	MBDA	50	58	43	Tuberculosis	39	33	23
10	Viral hepatitis	15	31	35	Viral hepatitis	7	15	17
YLD								
1	U. depression	241	421	704	U. depression	613	1119	2316
2	MBDA	430	517	634	Cancer	97	221	543
3	Cancer	96	232	579	Otitis media	384	171	493
4	Glaucoma	159	224	422	IHD	215	256	419
5	IHD	236	400	302	MBDA	160	265	389
6	Liver cirrhosis	15	59	240	Cataract	204	283	276
7	Cataract	109	308	159	COPD	160	355	271
8	Glomerular disease	78	68	129	Alzheimer	5	28	202
9	Peptic ulcer	54	75	106	Liver cirrhosis	4	24	187
10	Diabetes mellitus	446	28	101	Schizophrenia	16	51	179
DALY								
1	Cancer	1316	1606	1956	U. depression	614	1119	2316
2	U. depression	241	421	704	Cancer	899	1067	1405
3	MBDA	479	575	677	IHD	349	425	576
4	IHD	470	659	548	Otitis media	384	171	493
5	Liver cirrhosis	98	258	433	MBDA	162	268	392
6	Glaucoma	159	224	422	CVD	549	526	383
7	CVD	571	489	417	COPD	188	392	304
8	Diabetes mellitus	651	248	274	Cataract	204	283	276
9	COPD	104	517	166	Diabetes mellitus	310	386	276
10	Cataract	109	308	159	Liver cirrhosis	9	45	212
11	Glomerular disease	80	68	129	Alzheimer	5	28	202
12	Peptic ulcer	54	75	106	Schizophrenia	21	53	181
13	Otitis media	316	144	96	Renal failure	52	92	166
14	Parkinson	13	38	94	Glaucoma	209	119	136
15	Renal failure	63	56	80	Anemia	28	121	117
16	Epilepsy	32	67	78	Epilepsy	30	61	72
17	Tuberculosis	122	96	75	Arthrosis	128	102	71
18	Arthrosis	152	115	61	Parkinson	17	27	48
19	Alzheimer	3	12	47	Tuberculosis	50	43	34
20	Viral hepatitis	15	32	36	Viral hepatitis	7	15	20
21	Anemia	16	18	19	Glomerular disease	44	4	17
22	Schizophrenia	10	5	8	Peptic ulcer	0	0	2
23	Multiple sclerosis	1	4	7	Multiple sclerosis	2	2	1

Continued

Table 3 Continued

2010	*Men*				*Women*			
Rank	*Disease*	*2000*	*2005*	*2010*	*Disease*	*2000*	*2005*	*2010*
24	AURI	1	1	1	AURI	1	1	1
	Total	5077	6037	6593	Total	4261	5349	7704

AURI, acute upper respiratory infection; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; IHD, ischemic heart disease; MBDA, mental and behavioral disorder due to alcohol use; U. depression, unipolar depression.

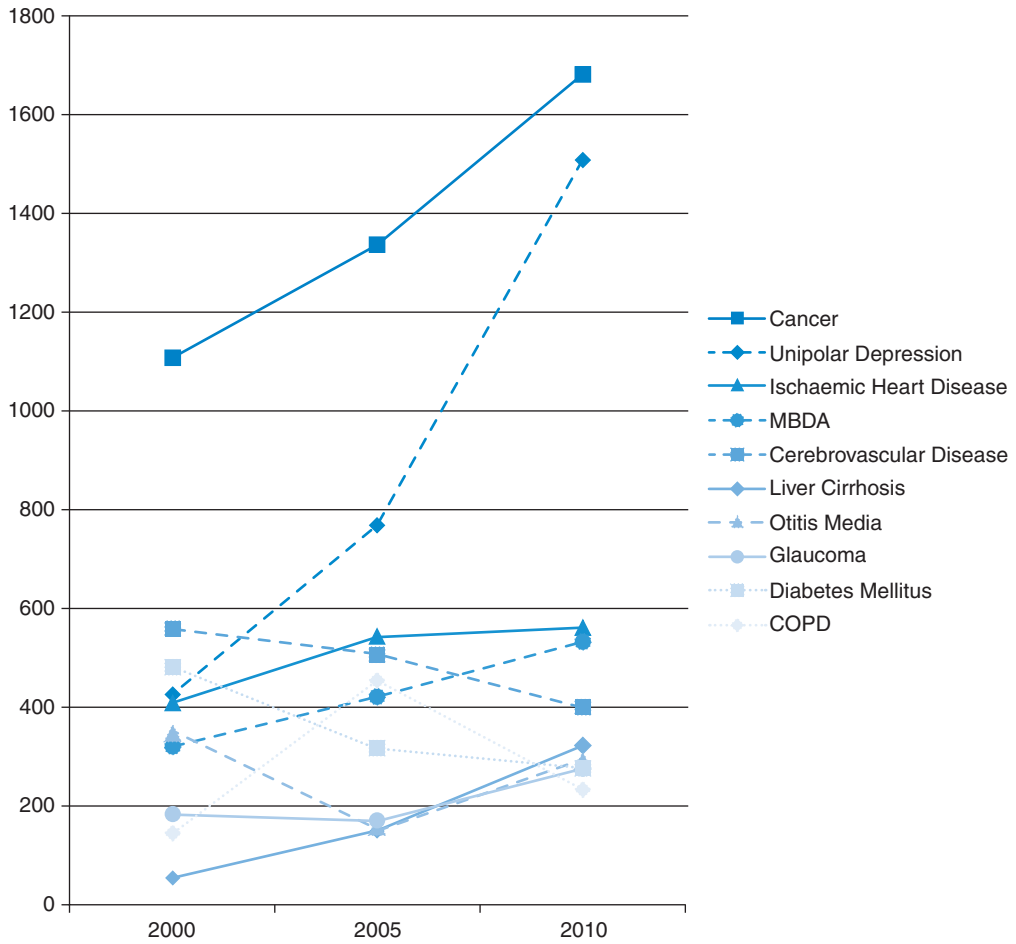

Figure 1 DALY per 100 000 for all population in 2000, 2005 and 2010 Korea. *Note*: COPD, chronic obstructive pulmonary disease; MBDA, mental and behavioral disorder due to alcohol use.

depression and ischemic heart disease became more significant, constituting the top three together with cancer in the latest year (i.e. from 427, 410 and 1109 in Year 2000 to 1508, 562 and 1681 in Year 2010, respectively). Specifically, a differential between cancer and unipolar depression almost disappeared during the period, i.e. 1109 versus 427 in 2000 and 1681 versus 1508 in 2010, respectively. The relative position of diabetes mellitus declined from the 4th (482) to the 9th (275), whereas that of MBDA/liver cirrhosis went up from the 8th/16th (322/54) to the 4th/6th (535/323) during 2000–10. Indeed, cerebrovascular disease, otitis media, glaucoma and chronic obstructive pulmonary disease were resilient during the period (i.e. from 560, 350, 184 and 146 in Year 2000 to 400, 294, 279 and 235 in Year 2010, respectively). In

addition, gender differences can be noted for diseases outside of the top-10 list in terms of DALYs per 10 0000. For example, glomerular disease and peptic ulcer were more significant for men (129/the 11th and 106/the 12th) than for women (17/the 21st and 2/the 22nd) in Year 2010, and vice versa for Alzheimer and schizophrenia (47/the 19th and 8/the 22nd for men versus 202/the 11th and 181/the 12th for women).

Discussion

Main findings of this study

The findings on the burden of disease in Korea during the period 2000–10 can be summarized as the following. Unipolar depression and ischemic heart disease became more significant in DALYs during 2000–10, constituting the top three together with cancer in the latest year. The relative fall of diabetes mellitus was contrasted with the relative rises of liver cirrhosis and MBDA during the period. Cerebrovascular disease, otitis media, glaucoma and chronic obstructive pulmonary disease were resilient during 2000–10. Indeed, gender differences can be noted for diseases outside of the top-10 list in terms of DALYs per 100 000. For example, glomerular disease and peptic ulcer were more significant for men than for women in Year 2010, and vice versa for Alzheimer and schizophrenia. Overall, the burden of disease in Korea is characterized by an increasing importance of cancer, unipolar depression and ischemic heart disease (i.e. 1681, 1508 and 562 person-years for Year 2010 in terms of DALYs per 100 000). At the same time, unipolar depression, liver cirrhosis and MBDA became very common in Korea (1508, 323 and 535 person-years for 2010).

What is already known on this topic

The existing literature indicates that the burden of disease in an advanced nation centers on cancer, unipolar depression and ischemic heart disease. In terms of DALYs per 10 0000 for the entire population, the three diseases ranked the top three in Australia for Y2003 (2567, 965 and 1325) and the top four in Spain for Y2008 (1760, 940 and 470).[14,15] These results agreed with global statistics in 2004. The same group constituted the top three in DALYs per 10 0000 for the entire population in a high-income nation on average for Y2004 (1862, 1024 and 788).[16] Indeed, otitis media/chronic obstructive pulmonary disease occupied the lower echelon of the top-10 list for the same measure in the high-income nations, e.g. the 8th (326)/the 7th (436) in Australia for Y2003, the 5th (450)/the 10th (260) in Spain for Y2008 and the 7th (430)/the 8th (379) in the high-income nation on average for Y2004.[14–16] But little explanation has been done on national variations in terms of disease burden in the developed world.

What this study adds

This study ameliorated the GBD approach, using more realistic assumptions and doing more accurate estimation of YLDs based on the IPM model. In order to calculate the YLDs of a disease without incidence data, the GBD Study Group normally uses the YLLs values from the mortality data, assuming that the YLDs/YLLs ratio stays constant during the study period. However, empirical results show that the YLDs/YLLs ratio for a major disease (such as cancer) is rising over time.[13] In this context, this study estimated the incidence from the prevalence (and mortality) based on the IPM model to estimate the average age of onset, the expected duration of disability and the YLDs. This study also managed to construct time-series data on prevalence, mortality/YLLs, incidence/YLDs and DALYs for major diseases in Korea for Y2000, Y2005 and Y2010.

Based on these approaches, this study demonstrates that Korea is converging with other advanced nations in disease burden. In terms of DALYs per 100 000 for the entire population, cancer, unipolar depression and ischemic heart disease (which ranked the top three in Australia for Y2003, the top four in Spain for Y2008 and the top three in a high-income nation on average for Y2004) made the top three in Korea for Y2010 (1681, 1508 and 562 person-years). This similarity remained intact in the lower half of the top-10 list for the same measure as otitis media/chronic obstructive pulmonary disease (which ranked between the 5th and the 8th in the nations listed above) held the 7th/the 10th positions in Korea for Y2010 (294/235 person-years). Korea's convergence with other advanced nations in disease burden might reflect their convergence in living standards, the age structure, health behavior and medical technology during the past four decades. A rise of Korea's gross domestic product (GDP) per capita relative to the Organization for Economic Cooperation and Development (OECD) average [e.g. from 0.28 to 0.86 (PPP, current international dollars) during 1980–2011[25]] has been accompanied by a growing proportion of the old population, a decline of physical activity, a rise of animal food consumption and an increase of body weight. Korea's percentage of the population aging 60 or older, which was 15% in 2009, is likely to reach 21% in 2018, the figure of the developed regions in 2009.[22,26] Korea's share of agriculture workforce—involving more intensive physical activity than industry/services workforce—dropped from 50.7 to 14.6 during 1969–93.[27] Meanwhile, the Korean percentage of energy intake from animal food went up from 5.1 to 14.2, with the BMI of

male/female adolescents 17 years old jumping up from 20.8/20.5 to 21.4 (kgm^{-2}).[27] This 'modified (or westernized)' dietary pattern became more robust among younger and metropolitan residents with more education and higher income in Korea during 1998–2005.[28] Korea's convergence with other developed nations has been apparent in medical technology as well, especially in selective, customized disease treatment.[29] These economic, demographic, behavioral and technological changes might have aided in shifting the centrality of disease from acute, physical to chronic, mental components in Korea.

Unlike Australia, Spain and other advanced nations during 2000–10, however, Korea has been characterized by unusually rapid emergences of unipolar depression, liver cirrhosis and MBDA during the period according to the results of this work. The share of unipolar depression in total DALYs was 0.16 in Korea for Y2010, twice as high as in Australia for Y2003 (0.07), Spain for Y2008 (0.08) or a high-income nation on average for Y2004 (0.08). In terms of DALYs per 100 000 for the entire population, in addition, liver cirrhosis and MBDA (which ranked the 16th and the 8th in 2000) came to hold the 6th and the 4th positions in 2010. These results suggest that the burden of disease in Korea follows the pattern of other advanced nations in general but also registers some unique characteristics affected by Korea's distinctive epidemiological, historical and sociocultural contexts from other advanced nations, e.g. higher infection of hepatitis B virus,[30] higher per-capita consumption of alcohol,[31] and, above all, more rapid economic growth and more dramatic social change but no appropriate response in health and welfare policy.[32–35] Korea achieved the most rapid economic expansion in the post-1970 world (i.e. the highest average annual growth rate in GDP per capita during 1970–2009, 111%, which is higher than China's 90% during 1980–2009 and five times as high as OECD's 21% during 1970–2009).[32] This rapid economic development was accompanied by dramatic social transitions such as an abrupt rise of the single/nuclear family (i.e. from 8.9%/16.9 to 16.2%/28.7% during 1990–2000[33]) and a sudden advent of aging society in Korea (it took 115 years in France, 24 years in Japan but only 18 years in Korea for the proportion of elders or those aging 65 years or older to reach 0.14 (aged society) from 0.07 (aging society)[9,34]). Midst these dramatic social transformations, however, social protection for women and 'unprepared' elders still remains much lower in Korea than in other advanced nations including Japan.[9,34,35] Korean women still suffer from their low insecurity in workplace and their excessive housework in traditional gender roles[35] while Korean elders are directly exposed to relative poverty, i.e. the share of elderly households whose incomes are below the half of the average household income was 0.45 in Korea but 0.22 in Japan and 0.13 in the OECD average for Y2008.[9,34] Such gaps between social change and policy response might explain more common suicide and depression among women and elders in contemporary Korea than other advanced nations such as Japan (e.g. the elder's suicide rate for Year 2006 was greater in Korea than in Japan by more than 100%, while the ratio of women's age-standardized suicide rate to men's was 0.47 in Korea and 0.42 in Japan for the same year).[9] Policy measures for women's greater access to high-quality employment and childcare might be crucial for their psychological well-being in Korea given their over-representation in irregular service industry.[33,36] Also, a steady extension of pension eligibility beyond the age of 65 and a continued expansion of social expenditure for elderly might be a priority for Korea's government given that public social expenditure for elderly constituted only 1.7% of GDP in Korea for Y2007, only a quarter of the OECD average for the same year.[34,36] Without these health and welfare policy reactions to the rapid demographic and socioeconomic changes in Korea, 'a nation of the economic miracle' will transform into 'a nation of the social crisis plagued with suicide and depression'. Korea's such experience might present good lessons and important health and welfare policy implications for all nations striving for rapid economic growth, whether they are in Africa, America, Asia, Europe or Oceania.

Limitations of this study

First, some diseases were excluded for the low quality of their prevalence data (e.g. asthma), while prevalence data were missing and estimated for certain diseases in certain years (e.g. for renal failure during 2003–05 and during 2007–10). More complete prevalence data might lead to a more accurate estimation for the burden of disease. Secondly, a comparative analysis of Korea and more other nations might bring richer insight regarding the burden of disease. Thirdly, the extension of this research into main risk factors in Korea is expected to further the horizon of knowledge on the burden of disease. In spite of these limitations, however, this work constructs rich data on and presents a rare comparative examination of disease burden in Korea, a nation with the most rapid demographic, socioeconomic, behavioral and technological transformations in the past four decades.

Funding

This work was supported by the Korean Foundation for Cancer Research [CB-2011-01-01].

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