RESEARCH ARTICLE

The Economic Burden of Cancer in Korea in 2009

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Abstract

Background: Cancer imposes a significant economic burden on individuals, families and society. The purpose of this study was to estimate the economic burden of cancer using the healthcare claims and cancer registry data in Korea in 2009. Materials and Methods: The economic burden of cancer was estimated using the prevalence data where patients were identified in the Korean Central Cancer Registry. We estimated the medical, non-medical, morbidity and mortality cost due to lost productivity. Medical costs were calculated using the healthcare claims data obtained from the Korean National Health Insurance (KNHI) Corporation. Non-medical costs included the cost of transportation to visit health providers, costs associated with caregiving for cancer patients, and costs for complementary and alternative medicine (CAM). Data acquired from the Korean National Statistics Office and Ministry of Labor were used to calculate the life expectancy at the time of death, age- and gender-specific wages on average, adjusted for unemployment and labor force participation rate. Sensitivity analysis was performed to derive the current value of foregone future earnings due to premature death, discounted at 3% and 5%. Results: In 2009, estimated total economic cost of cancer amounted to $17.3 billion at a 3% discount rate. Medical care accounted for 28.3% of total costs, followed by non-medical (17.2%), morbidity (24.2%) and mortality (30.3%) costs. Conclusions: Given that the direct medical cost sharply increased over the last decade, we must strive to construct a sustainable health care system that provides better care while lowering the cost. In addition, a comprehensive cancer survivorship policy aimed at lower caregiving cost and higher rate of return to work has become more important than previously considered.

Keywords: Cost analysis - cost of illness - cancer - health care costs - Korea

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Introduction

Cancer is currently the leading cause of death in developed countries (Jemal et al., 2011). In 2009, 69,780 cancer deaths were reported, accounting for 28.3% of all deaths in Korea (Jung et al., 2012). With the significant contribution of advances in modern medicine to the survival rates of cancer patients and aging of the population, the cancer burden in a society is expected to increase substantially in the future. To prioritize and allocate resources for cancer control efforts, it is necessary to quantify the cancer burden from the societal perspective. In turn, socioeconomic cost of cancer is consisted of direct costs (medical or non-medical) and indirect costs due to morbidity or premature mortality.

In Korea, Cancer already accounts for a significant portion of the national medical cost; the Korean National Health Insurance (KNHI) Corporation estimates that its insurer payments in 2009 were accounted for 12% of total expenditures (KNHIC, 2009). Non-medical costs are represented by but not limited to the relatively high level of both objective (e.g., patient hospitalizations, providing transportation) and subjective burden (e.g., emotional trauma, worry, reduced caregiver well-being) that family caregivers experience (Shin et al., 2012; Turkoglu and Kilic, 2012; Kim et al., 2013). For example, cancer forces some patients to give up their work either temporarily or permanently, which lead to the health-related impact of cancer on society (You et al., 2013; Hanly and Sharp, 2014). Therefore, it is crucial to estimate the burden of cancer for a representative patients group using a nationwide database to accurately picture the implications of cancer care cost in Korea. Until now, nation-wide studies of the economic burden of cancer care were conducted in 2002 and 2005 in Korea (Kim et al., 2008; Kim et al., 2009). Yet, more recent studies focused on individual cancer sites (Tachfouti et al., 2012; Yang, 2013; Byun et al., 2014; Wissinger et al., 2014) or specific components of the cancer care cost (Choi et al., 2014; Hanly and Sharp, 2014; Wissinger et al., 2014), thus failing to yield a gross estimate and the future direction of the cancer burden. In this study, we

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aim to derive the overall economic burden of cancer and examine the changing patterns of direct and indirect costs of cancer care, using the previous nationwide studies as references. To enhance comparability between studies, we used similar framework as previous studies (Kim et al., 2008; Kim et al., 2009). Documenting changing economic impact of cancer can assist setting the priority in health care research and delivery including prevention, diagnosis, and treatment of cancer.

Materials and Methods

Data source and study patient identification

The two major data sources used were the Korean Central Cancer Registry (KCCR) and the Korean National Health Insurance (KNHI) claims database. KCCR is a nationwide cancer registry program sponsored by the government in which more than 180 hospitals participate. The completeness of registration for 2009 was estimated to be 97.2% of cancer cases (Jung et al., 2012). For each patient, the KCCR included information on gender, date of diagnosis, cancer site, histology, and the Surveillance, Epidemiology, and End Results (SEER) summary stage, date of death, and so forth. Among 878,834 cancer cases in the KCCR in 2009, those with medical claims history (n = 861,132) in 2009 were selected. Patients with incomplete socio-demographic information (n = 270) were excluded, leaving 860,862 patients in the study. Then the study subjects were matched with the KNHI claims. Since medical providers are paid by the KNHI Corporation on Fee-for-service basis in Korea, vast information necessary for reimbursement of the medical claims are stored in the KNHI claims database. This data include patients' socio-demographic (such as sex, age, residential area, disease code, costs incurred), and clinical information (a detailed list of diagnostic tests, procedures, hospital length of stay and outpatient visits by type of medical service, prescription provided).

Cost classification and definition

In line with previous nation-wide studies (Kim et al., 2008; Kim et al., 2009), the cost of cancer was computed following the prevalence-based approach, which estimates the economic burden in year 2009 resulted from the prevalence of cancer. For this study, we adopted a societal perspective to include both direct costs (medical care cost, non-medical cost), and indirect costs (morbidity cost, mortality cost) of cancer. Medical care costs are expenditures spent on the medical procedures and services associated with treatment performed in hospital or clinic; this includes costs for hospitalization, outpatient visits and prescription drugs. Because administrative claims database records the cost of billed services only, fee for non-insured services paid out-of-pockets are estimated based on the survey result that is annually conducted by KNHI Corporation (KNIHC, 2010). Non-medical costs include transportation cost to visit healthcare providers, cost associated with caregiving for cancer patients, and cost for complementary and alternative medicine (CAM). A previous study in Korea of those employed showed that 26% lose their job within the first year of cancer diagnosis (Park et al., 2008). For patients who avoid the job loss, reducing work hours due to treatment is common, which result in earning less. In addition, family caregivers may also have to reduce paid work to support cancer patients on management of treatment schedule, accompanying hospital, monitoring health status of patient, and so forth. A prior study of 89 caregivers of female patients with advanced breast cancer showed that 69% of employed caregivers reported some form of adverse impact on work. Furthermore, entering the terminal stage, 77% reported missing work because of caregiving responsibilities (Grunfeld et al., 2004). Thus, morbidity costs are defined as the time and economic output lost from daily activities as well as work as a result of a disease and its treatment (Yabroff et al., 2004). Mortality costs are expressed as the present value of future productivity losses due to premature death (Luengo-Fernandez et al., 2013). Other components of cancer burden that are intangible or psychosocial costs (e.g., pain, grief, well-being) are not considered in this study. We were able to estimate the overall economic burden of cancer by combining the medical, non-medical, morbidity, and mortality cost. All costs estimated, are represented in 2009 US dollars using an exchange rate of 1,276 Korean Won to 1 US dollar, which was the annual exchange rate in 2009.

Cost estimation

Medical care cost was estimated using the health claims data from the KNHI Corporation. The ceiling on cumulative out-of-pocket payments was also applied for insured services. Due to limited benefits coverage, patients pay copayment for insured services and in full for non-insured services. As claims data included the cost for insurance-covered services only, it was necessary to identify the proportion of non-insured services among all services utilized to estimate the total medical cost of cancer. We applied the coverage rate for inpatient and outpatient services measured in the annual studies of non-covered service (KNIHC, 2010).

Transportation costs to health care providers were calculated on the basis of inpatient and outpatient hospital visits where an average one way transportation cost of $17.12 and $3.86 are applied for inpatient and outpatient visits, respectively (KCDC, 2009). In the calculation, one caregiver was included, assuming at least a caregiver would accompany hospital visits. Fee for caregiving services was estimated based on the individual annual inpatient days and an average daily wage of $43 for a professional caregiver service (KPHS, 2009). Lastly, the average cost of CAM ($1,136) was applied for the cost of CAM, which is value used in previous study (Kim et al., 2009).

We used the human capital approach to estimate the value of lost productivity resulting from morbidity, disability, and premature death, valued at the market wage (Drummond et al., 2005). Losses due to morbidity were computed separately for those who 1) reduced working hours due to cancer experience 2) lost their job due to cancer experience and 3) persons outside of the labor market (Kim et al., 2008). Morbidity cost for days lost from work due to cancer treatment is valued using

the average age- and gender-specific daily wage. Lost work days are calculated by summing the number of hospital inpatient days and half of outpatient visit days. For individuals who lost the job due to cancer, age- and gender-specific estimates of the average annual earnings were applied to determine morbidity. Finally, morbidity costs for those outside the labor market were valued by multiplying the average age- and gender-specific daily wages by number of days lost. All are aggregated to derive the overall morbidity cost of cancer.

We estimated the mortality costs using the following method. First, number of age and sex-specific cancer deaths in 2009 was used to predict the potential working years lost at death. Then we applied the age and sex specific probability of employment to the working years lost to derive the overall mortality cost. This method of estimating the mortality cost takes into consideration the life expectancy for different age and sex groups, changing pattern of earnings at different ages, employment rates, and appropriate discount rate to convert the stream of earnings into its present worth (Kim et al., 2008). Life expectancy at the age of death was obtained from the Korean Statistical Information System in 2009. And the data on percentage of the population with earnings and the annual average earnings by sex and age in 2009 were obtained from the 2009 Labor statistics of Korea (Ministry of Labor, 2009). Annual discount rates of 3% and 5% were applied.

In addition, as prior studies (Kim et al., 2008; Hanly and Sharp, 2014), we disregarded any deaths in children (<15) and 64 years and over since Korean workers generally retire after 65 and do not earn a wage. However, it is inaccurate and unethical to place no economic value on a person's life after 65. Therefore, the average annual earnings for the age group between 60 and 64 were used as a proxy measure for the economic value of the life after age 65, following prior study (Kim et al., 2008). For the purpose of sensitivity analysis, the premature death cost was recalculated by applying 50% (instead of 100%) of the average annual earnings for those aged between 60 and 64 years. Finally, to estimate the value of a caregiver's time spent to accompany a cancer patient to an outpatient visit, we multiplied the annual outpatient visits by an average half day wage. This assumed that half of the daily working hours were spent for an outpatient visit. The average hourly wage used was $9.76 (Ministry of Labor, 2009).

Results

Cancer prevalence

In 2009, a total of 403,342 men and 457,520 women with cancer were identified (Table 1). Among the patients, stomach cancer was the most prevalent (18.0%), followed by thyroid cancer (15.9%), colorectal cancer (13.8%),

Table 1. Number of Patients by Sex, Age and Cancer Site (Unit: Person,%)

Cancer Site	Total		Male		Female		Age(%)							
	N	%	N	%	N	%	<20	20-29	30-39	40-49	50-59	60-69	70-79	80≥
Stomach(C16)	155,400	18.0	103,164	25.6	52,236	11.4	0.3	3.2	8.5	12.9	16.6	22.0	23.5	19.4
Lung(C33-C34)	49,319	5.7	34,027	8.4	15,292	3.3	0.4	0.8	1.0	1.9	4.0	7.5	9.4	9.8
Liver(C22)	48,417	5.6	36,453	9.0	11,964	2.6	2.0	0.9	1.8	4.3	7.0	7.1	5.4	4.4
Colon and rectum(C18-C20)	119,134	13.8	69,968	17.3	49,166	10.7	0.3	2.8	4.8	7.7	12.4	17.0	18.7	20.0
Breast(C50)	88,013	10.2	399	0.1	87,614	19.1	0.1	3.4	13.1	20.1	15.1	7.1	3.6	2.5
Cervix uteri (C53)	34,207	4.0	-	0.0	34,199	7.5	0.1	2.4	5.6	6.5	4.6	3.1	2.7	2.4
Thyroid (C73)	136,949	15.9	19,930	4.9	117,019	25.6	4.0	38.9	42.7	29.1	19.5	9.7	4.3	2.1
Gallbladder(C23-C24)	13,324	1.5	6,708	1.7	6,616	1.4	0.0	0.1	0.2	0.5	1.0	1.9	2.5	3.4
Pancreas (C25)	8,442	1.0	4,682	1.2	3,760	0.8	0.3	0.3	0.3	0.4	0.8	1.1	1.5	1.9
Bladder(C67)	19,903	2.3	16,079	4.0	3,824	0.8	0.3	0.4	0.6	0.8	1.5	2.6	3.8	5.3
Prostate (C61)	29,749	3.5	29,749	7.4	-	0.0	0.0	0.0	0.0	0.1	1.0	4.2	7.5	9.4
Kidney(C64)	17,531	2.0	11,789	2.9	5,742	1.3	3.9	1.1	1.6	1.9	2.3	2.2	2.0	1.5
Esophagus(C15)	6,473	0.8	5,883	1.5	590	0.1	0.0	0.0	0.0	0.2	0.5	1.1	1.3	0.9
Ovary (C56)	10,594	1.2	-	0.0	10,592	2.3	3.1	5.4	2.2	1.6	1.4	0.9	0.6	0.5
Leukemia(C91-C95)	12,126	1.4	6,681	1.7	5,445	1.2	31.6	8.0	2.6	1.4	0.9	0.7	0.6	0.5
Oral cavity (C00-C08)	7,085	0.8	4,274	1.1	2,811	0.6	0.9	1.7	1.0	0.8	0.8	0.8	0.8	0.8
Larynx(C32)	6,819	0.8	6,384	1.6	435	0.1	0.0	0.0	0.1	0.2	0.6	1.2	1.2	1.0
Melanoma of skin(C43)	2,025	0.2	915	0.2	1,110	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.3
Brain and central nervous system (C70-C72)	7,381	0.9	3,875	1.0	3,506	0.8	12.8	5.4	1.8	1.0	0.6	0.5	0.4	0.4
Non-Hodgkin lymphoma (C82-C85;C96)	18,744	2.2	10,291	2.6	8,453	1.8	9.9	6.8	3.1	2.2	2.0	1.9	1.8	1.5
Hodgkin disease(C81)	1,390	0.2	881	0.2	509	0.1	1.4	2.1	0.5	0.1	0.1	0.1	0.1	0.0
Multiple myeloma(C90)	3,322	0.4	1,778	0.4	1,544	0.3	0.0	0.1	0.1	0.2	0.4	0.5	0.5	0.4
Testis(C62)	1,467	0.2	1,466	0.4	1	0.0	2.2	2.1	0.9	0.2	0.1	0.0	0.0	0.0
Corpus uteri (C54)	9,794	1.1	-	0.0	9,793	2.1	0.0	0.6	1.3	1.4	1.9	1.1	0.5	0.3
Nasopharynx(C11)	2,264	0.3	1,620	0.4	644	0.1	0.4	0.6	0.3	0.4	0.3	0.2	0.1	0.1
Other pharynx (C09-C10; C12-C14)	2,935	0.3	2,574	0.6	361	0.1	0.1	0.0	0.1	0.2	0.4	0.5	0.4	0.3
Others	48,055	5.6	23,761	5.9	24,294	5.3	25.7	12.3	5.4	3.8	3.9	4.9	6.5	10.8
Total	860,862	100	403,342	100	457,520	100	100	100	100	100	100	100	100	100

breast cancer (10.2%), lung cancer (5.7%) and liver cancer (5.6%). Examining the patients by age revealed that leukemia, thyroid, and gastric cancer were the most prevalent in the age groups of under years 20, 20-50, 60 and older, respectively.

Medical and non-medical costs

The total medical expenditure for cancer in Korea in 2009 amounted to $4,900 million of which the National Health Insurance paid 67.8% (Table 2). Inpatient services accounted for $2,953 million, or 60.3% of the total medical costs. And outpatient services amounted to $1,390 million, followed by the prescription drug cost of $557 million.

Distribution of the total medical cost by site of cancer showed that colorectal cancer incurred the highest cost ($703 million) (Table 3). It is followed by stomach cancer ($677 million), lung cancer ($520 million), liver cancer ($473 million) and breast cancer ($407 million). Non-medical cost amounted to $2,973 million, falling short of the medical cost of $4,900 million (Table 3). The highest non-medical cost occurred for individuals with stomach cancer ($518 million), followed by colorectal cancer ($426 million), thyroid cancer ($406 million), breast cancer ($275 million), and lung cancer ($212 million).

Morbidity costs and mortality costs

Table 4 shows the morbidity cost of cancer, defined by the value of lost earnings and the opportunity cost of lost productivity among the employed patients as well as those unable to work due to cancer related reasons.

Table 2. Medical Care Expenditures for Cancer by Type of Medical Service

Type of service	Insurer payment		Co-insurance		Not-covered		Total	
	Per patient ($)	Total ($ millions)	Per patient ($)	Total ($ millions)	Per patient ($)	Total ($ millions)	Per patient ($)	Total ($ millions)
All service	3,857	3,320	554	477	1,274	1,097	5,692	4,900
Inpatient	2,175	1,872	234	201	1,019	877	3,431	2,953
Outpatient	1,145	986	212	182	255	220	1,614	1,390
Prescription drugs	537	462	108	93	-	-	647	557

Table 3. Medical and Non-medical Costs According to Cancer Site

Cancer Site	Medical care costs		Non-medical costs*	
	Per patient ($)	Total ($ millions)	Per patient ($)	Total ($ millions)
Stomach	4,359	677	3,336	518
Lung	10,534	520	4,291	212
Liver	9,769	473	3,802	184
Colon and rectum	5,904	703	3,574	426
Breast	4,626	407	3,128	275
Cervix uteri	3,418	117	3,129	107
Thyroid	2,488	341	2,968	406
Gallbladder	8,336	111	4,165	55
Pancreas	10,769	91	4,490	38
Bladder	4,394	87	3,556	71
Prostate	5,423	161	3,906	116
Kidney	5,207	91	3,345	59
Esophagus	9,079	59	4,166	27
Ovary	7,218	76	3,538	37
Leukemia	18,613	226	3,487	42
Oral cavity	5,112	36	3,416	24
Larynx	4,738	32	3,597	25
Melanoma of skin	6,079	12	3,840	8
Brain and central nervous system	10,493	77	3,935	29
Non-Hodgkin lymphoma	8,435	158	3,456	65
Hodgkin disease	6,144	9	2,873	4
Multiple myeloma	17,376	58	4,799	16
Testis	2,601	4	2,078	3
Corpus uteri	3,875	38	3,185	31
Nasopharynx	6,515	15	3,791	9
Other pharynx	8,188	24	4,078	12
Others	6,154	296	3,610	173
Total	5,692	4,900	3,453	2,973

* Includes transportation, costs for caregiving and complementary and alternative medicine

Table 4. Lost Days and Morbidity Costs According to Cancer Site

Cancer Site	Lost days*		Morbidity costs†	
	Per patient	Total	Per patient	Total (millions)
Stomach	28.7	4,456,485	5,237	814
Lung	47.9	2,359,968	4,442	219
Liver	40.4	1,958,273	6,821	330
Colon and rectum	32.9	3,923,829	4,752	566
Breast	27.0	2,378,196	4,131	364
Cervix uteri	25.6	875,649	3,677	126
Thyroid	20.9	2,864,007	5,051	692
Gallbladder	45.6	607,658	3,868	52
Pancreas	54.6	460,581	4,809	41
Bladder	31.5	625,978	4,454	89
Prostate	34.7	1,032,450	3,251	97
Kidney	29.2	512,540	6,190	109
Esophagus	46.4	300,411	5,015	32
Ovary	35.6	377,512	3,859	41
Leukemia	42.0	509,882	5,113	62
Oral cavity	32.1	227,239	5,854	41
Larynx	32.9	224,069	5,082	35
Melanoma of skin	38.1	77,139	4,873	10
Brain and central nervous system	51.6	380,903	5,985	44
Non-Hodgkin lymphoma	34.0	637,245	5,691	107
Hodgkin disease	25.7	35,718	6,376	9
Multiple myeloma	58.7	194,934	5,226	17
Testis	14.7	21,622	8,463	12
Corpus uteri	26.3	257,386	3,745	37
Nasopharynx	38.4	87,004	7,946	18
Other pharynx	45.3	132,833	6,441	19
Others	35.2	1,691,073	4,448	214
Total	31.6	27,210,579	4,872	4,195

* Length of stay+outpatient visit days/2; †Includes the employed and unemployed due to cancer

Morbidity cost of cancer in Korea in 2009 amounted to $4,195 million, or $4,872 per patient (Table 4). Stomach cancer ranked the highest on total lost days, which are attributable to hospitalization and outpatient visits, and on morbidity cost with $814 million.

Premature mortality from cancer is a significant factor that affects the productivity of an economy. In 2009, 72,544 individuals died from cancer alone in Korea (Table 5). It is equal to a loss of $5,251 million of future income foregone at 3% discount rate, or $72,380 per death, and 17.3 life years of productivity lost per death. However, cancer mortality costs vary by cancer sites. Liver cancer ranked the highest, accounting for 23.3% of the total mortality costs, followed by stomach cancer (15.8%). On the other hand, mortality cost per patient was the highest in testis cancer, followed by nasopharyngeal caner, brain cancer, and leukemia.

Table 5. Number of Deaths, Person-years Lost, and Mortality Costs, according to Cancer Site

Cancer Site	No. of deaths	Life yrs lost (per death)	Mortality costs* Per patient	Total (millions)
Stomach	11,360	17	72,835	827
Lung	14,409	15.1	54,540	786
Liver	11,681	19.8	104,800	1,224
Colon and rectum	7,882	16	60,815	479
Breast	1,847	29.2	88,170	163
Cervix uteri	997	22.4	62,564	62
Thyroid	654	18.1	62,192	41
Gallbladder	3,235	14.8	47,323	153
Pancreas	3,796	16.7	64,206	244
Bladder	1,262	11.8	40,351	51
Prostate	1,598	9.6	27,433	44
Kidney	893	17.1	73,008	65
Esophagus	1,472	15.1	59,972	88
Ovary	799	24.9	68,601	55
Leukemia	1,453	27.9	136,919	199
Oral cavity	512	18.1	88,594	45
Larynx	431	13.3	49,718	21
Melanoma of skin	213	20.7	96,126	20
Brain and central nervous system	948	28.1	139,223	132
Non-Hodgkin lymphoma	1,413	20	92,324	130
Hodgkin disease	51	19.1	91,618	5
Multiple myeloma	695	17.2	61,031	42
Testis	17	38.8	322,618	5
Corpus uteri	263	23.5	61,773	16
Nasopharynx	196	24.1	148,128	29
Other pharynx	405	15.5	63,403	26
Others	4,062	17.5	72,873	296
Total	72,544	17.3	72,380	5,251

* Discounted at 3 percent

Table 6. Economic Costs of Cancer by Type of Cost

Type of costs	Per patient ($)	Total ($ millions)	%
Inpatient	3,431	2,953	17.1
Outpatient	1,614	1,390	8
Prescription drugs	647	557	3.2
Subtotal(medical care costs)	5,692	4,900	28.3
Caregiver time costs	1,771	1,525	8.8
Transportation	559	481	2.8
Complementary and alternative medicine	1,124	967	5.6
Subtotal(non-medical costs)	3,453	2,973	17.2
Morbidity costs	4,872	4,195	24.2
Mortality costs (discounted at 3%)	72,380	5,251	30.3
Total	86,398	17,318	100

*per death

Table 7. Sensitivity Analysis of Economic Costs of Cancer

Cost category	Subject group for calculating		Amount ($ millions)
Mortality costs	Discounted at 3%	Applying 100%	5,251
		Applying 50%*	4,144
	Discounted at 5%	Applying 100%	4,471
		Applying 50%*	3,553
Range of total economic costs†		17,318~15,621	

* 50% of the annual earnings of persons aged 60-64 years were used for the aged (65 years or over). †Include medical, non-medical and morbidity costs of 12,068 million dollar

Total economic cost of cancer was estimated at $17,318 million in Korea in 2009 (Table 6). Medical care costs, non-medical costs, morbidity cost, and mortality cost were 28.3%, 17.2%, 24.2%, 30.3% of the total cost, respectively. Result of the sensitivity analysis is shown in Table 7. Mortality costs ranged from $3,553 million to $5,251 million.

Discussion

The result of our study suggests that cancer is still a costly disease in Korea, accounting for over $17.3 billion of economic burden in 2009. Stomach cancer was identified as the single most costly cancer, with nearly $3 billion price tag. The six major categories of cancer: stomach, lung, liver, colorectal, breast, and cervix cancer, accounted for 61% of the total economic burden of cancer in Korea in 2009. In 2002 and 2005, economic burden of cancer was $9,417 million and $14.0 billion, respectively (Kim et al., 2008; Kim et al., 2009). Although the rate of increase in the cancer care cost has slowed down, it still imposes a substantial economic burden on society. Especially, direct cost and morbidity cost of cancer were on the increase, although mortality cost decreased over the last decade. Medical care cost, which accounted for 13.7% of the overall cost in 2002, was about third of the cancer burden in this study. This rapid increase is owed to an increase in cancer incidence, new indications for treatment with previously approved cancer drugs and to placement of new drugs on the market (Mariotto et al., 2011; Sullivan et al., 2011; Wani et al., 2013; Peixoto et al., 2014). Emerging trends of substituting surgeries with noninvasive/low-toxicity approaches and conventional radiotherapy with IMRT may also have driven up the medical care costs. Recently EU reported the total cost of cancer to be €126 billion in 2009, of which €51.0 billion was incurred by medical cost (Luengo-Fernandez et al., 2013). In the USA, the cost of cancer was estimated at US$212.6 billion in 2009, of which $86.6 billion was direct medical cost and $130.0 billion was mortality cost (American Cancer Society, 2014). In both studies, medical

costs accounted for nearly 40% of the overall economic burden, which is roughly 10% higher than our study result. However, hospital inpatient care in the EU study accounted for more than half of medical cost, which is comparable to the result of this study. The Korean government invested tremendous budget between 2005 and 2009 to decrease cancer patients' burden for medical costs. However, out-of-pocket cancer care cost still remains high due to strong presence of non-insured or partially insured medical costs. This financial burden can cause substantial distress, sometimes forcing patient to give up the optimal treatment. Therefore, considering steep increase and relatively low portion of medical cost in the overall cancer burden, evidence-based monitoring for medical cost as well as an effort for expanding limited benefits are needed. It has been pointed out that unnecessary testing and unproven medical procedures were the major factors of an increase in medical costs (Furlow, 2012). Discussing out-of-pocket costs between physician and patient is also important to choose alternative treatments that are less expensive but equally or nearly as effective (Ubel et al., 2013; Morden et al., 2014).

The increase of medical cost also led to corresponding increase of the non-medical costs. Especially, costs associated with informal or formal caregiving have grown substantially. Thus, in addition to reducing the treatment expenses, an effort to decrease the caregiving expenses is much needed. Family caregivers also report considerable distress that may interfere with their ability to provide emotional or logistical support and exacerbate patients' emotional distress (Braun et al., 2007; IOM, 2013). Thus, in the future cancer care setting, it is especially important for the care team to identify the psychosocial health needs of patients and their families, and to develop a care plan that addresses these needs.

Over the last decade, mortality cost has constituted the overwhelming majority of the total productivity loss. As mentioned above, estimated cancer-related premature mortality costs were declining but still substantial, accounting for a third of the overall cancer burden. Number of death, age at diagnosis and survival all impact the mortality costs. In particular, cancers with earlier age at onset and that have moderate or poor prognosis, tend to rank more highly in terms of costs (Hanly and Sharp, 2014). Contrary to the previous results, morbidity costs occupy a larger portion of total costs. This leads to excess health care expenditures. Multifaceted prevention strategies including research, education, policy change, and sustained intervention programs may help reduce the economic impact of cancer (Guy et al., 2013).

This study is performed in line with previous nation-wide researches (Kim et al., 2008; Kim et al., 2009). Key strengths of the study include the use of population data and comprehensive coverage of the component of cancer burden. Nevertheless, there are some limitations. First, in order to enhance the comparability of our results, we used similar method with the previous study (Kim et al., 2008), granting this study comparable limitations. For example, categories of cost for low quality of life, psychological morbidity, sexuality, and the pain of patient were omitted from this study. Second, the cost of CAM was measured using the survey conducted at a single hospital due to lack of reliable data, thus somewhat limiting generalizability of the result. Third, since we measured cancer cost based on prevalence, we were not able to estimate the lifetime cost of cancer. Last, the human capital approach undervalues some groups, such as children, women and the retired elderly; this is because this approach estimates costs from market activities that put greater weight on older and working male compared to younger person. Nevertheless, the human capital approach is widely used throughout the economic literature and used to enhance the comparability of this study.

In conclusion, this study estimated the economic costs attributed to cancer in Korea in 2009 using the nationwide database. Given that the direct medical cost sharply increased over the last decade, we must strive to construct a sustainable health care system that provides better care while lowering the cost. In addition, comprehensive cancer survivorship policy aimed at lower caregiving cost and higher rate of return to work has become more important than before.

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