

Full Length Research Paper

Sensitivity analysis of the economic burden using social insurance claim data

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The study is aimed at examining changes in economic burden in comparison with figures cited in previous studies. Data from South Korea's National Health Insurance claims database are used to measure the economic burden of chronic disease. Both direct and indirect costs are considered. Direct costs are those associated directly with treatment, medication, and transportation, and indirect costs are assessed in terms of the loss of productivity and their caregivers and consist of morbidity and mortality costs. We also undertake sensitivity analysis, wherein we extract incidence cases and categorize them in terms of their frequency of hospital visits (from one time to five times). The total economic burden posed by chronic disease in South Korea in 2010 was found to be approximately 3.7 million USD; indirect costs and direct medical costs accounted for most of the economic burden, although the rates of these varied from disease to disease. In a comparison of disability-adjusted life years values and the economic burden of diseases, diseases varied widely in terms of their burden. The findings of this study can be used to inform policymakers as they establish public health policies that address various disease burden indexes.

Key words: Chronic illness, economic analysis, measurement.

INTRODUCTION

As of 2010, worldwide, chronic diseases such as cardiovascular disease, cancer, chronic respiratory disease, and diabetes accounted for 60% of all deaths worldwide (35 million), and 80% or more of all deaths in developing and underdeveloped countries (WHO, 2005). It is also estimated that in 2015, 41 million people will die of chronic disease without having received preventive care or treatment (Strong et al., 2005). For this reason, the management of chronic diseases is important to maintaining stability and solidarity within the whole of society, in addition to improving personal health

conditions. With the general increase in life expectancy and aging in society, the presence of chronic disease may indeed extend the period of medical service and create quality-of-life problems.

In terms of worldwide research activities, in line with the "Global Burden of Disease" (GBD) of 1990, the use of the disability-adjusted life years (DALY) metric to assess quantitatively the risk inherent in chronic diseases and thus better understand the severity of various chronic diseases, has proliferated. The World Health Organization (WHO) developed a GBD research

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methodology and proposed its use to measure disease burden. The ensuing indexes include DALY, health-adjusted life years (HeaLY), disability-free life expectancy (DFLE), health-adjusted life expectancy (HALE), and disability-adjusted life expectancy (DALE) (Murray et al., 2000).

These indexes are used in the literature to assess in a country-specific manner the burdens related to all chronic diseases (Strong et al., 2005), as well as income-specific disease burdens (Abegunde et al., 2007). However, these studies feature low levels of precision, since they undertake DALY assessments while using data from unidentifiable sources; as a result, the estimated values are not based on accurate epidemiological data of the country in question.

In South Korea, DALY measurements have been undertaken of single diseases, such as dementia (Park et al., 2013), cancers (Cho et al., 2013), and stroke (Hong et al., 2011); disease burden has also been assessed in terms of risk factors, such as high levels of alcohol consumption (Lee et al., 2005). The majority of the studies had reliable results, because they actively excluded estimated values on the basis of insurance claim data, used domestic data, and worked to reflect actual health conditions; nonetheless, they failed to grasp the severity of chronic disease in terms of the burden it poses.

With an eye to mitigating the aforementioned limitations, the present study measures disease burden in terms of demographic characteristics; it also assesses the severity of various diseases, in consideration of the number of deaths caused by chronic disease over a certain period. This study also considers the periods of struggle against disease, by determining the average morbidity periods. This study examines results vis-à-vis the disease burden that South Koreans faced in 2010 on account of chronic disease, and compares its results to those of previous studies.

METHODS

Definition of "chronic disease"

The WHO defines "chronic disease" as a disease of a long duration, where impairment is permanent and irreversible, and where special training for rehabilitation is required; additionally, there is a need for long-term investigation or care. Here, we additionally describe a chronic disease as a "non communicable disease"; this is in line with the WHO's GBD project definition (WHO, 2005).

Data source

This study estimates the economic burden of chronic disease, using a prevalence-based approach that features a societal perspective. Claim data for in and outpatients, as drawn from the database of the National Health Insurance Corporation (NHIC) of South Korea, were used to collect information about chronic disease cases. Under the operational definition of "chronic disease" were cases who claimed from the NHIC for having a non-communicable

disease, in line with the GBD projects in the International Classification of Disease (10th version), as a primary or secondary diagnosis in 2010, either more than three times on an outpatient basis or once as an admission case.

Prevalence

This study measures the economic burden of chronic disease by using a prevalence approach. The proposed prices were estimated in U.S. dollars (USD) (with USD1 = 1,104.76 South Korean won [KRW]) by applying the average 2010 exchange rate of the Korea Exchange Bank. For outpatient visiting frequency, given concerns regarding code validity (e.g., the sometimes-incorrect recording of disease codes), we considered the test unreliable. We therefore calculated how many of the same subjects used medical institutions on account of having a given disease over 2010; the economic burden of that chronic disease was calculated by adding together the medical costs during that year for outpatient cases with more than three clinic visits and for inpatients admitted once.

Cost

South Korea has a single-insurer system, and 97% of its population is enrolled with the NHIC. Thus, it is rational to assume that data about spending and medical expenses that were derived from the NHIC database would be representative of the country's population. Since claim data from the NHIC do not consider non-covered service costs, transportation expenses, guardian expenses, and the like, but rather include only insurance-covered costs, it was difficult to estimate the total costs. This study uses South Korean health panel data to compensate for this limitation.

To calculate the socioeconomic burden of chronic disease, we classified costs as direct or indirect costs. Direct costs relate to treating disease; furthermore, they include direct medical care costs and direct nonmedical care costs. Direct medical care costs are covered by a variety of payers, including insurers and patients, and include non-covered care costs and pharmaceutical costs. To estimate non-covered care costs, we consulted the results of the NHIC's "Out of pocket expenses research"-data about the ratio of non-covered care costs to all costs. Pharmaceutical costs were estimated on the basis of the outpatient pharmaceutical cost rate of 56.13%, which is drawn from the annual statistics of the NHIC (HIRI, 2013). For sensitivity analysis, we adjusted the pharmaceutical cost rate by 80 to 120%.

The annual direct health care cost can be calculated as follows:

$$\text{Annual direct health care cost} = \sum_{m=1}^{12} DHC_m$$

$$DHC = \left[IC_m + \frac{(IC_m \times NBR_i)}{(1 - NBR_i)} + IPC_m \right] + \left[OC_m + \frac{(OC_m \times NBR_o)}{(1 - NBR_o)} + OPC_m \right] + RC_m$$

Where, DHC = direct health care cost; IC = inpatient cost; NBR_i = non-covered rate of inpatients; IPC = inpatient pharmaceutical cost; OC = outpatient cost; NBR_o = non-covered rate of outpatients; OPC = outpatient pharmaceutical cost, and RC = rehabilitation aid cost

Direct nonmedical costs comprise transportation costs incurred while visiting hospitals; they also include those incurred by guardians. We calculated the transportation cost by determining the number of hospitalizations and the days of visiting outpatient clinics, both of which were drawn from 2010 NHIC data, and multiplying it by per-trip transportation cost. South Korea health panel data from

2010 were used to determine the cost of round-trip transportation, as follows.

To calculate an outpatient's transportation cost, we used USD0.70, the cost of a one-way fare to visit a clinic. The transportation cost for an inpatient was therefore USD6.90 (including guardian) multiplied by 2 (that is, a round trip). We defined all patients aged 0 to 19 years, or 60 years or over, as requiring the assistance of a caregiver, and so for these individuals, transportations costs for two people were calculated.

South Korea has a culture where, rather than use the services of paid health care assistants, patients tend to be nursed by 20 to 60-year-old women within their family; alternatively, patients have relatives who act as guardians. The guardian costs were therefore

calculated by multiplying the total number of days of hospitalization by USD 51.40, the average daily wage among 20 to 50-year-old women in South Korea in 2009. However, since this caregiver cost was calculated for use with 2010 data, we needed to adjust the wage through the use of a price index. The caregiver expense was in this way found to be USD104.60, in 2010 dollars. For outpatients, we assumed that those aged 0 to 19 years or 60 years or older would be accompanied by a caregiver, and as with inpatients, we calculated the average caregiver wage per day in 2010 dollars. We assumed that the time taken to visit a clinic constituted one-third of the working hours in a day.

The annual direct non health care cost can be calculated as follows:

$$\text{Annual direct non - healthcare cost} = \sum_{m=1}^{12} NHC_m$$

$$NHC = \sum_{ag=0}^9 TFi \times Fi, ag \times 2 \times 2 + \sum_{ag=0}^1 TFo \times Fo, ag \times 2 \times 2 + \sum_{ag=6}^9 TFo \times Fo, ag \times 2 \times 2 + \sum_{ag=2}^5 TFo \times Fo, ag \times 2$$

$$+ \sum_{ag=0}^9 WC \times Fi, ag \times \frac{I_{2010}}{2009} + \sum_{ag=0}^1 WC \times Fo, ag \times \frac{I_{2010}}{2009} \times \frac{1}{3} + \sum_{ag=6}^9 WC \times Fo, ag \times \frac{I_{2010}}{2009} \times \frac{1}{3}$$

Where, NHC = direct non health care cost; TFi = one-way transportation fee for inpatient; Fi, ag = frequency of inpatients per age group; TFo = one-way transportation fee for outpatient, Fo, ag = frequency of outpatients per age group; WC = wage of caregivers and $I_{2010/2009}$ = price index for 2010, as per 2009 values. The indirect cost consisted of the cost of lost productivity and the cost of premature death; it was calculated through the use of the human resource approach(Kim et al., 2013). To calculate the cost of lost productivity, in the case of inpatients, we multiplied the number of days of hospitalization by the average wage per day.

Since we assumed that patients aged 0 to 19 years or 70 years or older do not participate in financially productivity activities, the cost due to lost productivity was calculated only for those aged 20 to 69 years. Statistics from the Ministry of Labor were used to estimate the average wage per day and the average working hours by age group. The opportunity cost related to visiting a clinic was estimated by multiplying the average number of visiting hours by the number of days visited. The average number of hours per outpatient was calculated as one-third of the working hours per day, including both transportation and actual visit time.

$$\text{Annual indirect Cost} = \sum_{m=1}^{12} IDC_m$$

$$IDC = \sum_{ag=2}^6 (AWag \times Fi, ag) + \sum_{ag=2}^6 (AWag \times Fo, ag \times \frac{1}{3}) + \sum_{ag=0}^6 (PAWag \times Fd, ag)$$

Where IDC = indirect cost; AWag = average wage of a certain age group; Fi, ag = frequency of inpatients per age group; Fo, ag = frequency of outpatients per age group; PAWag = present value of averaged wage on a certain age group and Fd, ag = frequency of deceased people per age group

Table 1 provides detailed information regarding the variables used in the current study.

The cost of premature death was estimated by cause of death, as reported by the National Statistical Office. Future incomes were discounted by 0.05 per year, to create a present value; these values were calculated until the age of 65 years. The annual indirect cost can be calculated as follows:

RESULTS

Figure 1 lists our findings vis-à-vis disease-specific economic burden, in terms of item-specific expenses. The total economic burden generated by chronic disease in

South Korea in 2010 was found to be approximately 3.7 million USD.

The cost of hospitalization and outpatient treatment accounted for the greatest proportion of direct medical costs, followed by pharmaceutical costs; rankings, however, differed from disease to disease. Premature death costs accounted for the greatest proportion of indirect costs among malignant tumors, cardio-cerebrovascular diseases, and digestive diseases, while among neurological diseases, nursing costs exceeded premature death costs (Figure 2).

When we compared the socioeconomic disease burden values to DALY values (Kim et al., 2013), we found that gastric and liver cancers, both of which had low DALY values, had relatively low socioeconomic disease burdens, while stroke and osteoarthritis had relatively larger socioeconomic disease burdens (Figure 3).

Table 1. Detailed variables and data sources per cost item.

Cost items	Detailed variables	Data sources	
Health cost	Direct medical cost	Inpatient costs: Average inpatient health care costs; average admission rate; non benefit rate: inpatients Outpatient costs: Average outpatient health care costs; average outpatient visit rate; non benefit rate: inpatients; pharmaceutical costs	NHIC claim data; data from 2011 survey regarding out-of-pocket payments made by patients otherwise covered by the NHIC NHIC claim data; data from 2011 survey regarding out-of-pocket payments made by patients otherwise covered by the NHIC; 2011 National Insurance Statistical Yearbook
	Direct non-fee medical cost	Transportation costs: Average admission rate; average number of admissions; one-way transportation fees for inpatients; average outpatient visit rate; average number of outpatient visits; one-way transportation fees for outpatients Caregiver costs: Average days of admission; average number of outpatient visits; average wage per day Productivity loss: average days of admission; average number of outpatient visits; average wage per day; average employment rate	NHIC claim data; the Third Korea National Health and Nutrition Examination Survey (KNHANES III), 2010: Health Service Utilization; 2009 national statistics: consumer price index NHIC claim data; 2009 national statistics: South Korean income data 2009 national statistics: South Korean income data; 2009 national employment and labor statistics
Indirect cost	Premature death cost	Average wage in per year, by age group; average retirement age; number of deaths per age group; interest rate	2009 national statistics: South Korean income data; 2009 annual report on cause-of-death statistics

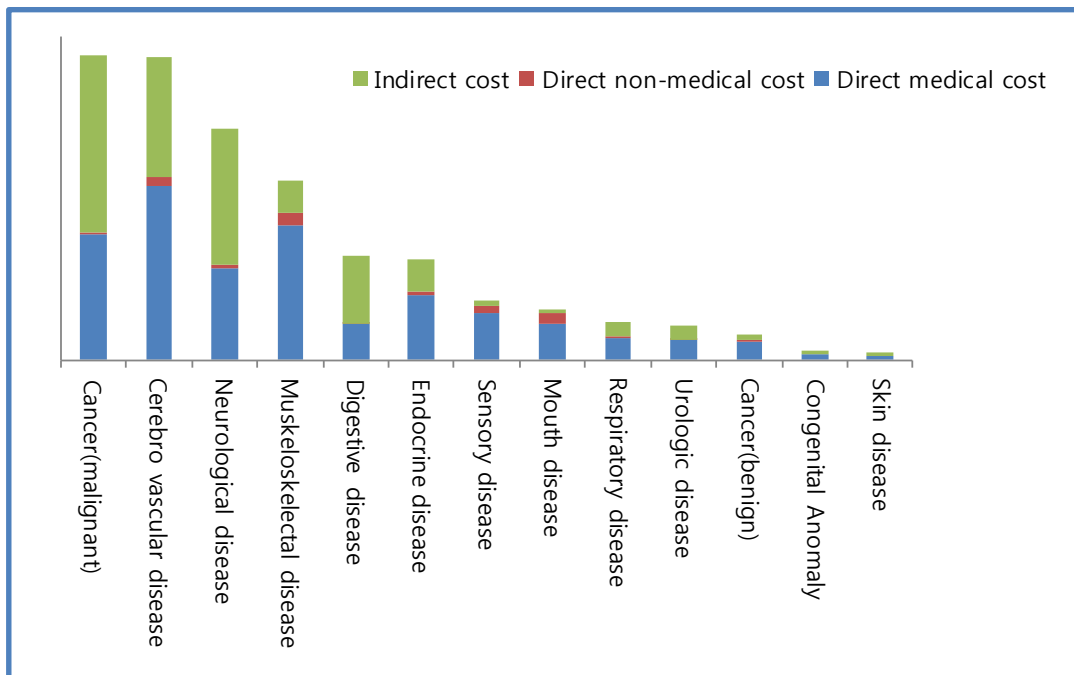


Figure 1. Socioeconomic burden of chronic disease in South Korea (2010), per disease .

According to the results of sensitivity analysis with the estimated values, the economic burden values were found not to be greatly affected by a loss of productivity

on account of the nonpayment rate of health insurance, wages, and the like; they were, however, greatly affected by a broad range of discount rates. In excluding cases

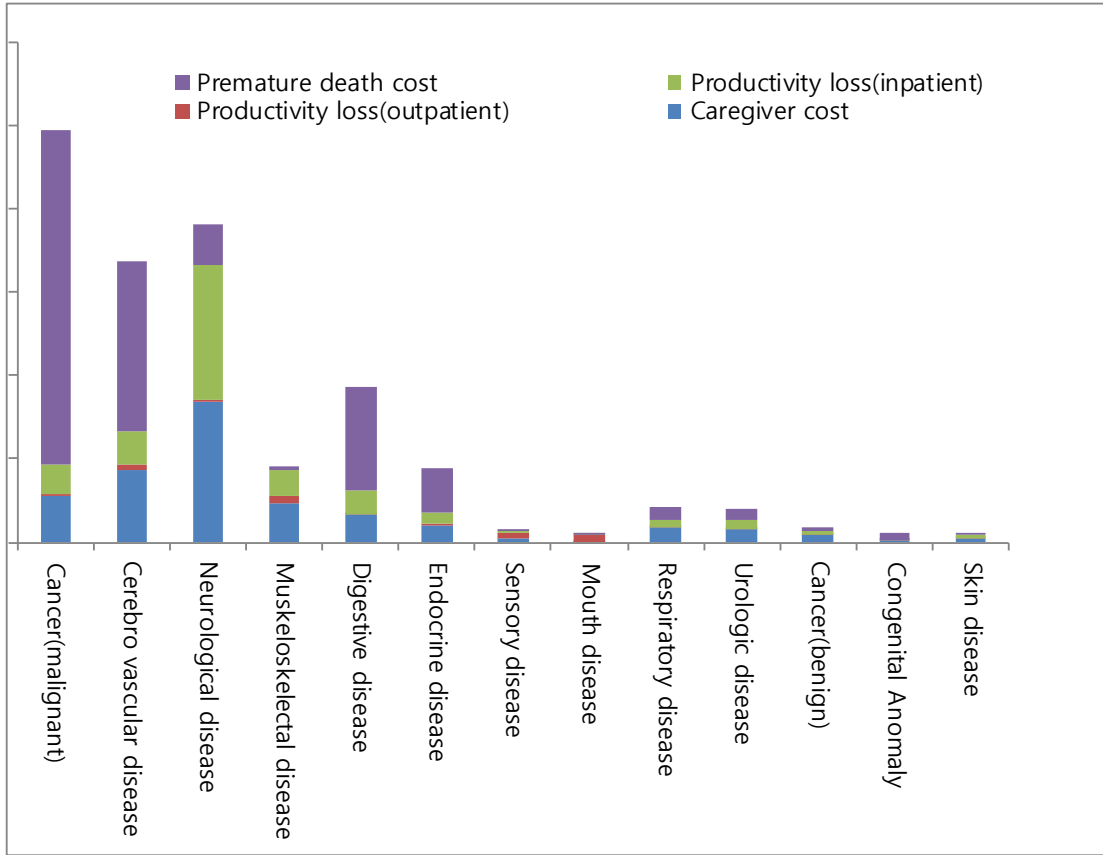


Figure 2. Indirect cost of chronic disease in South Korea (2010), per disease.

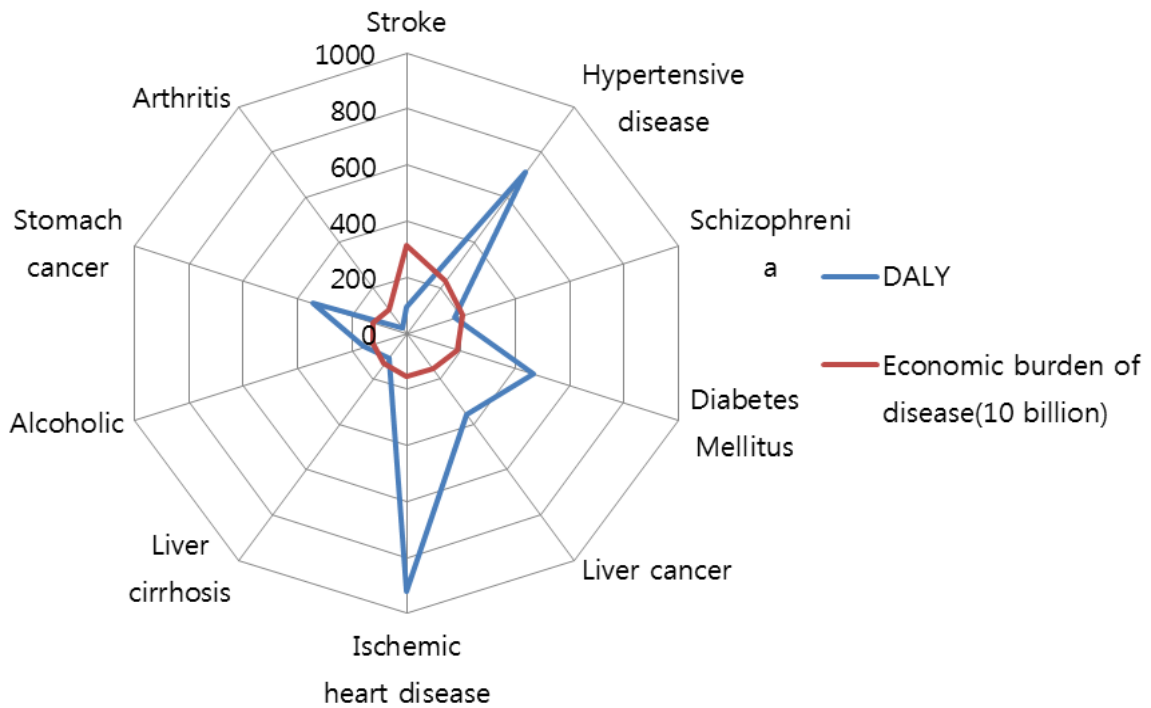


Figure 3. Comparisons of DALY and economic burden of disease values.

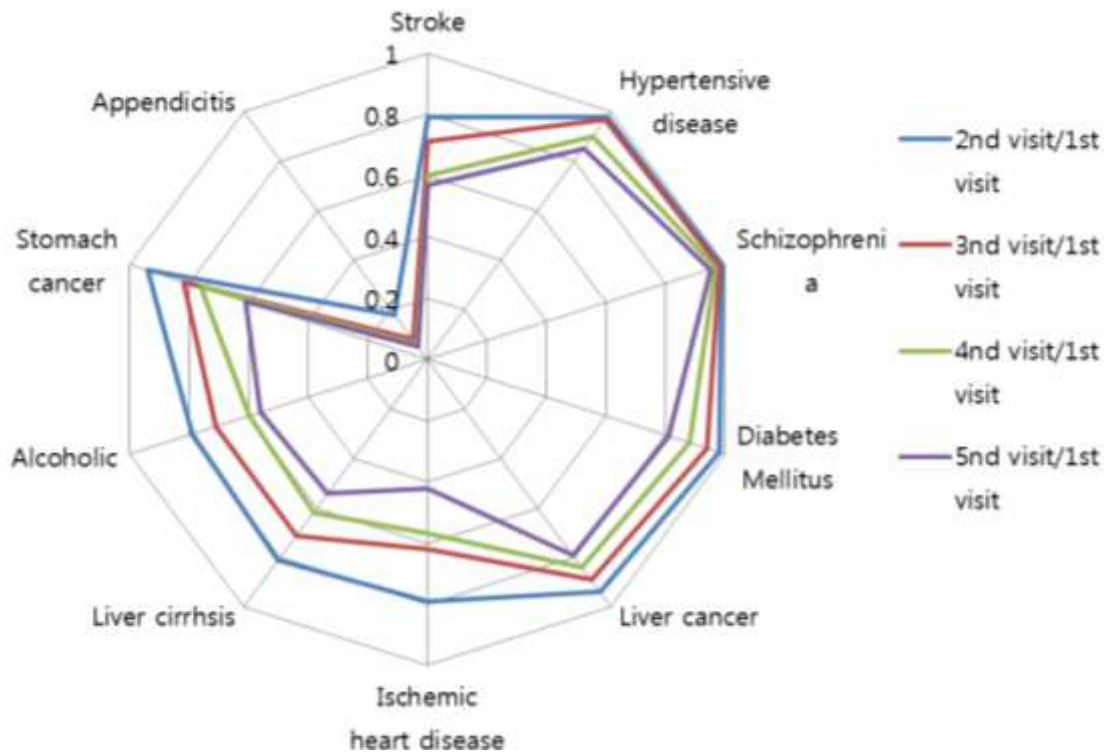


Figure 4. Sensitivity analysis of frequency of outpatient visits, per disease.

involving fewer than five visits, we found there to be no difference among the values among liver cancers, diabetes mellitus, schizophrenia, and hypertensive diseases, among others, all of which require continuous visits and involve detailed clinical pathological data and expert findings. However, other diseases showed values that differed from those of the others, among 50% or more of the cases (Figure 4).

DISCUSSION

This study compared social expenses incurred in 2010 on account of WHO-defined chronic disease; its main data source was South Korea's National Health Insurance Corporation (NHIC) database for the year 2010. We found the total economic burden incurred in that year by the presence of chronic disease to be approximately 3.7 million USD indirect and direct medical costs accounted for the greatest proportion of the overall economic burden, although these values varied from disease to disease.

Within the study year, an approximately USD8.2-billion economic burden was associated with malignant cancer, a disease that accounted for the greatest proportion of economic burden; this was followed closely by the USD 7.88 billion burden associated with cardio-cerebrovascular diseases. In the United States, as a point of comparison, approximately USD209.9 billion of economic burden was associated with cancers in 2005, while USD10.88 billion and USD14.9 billion was

associated with hypertension in 1998 and 2007, respectively (Hodgson and Cai, 2011). According to the 2008 GBD study, the economic burden associated with cardio-cerebrovascular diseases and cancers has increased among economically advanced countries. In this sense, the disease burden associated with chronic disease has increased sharply in South Korea, a country whose disease distribution has gradually changed to more closely resemble that seen in advanced countries (WHO, 2008).

In the current study, the medical cost for hospitalization and outpatient treatment accounted for the highest rate of direct medical costs, followed by pharmaceutical costs, although the ranking of these did vary from disease to disease. The death cost accounted for the highest proportion of indirect costs in malignant tumors, cardio-cerebrovascular diseases and digestive diseases, while among neurogenic diseases; nursing costs exceeded the death cost. This indicates that a disease with a high rate of fatality tends to incur a high productivity loss by causing early death, and that health problems stemming from a chronic disease may threaten the quality of life among the patient and his or her family members alike.

Especially after undertaking a comparison of DALY and economic burden of disease values, we found there to be great variance in the magnitude of disease burden among the diseases studied. These findings indicate that it is necessary to establish a method by which to measure economic disease burden in consideration of sensitivity to certain disease characteristics. This finding suggests that

policy should be established to address the various disease burden index values.

This study has some limitations. Its main data source is the database of South Korea's NHIC, and we were often compelled to exclude duplicate records, so as to prevent overestimation; there were also problems within the database with respect to erroneous classification information, possibly stemming from data entry error. In addition, this study does not take into consideration social costs related to folk remedies, nor cost increases that stem from comorbidity or complications.

In any case, the results of this study suggest the import of generating data that will inform various health policies.

These data can be generated by carrying out various follow-up studies and by continuously monitoring disease burden by using high-quality information culled from examinations of medical records and patients.

Conflicts of Interests

The authors have not declared any conflict of interests.

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