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Original Article

Socioeconomic costs of liver disease in Korea

Sunmi Lee[1], Woojin Chung[2], and Kyung-Rae Hyun[1]

[1]*Health Insurance Policy Research Institute, National Health Insurance Corporation;*
[2]*Graduate School of Public Health, Yonsei University, Seoul, Korea*

Background/Aims: This study analyzed the scale and trends of the social and economic costs of liver disease in Korea for the past 5 years. **Methods:** The social aspects of socioeconomic costs were projected for viral hepatitis (B15-B19), liver cirrhosis, malignant neoplasm of the liver (C22) and other liver diseases (K70-K76), as representative diseases by dividing costs into direct and indirect from 2004 to 2008. Direct costs include hospitalization, outpatient, and pharmacy costs in the health-care sector, and transportation and caregiver costs. Indirect costs include the future income loss due to premature death and the loss of productivity resulting from absence from work. **Results:** The social and economic costs of liver disease were projected to be KRW 5,858 billion in 2004, KRW 5,572 billion in 2005, KRW 8,104 billion in 2006, KRW 6,095 billion in 2007, and KRW 5,689 billion in 2008. The future income loss resulting from premature death is thus greatest, from 73.9% to 86.1%, followed by the direct medical costs, from 9.0% to 18.1%. The productivity loss resulting from absence from work accounts for 3.3-5.5%, followed by the direct nonmedical costs such as transportation and caregiver costs, at 1.5-2.5%. **Conclusions:** Among the socioeconomic costs of liver disease in Korea, the future income loss resulting from premature death is showing a decreasing trend, whereas direct medical costs are increasing dramatically. **(Korean J Hepatol 2011;17:274-291)**

Keywords: Viral hepatitis; Liver cirrhosis; Malignant neoplasm of the liver; Costs; Korea

See Editorial on Page 258

INTRODUCTION

As the human life span has been extended with the development of medicine, chronic diseases rather than acute ones have been increasing. Because it is hard to cure chronic liver disease completely and it should be controlled well for life, patients and their family members bear various burdens. Liver disease, one of the most representative chronic diseases, has showed a high prevalence rate in the East including South Korea and it includes chronic hepatitis, hepatic cirrhosis and hepatocellular carcinoma (HCC).

Liver disease ranked the eighth among causes of death in South Korea in 2009, and 6,868 died of liver disease for the one year.[1] It recorded adds the cause of fifth in males and did third in persons in their 40s. Moreover, the mortality rate of HCC showed the second highest level by following lung cancer and it did the highest in persons in their 40s and 50s.[1] In particular, a study estimating socioeconomic costs of major cause of death in South Korea revealed that the loss of productivity caused by premature death due to chronic liver disease ranked second next to that of cancer.[2] The high mortality of liver disease in economically active persons in their 40s and 50s means that the importance of liver disease management should be recognized by considering that chronic liver disease influences not only individuals or families but also the productivity of a society.[3]

The cost of illness is one of the most initial economic evaluation methods in the healthcare and it aims to measure the economic burden of illness in a society in terms of the consumption of healthcare resources and the loss of productivity.[4] In addition, studies on the cost of illness suggest the negative influence of illness and injury by using

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Abbreviations: HCC, hepatocellular carcinoma
Corresponding author: Kyung-Rae Hyun
Health Insurance Policy Research Institute, National Health Insurance Corporation, 168-9 Yeomri-dong, Mapo-gu, Seoul 121-749, Korea
Tel. +82-2-3270-9868, Fax. +82-2-3270-9840, E-mail; h7343@nhic.or.kr

a monetary unit which is a universal language of decision-makers and policy-makers. However, their results can provoke a considerable difference by countries, a base year for estimation, types of disease, cost items, formulas for estimation and data for analysis among researchers and can have problem relating to validity or reliability.[5,6] Nonetheless, studies on the cost of illness have been utilized as important indexes to prioritize the economic burdens of specific diseases, to determine the priority of research and development in National Institutes of Health, Institute of Medicine, the national assembly and others.[6]

Most previous studies on the cost of illness have dealt with major health risks like specific diseases[2,7,8] or smoking,[9-12] alcohol-drinking[13-15] and obesity[16-18] and their relevant diseases. But, even though liver disease exerts not a few negative effect in South Korea with recording a high mortality rate especially in economically active age groups as one of major death causes, there has been nearly no study analyzing the socioeconomic burden of liver disease precisely in the country. Therefore, this study aims to estimate the socioeconomic costs of major liver diseases (viral infection, liver cirrhosis and others and HCC) for the last five years (2004-2008) to provide basic data for the public awareness of the importance of prevention and management of liver disease.

MATERIALS AND METHODS

Materials

Studies on the cost of illness have been described by several researchers since 1960s.[6,19-21] Generally, studies on the cost of illness divide costs into direct, indirect and intangible ones and their viewpoints include a society, governmental institutions, employers, program providers and others. Most studies have measured the cost of illness from a societal perspective to consider its overall change comprehensively.[22] This study selected viral hepatitis (B15-B19), liver cirrhosis and others (K70-K76) and HCC (C22) (Table 1) as representative liver diseases, and estimated their socioeconomic costs in 2004 to 2008 by classifying them into direct and indirect costs.

Direct costs

The direct costs included direct medical costs and direct non-medical costs. The direct medical costs meant the sum of medical costs paid by outpatients and inpatients at medical institutions and at pharmacies to treat the liver disease. The total scale of treatment amount of Korean patients with liver disease can be investigated with health insurance data for items covered by the insurance at medical institutions and pharmacies. As the whole nation has been mandatorily insured through the national health insurance and a single system of health insurance claim data has been established in South Korea, various studies on cost of illness be conducted easily without an additional survey.[23,24] This study estimated the medical costs for items covered by the insurance by calculating the treatment amount of liver disease for inpatients and outpatients at medical institutions and at pharmacies by gender, age and year based on the National Health Insurance Statistical Yearbook (Appendix 1).[25]

By considering that the rate of uninsured out-of-pocket

Table 1. Categories of liver disease

Types of diseases (ICD-10 codes)	Sub-types of diseases (ICD-10 codes)
Viral hepatitis (B15-B19)	Acute hepatitis A (B15) Acute hepatitis B (B16) Other acute viral hepatitis (B17) Chronic viral hepatitis (B18) Unspecified viral hepatitis (B19)
Liver cirrhosis and other liver diseases (K70-K76)	Alcoholic liver disease (K70) Toxic liver disease (K71) Hepatic failure, NEC (K72) Chronic hepatitis, NEC (K73) Fibrosis and cirrhosis of liver (K74) Other inflammatory liver diseases (K75) Other diseases of liver (K76)
Malignant neoplasm of liver (C22)	Malignant neoplasm of liver and intrahepatic bile ducts (C22)

payments was 15.2%[26] in 2008, the exclusion of uninsured items underestimates the direct medical costs eventually not to reflect a socioeconomic loss related with liver disease. Therefore, for uninsured items, the medical costs among direct medical costs were estimated by applying the copayment rate of non-benefit (Appendix 2) for the total treatment amount for inpatients and outpatients at medical institutions and at pharmacies to the total treatment amount of liver disease by gender, age and year.[26]

The direct non-medical costs meant incidental expenses for the use of medical institutions or pharmacies, traffic costs for visits to clinics and costs of caregivers for inpatients. As the length of hospitalization and visiting days for medical service can be investigated as a whole, health insurance data are the most objective and comprehensive data to calculate direct non-medical costs. The traffic costs were estimated by multiplying the number of visit days of liver disease patients by gender and age by an average round-trip traffic cost per one visit. At this time, the number of visit days by gender and age was gained from the National Health Insurance Statistical Yearbook[25] (Appendix 3) and the average round-trip traffic cost was calculated to be KRW 1,191, KRW 1,251, KRW 1,309, KRW 1,356 and KRW 1,475 in 2005 to 2008, respectively by applying the consumer price index of traffic costs[27] to the average round-trip traffic cost per one visit to an outpatient clinic (KRW 1,475) in 2008 Korean Health Panel Survey.[28] In addition, costs of caregivers were regarded as personnel expenses of caregivers and opportunity costs of guardians of inpatients. The number of hospitalization days due to liver disease by gender and age was obtained from the National Health Insurance Statistical Yearbook[25] (Appendix 3) and the daily average personnel expenses of caregivers (KRW 60,000) suggested by Korean caregiver societies was input as the personnel expenses of caregivers or the opportunity costs of guardians. The costs of caregivers of the patients were estimated by multiplying the personnel expenses by the number of hospitalization days.

Indirect costs

Indirect costs included lost earnings due to premature death caused by liver disease and loss of productivity following absences from work to visit medical institutions. The lost earnings due to premature death was estimated by multiplying the human loss per person by the number of deaths due to liver disease by gender and age and the period from the year after death to the average life expectancy by gender and age. The number of deaths due to liver disease was secured from Annual Report on the Cause of Death Statistics (Appendix 4) published annually by Statistics Korea. The human loss per person was calculated with the probability of survival, employment rate, average annual income and wage growth rate by gender and age in each year from the year after death to the average life expectancy (Appendix 5). Therefore, the lost earnings due to premature death was estimated with the number of deaths by gender and age from Annual Report on the Cause of Death Statistics,[29] the average life expectancy and the survival rate by gender and age from Life Table,[30] the employment rate by gender and age from Annual Report on the Economically Active Population Survey,[31] the average annual real wage by gender and age from Basic Survey on Wage Structure[32] and the real wage growth rate of industry by gender and age from Survey Report on the Wages and Working Hours at Establishments.[33] At this time, this study applied a discount rate to convert future costs after premature death into the present values in each year and it reflected an individual time preference or an interest rate. The future costs were changed into the present values by dividing them by 5% discount rate.

The loss of productivity following absences from work to visit medical institutions to treat liver disease was calculated by gaining the numbers of hospitalization days and visit days due to liver disease by gender, age and year from the National Health Insurance Statistical Yearbook[25] (Appendix 3) and by multiplying the numbers by the average daily income by gender, age and year from Basic Survey on Wage Structure.[32] Cost items for estimation, major indexes to calculate each cost item and sources of indexes are summarized in Table 2.

Methods

Direct costs (*DC*) consisted of direct medical costs such as expenses of insured and uninsured items for inpatients and outpatients at medical institutions and at pharmacies to treat liver disease and direct non-medical costs like traffic costs to visit medical institutions and costs of caregivers for inpatients. Therefore, as shown in the following formulas for

Table 2. Categories related to liver disease and data sources

Types of costs	Categories		Estimation variables	Data sources
Direct costs	Direct medical costs	Benefit sector*	Treatment amount of hospitalization, outpatient and pharmacy	National health insurance statistical yearbook,[25] Survey on the benefit coverage rate of national health insurance[26]
		Non benefit sector	Treatment amount and non-benefit rate of hospitalization, outpatient and pharmacy	
	Direct non-medical costs	Transportation	Outpatient visit day, Round-trip transportation cost	National health insurance statistical yearbook,[25] Report of Korea health panel survey[28]
		Care-giver	Hospitalization day, Average daily care-giver cost	
Indirect costs	Future income loss due to premature death		Number of death, Survival rate, Employment rate, Average annual real wage, Growth rate of real wage, Discount rate	Annual report on the cause of death statistics,[29] Life tables for Korea,[30] Annual report on the economically active population survey,[31] Basic survey on wage structure,[32] Survey report on the wages and working hours at establishments[33]
	Productivity loss resulting from absence from work		Hospitalization day, Outpatient visit day, Employment rate, Average daily wage	National health insurance statistical yearbook,[25] Annual report on the economically active population survey,[31] Basic survey on wage structure[32]

* It is composed costs burdened by insurer and by beneficiary.

estimation, the direct medical costs were estimated by summing the total treatment amount of inpatients (*IP*) and outpatients (*OP*) and at pharmacies (*P*) based on the health insurance data by gender, age and disease (Appendix 1) and the value of multiplying the total treatment amount by the rate of uninsured out-of pocket payments to the total treatment amount of each group (α, β, γ) (Appendix 2). In addition, the traffic costs were obtained by multiplying the number of visit days (*OV*) by gender, age and disease (Appendix 3) by the average round-trip traffic costs per one visit to outpatient clinic (*MT*), and the costs of caregivers were done by multiplying the number of hospitalization days by gender, age and disease (*IV*) (Appendix 3) by the daily average personnel expenses of caregivers (*MC*).

$$DC = \sum_i \sum_j \sum_k \{IP_{ijk}(1+\alpha) + OP_{ijk}(1+\beta) + P_{ijk}(1+\gamma)\} + \sum_i \sum_j \sum_k (OV_{ijk} \times MT_j) + \sum_i \sum_j \sum_k (IV_{ijk} \times MC)$$

DC = direct costs

i = 1, 2, …, n disease, j = 1, 2 gender, k = 0, 1, …, n age

IP_{ijk} = total treatment amount of inpatients of i, j and k in health insurance data

OP_{ijk} = total treatment amount of outpatients of i, j and k in health insurance data

P_{ijk} = total treatment amount at pharmacies of i, j and k in health insurance data

α = rate of uninsured out-of pocket payments to total treatment amount of inpatients

β = rate of uninsured out-of pocket payments to total treatment amount of outpatients

γ = rate of uninsured out-of pocket payments to total treatment amount at pharmacies

OV_{ijk} = number of visit days of i, j and k

MT_j = average round-trip traffic costs per one visit to an outpatient clinic of j

IV_{ijk} = number of hospitalization days of i, j and k, MC = daily average costs of caregivers

Indirect costs included the lost earnings due to premature death by liver disease and the loss of productivity following absences from work to visit medical institutions. The lost earnings due to premature death could be determined by how to measure the human value and methods for the measurement were gross loss of output or human capital approach and net loss of output approach. The former

converts the total labor income of premature deaths into the present value and the latter deducts future consumption from the estimate of the former.

Future income of premature deaths was estimated by applying the most common gross loss of output or human capital approach.[34] So, the lost earnings of premature deaths due to liver disease were calculated by multiplying the human loss by gender and age (Appendix 5) obtained with the survival rate by gender and age (*S*), the employment rate (*E*), the yearly average real wage (*YW*), the real wage growth rate (*WR*) and the discount rate (*r*) by the number of deaths due to liver disease by gender, age and disease (*D*) (Appendix 4).

$$HCC = \sum_i \sum_j \sum_k \left\{ D_{ijk} \times \frac{S_{jk}^{k+\tau} \times E_{jk}^{k+\tau} \times YW_{jk}^{k+\tau} \times WR^{k+\tau}}{(1 \times r)^{k+\tau}} \right\}$$

HCC = lost earnings due to premature death

i = 1, 2, …, n disease, j = 1, 2 gender, k = 0, 1, …, n age, τ = years

Di,j,k = number of deaths of i, j and k

$S_{jk}^{k+\tau}$ = probability of survival of a person with j and k in k+τ

$E_{jk}^{k+\tau}$ = employment rate of a person with j and k in k+τ

$YW_{jk}^{k+\tau}$ = yearly average real wage of a person with j and k in k+τ

$WR^{k+\tau}$ = real wage growth rate in k+τ, r = discount rate

The loss of productivity following absences from work to visit medical institutions to treat liver disease (*PLC*) was estimated by multiplying the sum of the number of hospitalization days by gender, age and disease (*IV*) and a third of the number of visit days (*OV*) (Appendix 3) by the employment rate by gender and age (*E*) and the daily average wage by gender and age (*DW*). At this time, to revise the difference in the loss of productivity between outpatients and inpatients, the rate of physician productivity for outpatients to that for inpatients suggested by Noh et al[14] and Jung and Ko[2] was applied. The number of non productive days was calculated by adding one third of the number of visit days to the number of hospitalization days.

$$PLC = \sum \{ (IV_{ijk} + 1/3 OV_{ijk}) \times E_{jk} \times DW_{jk} \}$$

PLC = loss of productivity following sick leave

i = 1, 2, …, n disease, j = 1, 2 gender, k = 0, 1, …, n age

IV_{ijk} = number of hospitalization days of i, j and k

OV_{ijk} = number of visit days of i, j and k

E_{jk} = employment rate of j and k

DW_{jk} = daily average wage of j and k

RESULTS

Direct costs

The medical costs of inpatients and outpatients at medical institutions and at pharmacies to treat liver disease or the sum of benefits paid by the insurer, legal out-of pocket payments and uninsured out-of pocket payments, increased 1.8 times from KRW 588.7 billion in 2004 to KRW 1,032.2 billion in 2008. For the costs by gender, those of males became 1.7 times from KRW 417.5 billion to KRW 724.3 billion and those of females did 1.8 times from KRW 171.2 billion to KRW 307.9 billion, respectively for the same period. The medical costs of males and females accounted for 70.2% and 29.8% of the total costs, respectively in 2008 and the rate of males was 2.4 times higher than that of females. The rate of medical costs by age recorded the highest level or 27.0-28.7% in the patients in their 50s, and those in their 40s (21.3-23.5%), 60s (21.1-22.0%), 30s (10.7-11.0%) and 70s (8.4-9.5%) (Table 3).

Traffic costs went up 1.3 times from KRW 5.5 billion in 2004 to KRW 7 billion in 2008. The traffic costs of males increased 1.3 times from 3.6 to KRW 4.5 billion and those of females did from KRW 1.9 billion to KRW 2.5 billion, respectively for the same period. The rate of traffic costs was found to be 1.8 times higher in males than in female by recording 64.4% and 35.6%, respectively in 2008. The traffic costs by age accounted for the largest portion or 23.1-25.6% in liver disease patients in their 40s, and those in their 50s (21.8-24.6%), 30s (15.8-17.1%), 60s (15.7-16.7%) and 20s (8.7-9.4%) (Table 4).

The personnel expenses of paid caregivers or the opportunity costs of guardians to care inpatients with liver disease increased 1.2 times from KRW 111.5 billion in 2004 to KRW 133 billion in 2008. The costs of males became higher 1.2 times from KRW 82.9 billion to KRW 95.4 billion and those of females did 1.3 times from KRW 28.6 billion to KRW 37.7 billion, respectively. In addition, the rates of

Table 3. Direct medical costs related to liver disease (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	<10	1,830	0.4	2,115	0.5	2,018	0.4	2,102	0.3	2,404	0.3
	10-19	5,111	1.2	5,548	1.2	5,519	1.1	6,004	0.9	6,509	0.9
	20-29	18,793	4.5	21,924	4.7	24,934	4.8	28,882	4.5	34,844	4.8
	30-39	45,585	10.9	50,670	10.9	57,449	11.1	71,029	11.1	81,248	11.2
	40-49	106,053	25.4	114,954	24.7	125,232	24.1	150,287	23.4	165,158	22.8
	50-59	116,747	28.0	132,826	28.5	152,168	29.3	191,676	29.9	213,519	29.5
	60-69	88,944	21.3	97,310	20.9	106,325	20.5	131,657	20.5	150,574	20.8
	70-79	29,417	7.1	34,788	7.5	39,491	7.6	50,954	8.0	59,697	8.2
	≥80	5,027	1.2	5,862	1.3	6,616	1.3	8,528	1.3	10,323	1.4
	Total	417,507	100.0	465,996	100.0	519,751	100.0	641,117	100.0	724,276	100.0
Female	<10	1,408	0.8	1,480	0.8	1,381	0.7	1,567	0.6	1,828	0.6
	10-19	2,429	1.4	2,560	1.4	2,770	1.3	2,971	1.1	3,697	1.2
	20-29	10,337	6.0	12,062	6.4	14,363	6.8	16,209	6.1	20,141	6.5
	30-39	17,502	10.2	19,902	10.5	21,594	10.2	26,630	10.0	32,187	10.5
	40-49	32,148	18.8	35,605	18.8	39,874	18.8	48,513	18.3	54,439	17.7
	50-59	42,147	24.6	46,485	24.5	52,795	24.9	68,222	25.7	79,026	25.7
	60-69	40,348	23.6	43,799	23.1	48,180	22.7	60,805	22.9	68,949	22.4
	70-79	20,207	11.8	22,729	12.0	25,425	12.0	32,237	12.2	38,227	12.4
	≥80	4,666	2.7	5,205	2.7	5,852	2.8	8,017	3.0	9,444	3.1
	Total	171,193	100.0	189,828	100.0	212,232	100.0	265,171	100.0	307,939	100.0
Overall	<10	3,238	0.6	3,595	0.6	3,400	0.5	3,669	0.4	4,232	0.4
	10-19	7,541	1.3	8,108	1.2	8,289	1.1	8,974	1.0	10,206	1.0
	20-29	29,130	5.0	33,985	5.2	39,296	5.4	45,091	5.0	54,985	5.3
	30-39	63,087	10.7	70,573	10.8	79,043	10.8	97,659	10.8	113,435	11.0
	40-49	138,201	23.5	150,559	23.0	165,106	22.6	198,800	21.9	219,598	21.3
	50-59	158,894	27.0	179,311	27.3	204,962	28.0	259,898	28.7	292,544	28.3
	60-69	129,291	22.0	141,109	21.5	154,505	21.1	192,462	21.2	219,524	21.3
	70-79	49,624	8.4	57,517	8.8	64,916	8.9	83,190	9.2	97,924	9.5
	≥80	9,693	1.7	11,067	1.7	12,467	1.7	16,545	1.8	19,767	1.9
	Total	588,700	100.0	655,824	100.0	731,984	100.0	906,288	100.0	1,032,215	100.0

costs of caregivers in male patients recorded 71.7% and 28.3%, respectively in 2008 and the rate of males was 2.5 times higher than that of females. The rate of costs of caregivers by age showed the highest level or 24.3-26.5% in the patients in their 50s, and those in their 60s (21.1-22.1%), 40s (18.8- 23.7%), 70s (10.0-13.1%) and 30s (9.4-10.8%) (Table 5).

Indirect costs

Indirect costs included the lost earnings due to premature death caused by liver disease and the loss of productivity following absences from work. The lost earnings due to premature death reduced from KRW 4,925 billion in 2004 to KRW 4,205.1 billion in 2008 by 14.6% and the lost earnings of males declined from KRW 4,623.7 billion to KRW 3,934.5 billion by 14.9% and those of females did from KRW 301.4 billion to KRW 270.6 billion by 10.2%, respectively. The rates of lost earnings in males and females with liver disease were 93.6% and 6.4%, respectively in 2008, so the rate of males was 14.5 times higher than that of

Table 4. Transportation costs related to liver disease (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	<10	33	0.9	34	0.9	32	0.8	29	0.7	28	0.6
	10-19	113	3.2	127	3.3	124	3.0	120	2.7	121	2.7
	20-29	314	8.8	339	8.8	373	9.0	364	8.3	374	8.3
	30-39	637	17.8	675	17.4	717	17.3	749	17.0	752	16.7
	40-49	967	27.0	1,024	26.4	1,063	25.7	1,110	25.2	1,099	24.4
	50-59	781	21.8	879	22.7	967	23.4	1,064	24.2	1,107	24.5
	60-69	548	15.3	584	15.1	625	15.1	689	15.7	723	16.0
	70-79	162	4.5	187	4.8	211	5.1	246	5.6	271	6.0
	≥80	22	0.6	25	0.7	28	0.7	31	0.7	36	0.8
	Total	3,578	100.0	3,874	100.0	4,139	100.0	4,401	100.0	4,510	100.0
Female	<10	26	1.3	26	1.3	26	1.2	23	1.0	22	0.9
	10-19	56	2.9	58	2.8	60	2.7	57	2.4	58	2.3
	20-29	195	10.3	211	10.2	226	10.2	225	9.5	238	9.5
	30-39	303	15.9	321	15.5	333	15.1	346	14.7	356	14.3
	40-49	434	22.8	469	22.6	486	22.0	508	21.6	517	20.8
	50-59	414	21.7	474	22.8	521	23.5	576	24.4	619	24.8
	60-69	328	17.2	352	17.0	378	17.1	412	17.5	446	17.9
	70-79	128	6.7	143	6.9	159	7.2	183	7.8	204	8.2
	≥80	20	1.1	23	1.1	25	1.1	29	1.2	33	1.3
	Total	1,905	100.0	2,078	100.0	2,215	100.0	2,359	100.0	2,493	100.0
Overall	<10	59	1.1	60	1.0	58	0.9	52	0.8	50	0.7
	10-19	169	3.1	185	3.1	183	2.9	176	2.6	179	2.6
	20-29	509	9.3	550	9.3	599	9.4	589	8.7	611	8.7
	30-39	940	17.1	996	16.7	1,050	16.5	1,095	16.2	1,108	15.8
	40-49	1,401	25.6	1,494	25.1	1,549	24.4	1,619	24.0	1,616	23.1
	50-59	1,195	21.8	1,353	22.7	1,487	23.4	1,640	24.3	1,726	24.6
	60-69	876	16.0	936	15.7	1,003	15.8	1,100	16.3	1,170	16.7
	70-79	290	5.3	330	5.6	370	5.8	429	6.3	475	6.8
	≥80	43	0.8	48	0.8	53	0.8	60	0.9	69	1.0
	Total	5,482	100.0	5,952	100.0	6,353	100.0	6,760	100.0	7,003	100.0

females. The rate by age recorded the highest level or 39.4-44.0% in liver disease patients in their 40s, and those in their 50s (21.1-33.9%), 30s (9.1-22.2%), 60s (7.9-13.1%) and 70s (1.1-3.5%). This showed the premature deaths in economically active age groups provoked a significant social loss of productivity (Table 6).

The scale of loss of productivity following absences from work to treat liver disease went up 1.4 times from KRW 227.3 billion in 2004 to KRW 311.2 billion in 2008 and the scale of males was raised 1.3 times from KRW 183.8 billion to KRW 247.6 billion and those of females was 1.5 times from KRW 43.5 billion to KRW 63.6 billion, respectively for the same period. The rates of loss of productivity in males and females accounted for 79.6% and 20.4%, respectively in 2008 and that of males was found to be 3.9 times higher than that of females. The loss of productivity by age recorded the highest level or 27.0-32.1% in liver disease patients in their 40s, and those in their 50s (26.7-30.0%), 60s

Table 5. Caregiver costs related to liver disease (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	<10	342	0.4	403	0.5	343	0.4	303	0.3	372	0.4
	10-19	659	0.8	627	0.8	687	0.8	681	0.8	936	1.0
	20-29	3,384	4.1	3,715	4.5	4,091	4.9	3,793	4.2	5,346	5.6
	30-39	8,905	10.7	8,566	10.3	8,933	10.6	8,883	9.8	10,441	11.0
	40-49	21,581	26.0	20,289	24.4	19,447	23.1	19,965	22.1	19,704	20.7
	50-59	22,781	27.5	23,426	28.2	23,335	27.7	25,525	28.3	25,247	26.5
	60-69	17,480	21.1	17,631	21.2	17,753	21.1	19,517	21.6	20,382	21.4
	70-79	6,467	7.8	7,042	8.5	7,947	9.4	9,463	10.5	10,289	10.8
	≥80	1,301	1.6	1,527	1.8	1,738	2.1	2,200	2.4	2,657	2.8
	Total	82,899	100.0	83,227	100.0	84,274	100.0	90,331	100.0	95,375	100.0
Female	<10	248	0.9	278	1.0	235	0.8	224	0.7	297	0.8
	10-19	264	0.9	289	1.0	308	1.0	320	1.0	500	1.3
	20-29	1,375	4.8	1,583	5.4	2,040	6.6	1,907	5.6	2,993	7.9
	30-39	2,306	8.1	2,414	8.2	2,656	8.6	2,744	8.1	3,935	10.5
	40-49	4,870	17.1	4,770	16.3	4,619	14.9	4,997	14.8	5,302	14.1
	50-59	6,277	22.0	6,414	21.9	6,252	20.2	6,812	20.2	7,082	18.8
	60-69	7,066	24.7	7,022	23.9	7,257	23.5	7,899	23.4	7,677	20.4
	70-79	4,710	16.5	4,981	17.0	5,593	18.1	6,337	18.8	7,097	18.8
	≥80	1,451	5.1	1,576	5.4	1,975	6.4	2,550	7.6	2,789	7.4
	Total	28,566	100.0	29,327	100.0	30,935	100.0	33,790	100.0	37,673	100.0
Overall	<10	590	0.5	680	0.6	578	0.5	527	0.4	669	0.5
	10-19	922	0.8	916	0.8	994	0.9	1,002	0.8	1,436	1.1
	20-29	4,759	4.3	5,298	4.7	6,131	5.3	5,700	4.6	8,339	6.3
	30-39	11,210	10.1	10,981	9.8	11,589	10.1	11,627	9.4	14,377	10.8
	40-49	26,451	23.7	25,059	22.3	24,066	20.9	24,962	20.1	25,006	18.8
	50-59	29,059	26.1	29,840	26.5	29,587	25.7	32,337	26.1	32,329	24.3
	60-69	24,545	22.0	24,653	21.9	25,010	21.7	27,416	22.1	28,059	21.1
	70-79	11,177	10.0	12,023	10.7	13,540	11.8	15,800	12.7	17,387	13.1
	≥80	2,752	2.5	3,104	2.8	3,714	3.2	4,750	3.8	5,446	4.1
	Total	111,465	100.0	112,554	100.0	115,209	100.0	124,121	100.0	133,047	100.0

(14.1-15.2%), 30s (13.9-15.4%) and 70s (5.7-7.9%) (Table 7).

Overall costs

When all socioeconomic costs of liver disease for the last five years were put together, they recorded KRW 5,858 billion, KRW 5,572.4 billion, KRW 8,104.3 billion, KRW 6,095.2 billion and KRW 5,688.6 billion in 2004 to 2008, respectively. According to cost items, the lost earnings caused by liver disease-related premature death accounted for the largest portion of the total socioeconomic costs or 73.9-86.1%, and the rates of direct medical costs, the loss of productivity following sick leave and direct non-medical costs such as traffic costs and costs of caregivers were 9.0-18.1%, 3.3- 5.5% and 1.5-2.5%, respectively. In particular, the rate of lost earnings out of the total socioeconomic costs slightly decreased from 2004 to 2008 but

Table 6. Future income loss due to premature death related to liver disease (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	<10	14,618	0.3	12,436	0.3	10,407	0.2	7,757	0.2	2,834	0.1
	10-19	6,103	0.1	3,820	0.1	11,975	0.2	5,584	0.1	5,433	0.1
	20-29	46,797	1.0	47,830	1.1	206,939	3.2	33,442	0.8	30,262	0.8
	30-39	592,777	12.8	459,006	10.8	1,460,125	22.4	415,465	9.3	347,706	8.8
	40-49	2,075,455	44.9	1,868,067	44.0	2,922,508	44.9	1,937,486	43.5	1,578,378	40.1
	50-59	1,290,001	27.9	1,252,887	29.5	1,359,083	20.9	1,404,538	31.6	1,350,872	34.3
	60-69	515,947	11.2	508,438	12.0	478,007	7.3	535,303	12.0	494,823	12.6
	70-79	81,967	1.8	91,478	2.2	61,793	1.0	112,891	2.5	124,199	3.2
	Total	4,623,664	100.0	4,243,963	100.0	6,510,836	100.0	4,452,467	100.0	3,934,506	100.0
Female	<10	2,588	0.9	1,979	0.6	1,040	0.2	2,600	0.8	1,118	0.4
	10-19	2,673	0.9	2,593	0.8	3,768	0.8	1,691	0.5	1,288	0.5
	20-29	10,625	3.5	12,287	4.0	28,656	6.1	10,130	3.3	6,764	2.5
	30-39	41,264	13.7	47,154	15.2	88,517	18.8	43,874	14.1	33,107	12.2
	40-49	92,915	30.8	97,800	31.6	147,442	31.3	84,617	27.2	78,624	29.1
	50-59	78,259	26.0	76,998	24.9	111,820	23.7	86,067	27.7	74,526	27.5
	60-69	56,849	18.9	53,409	17.2	71,884	15.3	60,419	19.4	53,926	19.9
	70-79	16,181	5.4	17,654	5.7	17,872	3.8	21,870	7.0	21,266	7.9
	Total	301,355	100.0	309,874	100.0	470,999	100.0	311,268	100.0	270,618	100.0
Overall	<10	17,206	0.4	14,415	0.3	11,447	0.2	10,357	0.2	3,951	0.1
	10-19	8,776	0.2	6,413	0.1	15,743	0.2	7,276	0.2	6,721	0.2
	20-29	57,422	1.2	60,117	1.3	235,595	3.4	43,571	0.9	37,026	0.9
	30-39	634,042	12.9	506,161	11.1	1,548,641	22.2	459,339	9.6	380,813	9.1
	40-49	2,168,370	44.0	1,965,867	43.2	3,069,950	44.0	2,022,102	42.5	1,657,002	39.4
	50-59	1,368,259	27.8	1,329,886	29.2	1,470,902	21.1	1,490,605	31.3	1,425,398	33.9
	60-69	572,797	11.6	561,847	12.3	549,892	7.9	595,723	12.5	548,749	13.1
	70-79	98,148	2.0	109,132	2.4	79,665	1.1	134,761	2.8	145,464	3.5
	Total	4,925,019	100.0	4,553,837	100.0	6,981,835	100.0	4,763,735	100.0	4,205,124	100.0

the rate of direct medical costs or costs paid by health insurance sharply increased (Table 8).

Analysis on the socioeconomic costs of liver disease by gender and age revealed that 88.0-90.7% of the total costs were incurred in males, and the rate of patients with liver disease in their 40s showed the highest (34.9-41.2%) and the rates of those in their 50s and 30s followed it by recording 22.0-32.4% and 9.8-20.7%, respectively. The costs of males were higher in those in their 40s (36.7-42.7%), 50s (21.8-33.3%) and 30s (9.5-21.2%) in the order and those of females were higher in those in their 50s (23.8-26.2%), 40s (22.3-26.5%) and 60s (17.8-20.9%) in the order (Table 9).

DISCUSSION

Liver disease is one of major death causes in South Korea and the number of deaths caused by it tends to be high in economically active age groups as a representative disease provoking a significant loss of productivity due to premature death. In 2001, liver disease ranked fifth among death causes in South Korea but its loss of productivity due to premature death was found to be the highest except cancer which is the

Table 7. Productivity loss resulting from absence from work related to liver disease (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	10-19	1,441	0.8	1,563	0.8	1,651	0.8	1,530	0.7	1,488	0.6
	20-29	6,923	3.8	7,930	4.0	8,970	4.2	8,537	3.6	10,259	4.1
	30-39	27,496	15.0	28,973	14.7	30,629	14.3	31,784	13.5	34,725	14.0
	40-49	62,796	34.2	64,339	32.7	66,780	31.1	71,473	30.3	71,140	28.7
	50-59	51,136	27.8	57,456	29.2	65,044	30.3	74,256	31.5	76,184	30.8
	60-69	25,313	13.8	26,652	13.5	29,724	13.8	33,663	14.3	36,775	14.9
	70-79	8,715	4.7	9,915	5.0	12,170	5.7	14,845	6.3	17,012	6.9
	Total	183,820	100.0	196,828	100.0	214,969	100.0	236,089	100.0	247,582	100.0
Female	10-19	722	1.7	823	1.7	920	1.7	929	1.6	999	1.6
	20-29	3,770	8.7	4,296	9.1	4,940	9.2	4,768	8.2	5,917	9.3
	30-39	7,488	17.2	8,126	17.2	8,778	16.3	9,183	15.8	10,965	17.2
	40-49	10,048	23.1	11,022	23.3	11,787	21.8	12,400	21.3	12,971	20.4
	50-59	9,518	21.9	10,805	22.8	12,170	22.5	13,909	23.9	14,548	22.9
	60-69	7,712	17.7	7,816	16.5	9,537	17.7	10,352	17.8	10,602	16.7
	70-79	4,212	9.7	4,489	9.5	5,863	10.9	6,696	11.5	7,613	12.0
	Total	43,469	100.0	47,378	100.0	53,995	100.0	58,236	100.0	63,615	100.0
Overall	10-19	2,163	1.0	2,386	1.0	2,571	1.0	2,458	0.8	2,487	0.8
	20-29	10,694	4.7	12,227	5.0	13,911	5.2	13,305	4.5	16,177	5.2
	30-39	34,984	15.4	37,100	15.2	39,407	14.7	40,967	13.9	45,690	14.7
	40-49	72,843	32.1	75,361	30.9	78,567	29.2	83,873	28.5	84,111	27.0
	50-59	60,654	26.7	68,261	28.0	77,215	28.7	88,165	30.0	90,732	29.2
	60-69	33,025	14.5	34,467	14.1	39,261	14.6	44,015	15.0	47,376	15.2
	70-79	12,927	5.7	14,405	5.9	18,032	6.7	21,541	7.3	24,625	7.9
	Total	227,290	100.0	244,206	100.0	268,963	100.0	294,325	100.0	311,198	100.0

number one death cause. Although liver disease leads to a considerable socioeconomic loss in the country like this, basic studies to establish liver disease-related health insurance policies are insufficient. Therefore, this study was conducted to provide basic data for policy making for the prevention and the management of liver disease in the future by estimating the socioeconomic costs of major liver diseases for the last five years from a societal perspective.

Liver diseases analyzed in this study were viral hepatitis (B15-B19), liver cirrhosis and other liver disease (K70-K76) and HCC (C22) and the costs of them were estimated by dividing them largely into direct and indirect costs. The directs costs contained the treatment amount covered and not covered by health insurance for inpatients and outpatients at medical institutions and at pharmacies, the traffic costs to visit medical institutions and the personnel expenses of caregivers or the opportunity costs of guardians for inpatients. The indirect costs did the lost earnings caused by liver disease-related premature death and the loss of productivity following absences from work to visit medical institutions.

According to the results, the socioeconomic costs of liver disease were estimated to be KRW 5,858 billion, KRW 5,572.4 billion, KRW 8,104.3 billion, KRW 6,095.2 billion and KRW 5,688.6 billion from 2004 to 2008, respectively. By the cost items, the lost earnings caused by liver disease-related premature death accounted for the largest portion of the total costs or 73.9-86.1%, and the direct medical costs (9.0-18.1%), the loss of productivity following sick leave (3.3-5.5%) and the traffic costs and the costs of caregivers (1.5-2.5%) followed it in the order.

Table 8. Socioeconomic costs of liver disease (units: KRW 1,000,000, %)

Categories			2004		2005		2006		2007		2008	
Direct costs	Direct medical costs	Benefit sector*	467,088	8.0	525,685	9.4	615,357	7.6	770,622	12.6	857,822	15.1
		Non benefit sector	121,612	2.1	130,139	2.3	116,627	1.4	135,666	2.2	174,393	3.1
		Subtotal	588,700	10.0	655,824	11.8	731,984	9.0	906,288	14.9	1,032,215	18.1
	Direct non-medical costs	Transportation	5,482	0.1	5,952	0.1	6,353	0.1	6,760	0.1	7,003	0.1
		Care-giver	111,465	1.9	112,554	2.0	115,209	1.4	124,121	2.0	133,047	2.3
		Subtotal	116,948	2.0	118,506	2.1	121,563	1.5	130,881	2.1	140,050	2.5
	Subtotal		705,648	12.0	774,330	13.9	853,547	10.5	1,037,169	17.0	1,172,266	20.6
Indirect costs	Future income loss due to premature death		4,925,019	84.1	4,553,837	81.7	6,981,835	86.1	4,763,735	78.2	4,205,124	73.9
	Productivity loss resulting from absence from work		227,290	3.9	244,206	4.4	268,963	3.3	294,325	4.8	311,198	5.5
	Subtotal		5,152,308	88.0	4,798,044	86.1	7,250,798	89.5	5,058,060	83.0	4,516,322	79.4
Total			5,857,956	100.0	5,572,374	100.0	8,104,345	100.0	6,095,229	100.0	5,688,587	100.0

* It is composed costs burdened by insurer and by beneficiary.

Out of the total socioeconomic costs of liver disease, 88.0-90.7% were incurred in males, and the costs by age showed higher rate in the patients in their 40s (34.9-41.2%), 50s (22.0-32.4%) and 30s (9.8-20.7%) in the order.

A study of Jung and Ko[2] estimated the socioeconomic costs of the top five diseases for death causes in South Korea by classifying the costs into direct and indirect costs. In their study, the direct costs included medical expenditures, traffic costs and costs of guardians and the indirect costs did costs of lost workdays due to illness and lost earnings due to premature death. They reported that the costs of cancer (malignant neoplasm) or number one death cause, cerebrovascular disease, heart disease, diabetes and liver disease were KRW 7,735.8 billion, KRW 2,313.8 billion, KRW 2,141.7 billion, KRW 1,158.8 billion and KRW 2,620.1 billion, respectively. For liver disease, the lost earnings due to premature death accounted for 88.3% of the total costs and rates of the medical expenditures of inpatients and outpatients, the costs of lost workdays, the costs of caregivers and the traffic costs recorded 7.7%, 2.4%, 1.1% and 0.5%, respectively.

In the comparison of the results between their study and this one, the study of Jung and Ko[2] showed that the socioeconomic costs of liver disease were estimated to be KRW 2,620.1 billion in 2001 while this study found that the costs were done to be KRW 5,858 billion in 2004, so the difference in the costs was significant. That is considered to result from not only the difference in the year of estimation and the methodologies but also the exclusion of the costs at pharmacies, which accounted for a considerable portion in the total costs, in the study of Jung and Ko.[2] But, the finding that the rate of lost earnings due to premature death recorded the highest level among the socioeconomic costs of liver disease and the lost earnings by age showed the highest rates in economically active persons in their 30s, 40s and 50s, tended to be similar in both of the two studies and it led to a large influence on the loss of productivity in the society at large.

In addition, studies estimating the socioeconomic costs of disease have been reported continuously in Canada since 1986. A study calculating the socioeconomic costs by classifying total disease into 20 groups such as cardiovascular disease, musculoskeletal disease and cancer with the data in 1998 was published.[34] The study in Canada[34] largely divided the costs of diseases into direct and indirect costs, and the direct costs included treatment amount at medical institutions, drug expenditures and doctor bills and the indirect costs contained death costs and costs of prevalence of short- and long-term disorder. According to its results, although it did not examine liver disease specifically, the direct and indirect

Table 9. Socioeconomic costs of liver disease stratified according to sex and age group (units: KRW 1,000,000, %)

		2004		2005		2006		2007		2008	
Male	<10	16,823	0.3	14,988	0.3	12,800	0.2	10,191	0.2	5,638	0.1
	10-19	13,427	0.3	11,685	0.2	19,956	0.3	13,919	0.3	14,487	0.3
	20-29	76,211	1.4	81,738	1.6	245,307	3.3	75,018	1.4	81,085	1.6
	30-39	675,400	12.7	547,890	11.0	1,557,853	21.2	527,910	9.7	474,872	9.5
	40-49	2,266,852	42.7	2,068,673	41.4	3,135,030	42.7	2,180,321	40.2	1,835,479	36.7
	50-59	1,481,446	27.9	1,467,474	29.4	1,600,597	21.8	1,697,059	31.3	1,666,929	33.3
	60-69	648,232	12.2	650,615	13.0	632,434	8.6	720,829	13.3	703,277	14.0
	70-79	126,728	2.4	143,410	2.9	121,612	1.7	188,399	3.5	211,468	4.2
	≥80	6,350	0.1	7,414	0.1	8,382	0.1	10,759	0.2	13,016	0.3
	Total	5,311,468	100.0	4,993,888	100.0	7,333,969	100.0	5,424,405	100.0	5,006,249	100.0
Female	<10	4,270	0.8	3,763	0.7	2,682	0.3	4,414	0.7	3,265	0.5
	10-19	6,144	1.1	6,323	1.1	7,826	1.0	5,968	0.9	6,542	1.0
	20-29	26,302	4.8	30,439	5.3	50,225	6.5	33,239	5.0	36,053	5.3
	30-39	68,863	12.6	77,917	13.5	121,878	15.8	82,777	12.3	80,550	11.8
	40-49	140,415	25.7	149,666	25.9	204,208	26.5	151,035	22.5	151,853	22.3
	50-59	136,615	25.0	141,176	24.4	183,558	23.8	175,586	26.2	175,801	25.8
	60-69	112,303	20.5	112,398	19.4	137,236	17.8	139,887	20.9	141,600	20.8
	70-79	45,438	8.3	49,996	8.6	54,912	7.1	67,323	10.0	74,407	10.9
	≥80	6,137	1.1	6,804	1.2	7,852	1.0	10,596	1.6	12,266	1.8
	Total	546,488	100.0	578,485	100.0	770,376	100.0	670,824	100.0	682,338	100.0
Overall	<10	21,093	0.4	18,750	0.3	15,483	0.2	14,605	0.2	8,902	0.2
	10-19	19,571	0.3	18,008	0.3	27,780	0.3	19,886	0.3	21,029	0.4
	20-29	102,514	1.7	112,177	2.0	295,532	3.6	108,256	1.8	117,138	2.1
	30-39	744,263	12.7	625,811	11.2	1,679,730	20.7	610,687	10.0	555,423	9.8
	40-49	2,407,266	41.1	2,218,340	39.8	3,339,238	41.2	2,331,356	38.2	1,987,333	34.9
	50-59	1,618,061	27.6	1,608,651	28.9	1,784,153	22.0	1,872,645	30.7	1,842,729	32.4
	60-69	760,534	13.0	763,012	13.7	769,671	9.5	860,716	14.1	844,878	14.9
	70-79	172,166	2.9	193,407	3.5	176,523	2.2	255,721	4.2	285,875	5.0
	≥80	12,488	0.2	14,219	0.3	16,234	0.2	21,355	0.4	25,282	0.4
	Total	5,857,956	100.0	5,572,373	100.0	8,104,345	100.0	6,095,229	100.0	5,688,587	100.0

costs of the digestive disease including liver disease accounted for 4.2% (USD 3.54 billion) and 3.1% (USD 2.31) of the costs of total diseases and their sum recorded 7.3% (USD 5.85 billion). As the study in Canada found that the weight of direct costs incurred by visiting medical institutions directly to treat digestive disease were estimated to be larger than that of indirect costs such as death costs, the finding was different from that of Korean studies investigating only liver disease.

This study is meaningful as the latest study on estimation of the socioeconomic costs of liver disease for the longest period. Moreover, because it calculated the costs from a societal perspective, it included the extensive effect of liver disease on the society at large. In particular, all Koreans have been insured mandatorily and the country has established a single insurance claim system so that the total scale of healthcare utilization except uninsured items can be grasped when liver disease patients utilize medical institutions or

pharmacies. As this study used these health insurance data to estimate direct medical costs, direct non-medical costs (traffic costs, costs of caregivers) and the loss of productivity following sick leave, the validity and the reliability of results of this study were expected to be enhanced. However, for direct medical costs, uninsured items not paid by the health insurance system needed to be included to calculate actual costs exactly but this study gained the uninsured medical costs by estimating them with the rate of uninsured out-of pocket payments[26] in South Korea published by National Health Insurance Corporation every year since 2004. But, the data had a limitation that they did not include those about packs of prepared herb medicine in the oriental medicine and health improving agents like vitamin supplements at pharmacies. Although this study utilized the best available data and methodology to enhance the reliability and the utilization of the results, it had some limitations as follows.

First, in the process of investigating the healthcare utilization with the health insurance data related to liver disease, the data were extracted with only principal diagnosis as a standard with excluding liver disease as additional diagnosis, so the directs costs and the loss of productivity following sick leave could be underestimated. Second, costs of driving cars to visit outpatient clinics due to liver disease were excluded from the mean traffic costs so that the average round-trip traffic costs per one visit to an outpatient clinic could be underestimated. Third, for costs of caregivers for inpatients with liver disease, the nursing of guardians or paid caregivers might be determined by the severity of disease and the costs of caregivers could be incurred at home as well as at medical institutions. However, because of no data about the rate of the care-giving at home and the correlation between the severity of disease and the utilization rate of care-giving service, this study limited cases to calculate the costs of caregivers to inpatients at medical institutions, so the costs of caregivers was estimated on the assumption that the inpatients needed full-time care-giving. Fourth, in the process of estimating the future income loss due to premature death caused by liver disease and the loss of productivity following sick leave, this study analyzed only employees with income except unemployed persons (job seekers) and economically inactive population (housewives, students and persons waiting to enter the army) among the working-age group aged over 15 years to calculate the scale of objective and valid income loss. So, the exclusion of unpaid productive activities of unemployed persons and economically inactive population could underestimate the loss of productivity following premature deaths and sick leave, but objective and valid data to investigate the rate of the population and the economic value of the unpaid activities were insufficient. Fifth, the loss of productivity following sick leave contained the decreased or lost income of employed liver disease patients due to hospitalization or visits to medical institutions. However, a simple rest at home or other places during sick leave by the severity of disease was excluded in this study because of no data about the population, so the loss of productivity following sick leave could be underestimated. Lastly, the health insurance data are collected based on claims submitted to National Health Insurance Corporation by healthcare providers to receive costs paid by the insurer among the total costs of patients. Therefore, validity issues related with diagnosis and the content of medical service in the health insurance data have been raised continuously and particularly up-coding of reporting wrong disease codes intentionally works as a factor hampering the reliability of studies using the data. However, despite these fundamental limitations of the health insurance data, this study is considered to have relatively less up-coding inducing factors by analyzing liver disease or one of comparatively severe diseases and some up-coding related errors within liver disease are thought not to influence the results of this study considerably because this study analyzed the total liver disease not a part of the disease.

In conclusion, the socioeconomic costs of liver disease, although they were slightly different by year, were as much as maximally KRW 8,104.3 billion in 2006. The lost earnings caused by liver disease-related premature deaths accounted for the largest portion or 73.9-86.1%. However, while the rate of lost earnings tended to reduce slightly from 2004 to 2008, the rate of direct medical costs paid by health insurance increased sharply. These findings meant that measures to improve the efficiency of the medical costs of liver disease are necessary.

Moreover, 88.0-90.7% out of the socioeconomic costs of liver disease were incurred in males, and the costs by age recorded the highest rate or 34.9-41.2% of the total costs in liver disease patients in their 40s and those in their 50s (22.0-32.4%) and 30s (9.8-20.7%) followed them in the order. That shows that liver disease provokes a significant loss in most economically active age groups, and if appropriate

measures for the management of liver disease are not prepared, not only the loss of productivity in the society at large but also various potential loss are expected to be raised. Lastly, the results of this study are considered to be useful for promoting the public awareness of the urgency of the prevention and the management of liver disease and for prioritizing disease-related policies in various health projects.

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Appendix 1. Cost of treatment related to liver disease (units: KRW 1,000,000)*

		2004			2005			2006			2007			2008		
		Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy
Male	<10	581	757	99	800	761	88	807	772	81	913	733	80	1,119	704	91
	10-19	768	2,539	953	793	2,810	1,071	984	2,863	889	1,005	2,949	1,196	1,462	2,861	1,116
	20-29	3,141	7,933	4,722	3,413	8,564	6,786	4,735	9,948	7,108	4,994	10,225	10,244	8,190	10,373	11,375
	30-39	10,691	16,121	10,922	10,522	17,160	15,140	13,670	20,243	15,999	15,425	22,375	24,594	19,409	22,732	27,854
	40-49	38,120	27,902	18,553	38,807	30,068	24,242	44,036	36,455	25,822	49,248	40,863	39,214	53,501	41,371	44,412
	50-59	49,683	25,607	15,853	55,049	30,060	19,515	65,867	39,709	21,117	79,801	48,547	33,276	84,394	51,923	39,814
	60-69	40,474	16,838	11,630	44,237	19,172	12,267	51,079	24,594	12,036	61,866	30,072	18,029	67,733	33,944	20,747
	70-79	14,445	4,815	3,283	17,320	5,794	3,560	21,250	7,310	3,711	27,215	9,191	5,838	30,677	10,552	6,787
	≥80	2,714	641	439	3,249	713	452	4,028	889	420	5,225	1,100	668	6,103	1,279	801
	Total	160,616	103,152	66,454	174,191	115,102	83,122	206,456	142,782	87,183	245,693	166,054	133,140	272,589	175,740	152,997
Female	<10	449	591	64	512	589	62	483	602	57	652	568	71	831	556	70
	10-19	397	1,282	320	460	1,320	339	605	1,432	312	664	1,472	371	1,165	1,468	393
	20-29	1,926	4,837	1,765	2,419	5,248	2,377	3,834	5,999	2,390	4,075	6,322	3,489	5,893	6,819	4,118
	30-39	3,542	7,678	3,207	4,110	8,318	4,154	4,761	9,479	4,326	5,915	10,382	6,700	8,419	10,981	7,757
	40-49	8,696	11,585	5,858	9,073	12,841	7,446	11,217	14,971	7,860	12,738	16,629	12,487	14,190	17,235	14,772
	50-59	14,364	12,089	7,270	14,837	13,942	8,907	17,382	17,833	9,524	21,723	21,437	15,164	24,553	23,265	18,471
	60-69	16,120	9,092	6,636	17,143	10,333	7,324	20,129	12,830	7,302	24,685	15,543	11,165	26,148	17,565	13,321
	70-79	9,643	3,262	2,692	10,799	3,870	2,933	13,248	4,701	2,941	16,323	5,934	4,657	18,622	6,829	5,567
	≥80	2,639	463	399	2,932	564	419	3,646	665	408	5,064	865	642	5,681	1,020	786
	Total	57,775	50,880	28,212	62,285	57,025	33,961	75,305	68,512	35,119	91,839	79,152	54,744	105,503	85,738	65,254
Overall	<10	1,030	1,348	164	1,312	1,350	151	1,289	1,374	138	1,565	1,301	151	1,950	1,260	160
	10-19	1,164	3,821	1,272	1,253	4,130	1,410	1,590	4,294	1,201	1,668	4,421	1,567	2,627	4,329	1,509
	20-29	5,067	12,770	6,487	5,832	13,812	9,163	8,570	15,946	9,498	9,069	16,546	13,733	14,083	17,192	15,493
	30-39	14,233	23,799	14,129	14,632	25,478	19,294	18,431	29,722	20,325	21,340	32,757	31,294	27,828	33,714	35,611
	40-49	46,816	39,487	24,411	47,880	42,908	31,688	55,253	51,427	33,682	61,986	57,492	51,700	67,691	58,606	59,184
	50-59	64,047	37,697	23,123	69,887	44,001	28,423	83,248	57,542	30,641	101,524	69,984	48,440	108,947	75,188	58,285
	60-69	56,594	25,929	18,266	61,380	29,506	19,591	71,208	37,424	19,338	86,551	45,615	29,194	93,882	51,509	34,068
	70-79	24,088	8,077	5,975	28,119	9,664	6,493	34,498	12,011	6,652	43,537	15,124	10,496	49,299	17,381	12,354
	≥80	5,353	1,103	839	6,182	1,278	871	7,674	1,554	828	10,289	1,965	1,310	11,784	2,299	1,587
	Total	218,391	154,031	94,666	236,476	172,127	117,083	281,761	211,294	122,301	337,531	245,206	187,884	378,093	261,478	218,252

* source: National health insurance corporation, Health Insurance Review & Assessment Service (2005-2009).[25]

Appendix 2. Ratio of treatment cost to nonbenefit cost (unit: %)*

	2004	2005	2006	2007	2008
Inpatient	40.25	40.00	27.75	25.00	30.38
Outpatient	20.63	18.76	17.37	19.90	21.07
Pharmacy	2.04	2.77	1.42	1.32	2.04

* source: Choi et al (2009).[26]

Appendix 3. Visit days related to liver disease (units: days)*

		2004		2005		2006		2007		2008	
		Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient
Male	<10	5,692	27,680	6,711	26,891	5,722	24,378	5,053	21,138	6,203	18,952
	10-19	10,976	94,945	10,443	101,588	11,442	94,473	11,354	88,138	15,596	81,746
	20-29	56,396	263,465	61,921	270,812	68,184	284,969	63,217	268,283	89,105	253,298
	30-39	148,411	534,410	142,771	539,370	148,885	547,684	148,058	552,321	174,023	509,669
	40-49	359,687	811,613	338,157	818,865	324,117	812,381	332,751	818,876	328,408	745,111
	50-59	379,690	655,997	390,441	702,979	388,913	738,727	425,417	784,248	420,777	750,531
	60-69	291,327	460,281	293,847	466,725	295,884	477,445	325,286	507,813	339,698	490,348
	70-79	107,784	136,010	117,370	149,483	132,453	161,540	157,713	181,152	171,488	183,802
	≥80	21,688	18,753	25,456	19,991	28,972	21,330	36,670	23,121	44,281	24,343
	Total	1,381,651	3,003,154	1,387,117	3,096,704	1,404,572	3,162,927	1,505,519	3,245,090	1,589,579	3,057,800
Female	<10	4,133	21,446	4,630	21,039	3,911	19,732	3,738	16,914	4,952	15,010
	10-19	4,392	46,719	4,817	46,497	5,129	45,545	5,341	41,822	8,338	39,417
	20-29	22,918	164,036	26,383	169,051	34,004	172,958	31,789	165,890	49,879	161,068
	30-39	38,430	254,414	40,238	256,610	44,263	254,856	45,733	255,251	65,588	241,355
	40-49	81,171	364,587	79,497	375,108	76,986	371,708	83,277	374,921	88,363	350,802
	50-59	104,623	347,362	106,892	378,648	104,206	398,018	113,533	424,837	118,040	419,428
	60-69	117,764	275,289	117,039	281,558	120,951	289,245	131,642	303,633	127,946	302,667
	70-79	78,493	107,839	83,016	114,358	93,210	121,233	105,622	134,964	118,288	138,111
	≥80	24,178	17,151	26,271	18,108	32,923	19,047	42,495	21,401	46,482	22,360
	Total	476,102	1,598,843	488,783	1,660,977	515,583	1,692,342	563,170	1,739,633	627,876	1,690,218
Overall	<10	9,825	49,126	11,341	47,930	9,633	44,110	8,791	38,052	11,155	33,962
	10-19	15,368	141,664	15,260	148,085	16,571	140,018	16,695	129,960	23,934	121,163
	20-29	79,314	427,501	88,304	439,863	102,188	457,927	95,006	434,173	138,984	414,366
	30-39	186,841	788,824	183,009	795,980	193,148	802,540	193,791	807,572	239,611	751,024
	40-49	440,858	1,176,200	417,654	1,193,973	401,103	1,184,089	416,028	1,193,797	416,771	1,095,913
	50-59	484,313	1,003,359	497,333	1,081,627	493,119	1,136,745	538,950	1,209,085	538,817	1,169,959
	60-69	409,091	735,570	410,886	748,283	416,835	766,690	456,928	811,446	467,644	793,015
	70-79	186,277	243,849	200,386	263,841	225,663	282,773	263,335	316,116	289,776	321,913
	≥80	45,866	35,904	51,727	38,099	61,895	40,377	79,165	44,522	90,763	46,703
	Total	1,857,753	4,601,997	1,875,900	4,757,681	1,920,155	4,855,269	2,068,689	4,984,723	2,217,455	4,748,018

* source: National health insurance corporation, Health Insurance Review & Assessment Service (2005-2009).[25]

Appendix 4. Deaths related to liver disease (units: persons)*

	2004		2005		2006		2007		2008	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-4	10	2	9	4	6	2	9	2	5	5
5-9	5	4	5	1	3	0	1	5	1	0
10-14	2	2	3	2	1	1	1	1	1	1
15-19	4	4	1	4	9	6	5	3	7	3
20-24	14	8	11	13	40	18	10	9	10	9
25-29	33	19	38	18	138	42	24	16	28	11
30-34	158	47	137	57	425	92	101	48	95	38
35-39	585	94	433	102	1,110	153	386	90	372	82
40-44	1,545	207	1,277	204	2,153	275	1,098	132	973	143
45-49	2,347	282	2,172	305	2,287	350	2,127	269	1,915	268
50-54	2,351	348	2,244	361	2,071	399	2,227	346	2,280	357
55-59	2,318	431	2,161	399	1,961	514	2,024	387	2,108	325
60-64	2,325	621	2,227	586	1,909	654	1,915	522	1,811	454
65-69	1,931	701	1,925	668	1,381	698	1,953	684	1,972	733
70-74	1,267	645	1,388	716	825	609	1,444	714	1,598	706
75-79	774	607	800	592	455	443	886	630	962	654
80-84	477	394	445	449	168	181	484	465	511	481
≥85	182	285	202	277	52	71	271	295	284	339
Total	16,328	4,701	15,478	4,758	14,994	4,508	14,966	4,618	14,933	4,609

* source: Statistics Korea (2005-2009).[29]

Appendix 5. Human capital loss per capita stratified according to sex, age, and year (units: KRW 1,000)

	2004		2005		2006		2007		2008	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0-4	968,308	425,852	875,773	392,670	1,150,825	520,012	770,284	353,901	461,151	223,537
5-9	986,965	434,057	910,882	407,977	1,167,408	527,504	824,514	378,469	527,880	255,883
10-14	1,005,981	442,420	946,390	423,881	1,184,229	535,105	881,750	404,742	604,265	292,909
15-19	1,022,649	447,124	980,551	436,326	1,198,926	538,834	940,491	428,866	689,770	331,648
20-24	1,020,378	426,258	996,153	421,658	1,196,189	515,191	982,463	426,849	766,912	347,817
25-29	985,190	379,732	970,326	378,070	1,152,840	461,484	984,042	393,007	806,887	330,310
30-34	898,009	328,001	892,466	329,099	1,054,007	400,784	932,171	349,329	795,551	300,466
35-39	770,756	274,979	777,687	278,387	911,866	337,546	832,425	301,180	731,529	264,508
40-44	623,103	220,161	635,710	224,194	745,922	272,020	702,206	247,549	628,695	221,439
45-49	474,120	167,878	486,310	170,704	575,661	207,534	548,408	193,086	504,782	175,218
50-54	332,101	121,448	341,122	121,998	404,743	148,854	396,079	140,823	368,474	128,652
55-59	219,686	83,515	225,548	82,599	265,609	101,998	258,137	96,491	242,292	87,991
60-64	143,247	53,320	145,084	52,639	169,758	65,432	165,948	62,381	156,550	57,132
65-69	94,716	33,862	96,278	33,777	111,470	41,679	111,374	40,726	107,156	38,183
70-74	55,125	19,779	56,567	19,920	64,770	24,310	66,364	24,364	65,880	23,573
75-79	15,663	5,640	16,204	5,729	18,367	6,923	19,258	7,101	19,671	7,069

Appendix 1. Cost of treatment related to liver disease (units: KRW 1,000,000)*

		2004			2005			2006			2007			2008		
		Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy	Inpatient	Outpatient	Pharmacy
Male	<10	581	757	99	800	761	88	807	772	81	913	733	80	1,119	704	91
	10-19	768	2,539	953	793	2,810	1,071	984	2,863	889	1,005	2,949	1,196	1,462	2,861	1,116
	20-29	3,141	7,933	4,722	3,413	8,564	6,786	4,735	9,948	7,108	4,994	10,225	10,244	8,190	10,373	11,375
	30-39	10,691	16,121	10,922	10,522	17,160	15,140	13,670	20,243	15,999	15,425	22,375	24,594	19,409	22,732	27,854
	40-49	38,120	27,902	18,553	38,807	30,068	24,242	44,036	36,455	25,822	49,248	40,863	39,214	53,501	41,371	44,412
	50-59	49,683	25,607	15,853	55,049	30,060	19,515	65,867	39,709	21,117	79,801	48,547	33,276	84,394	51,923	39,814
	60-69	40,474	16,838	11,630	44,237	19,172	12,267	51,079	24,594	12,036	61,866	30,072	18,029	67,733	33,944	20,747
	70-79	14,445	4,815	3,283	17,320	5,794	3,560	21,250	7,310	3,711	27,215	9,191	5,838	30,677	10,552	6,787
	≥80	2,714	641	439	3,249	713	452	4,028	889	420	5,225	1,100	668	6,103	1,279	801
	Total	160,616	103,152	66,454	174,191	115,102	83,122	206,456	142,782	87,183	245,693	166,054	133,140	272,589	175,740	152,997
Female	<10	449	591	64	512	589	62	483	602	57	652	568	71	831	556	70
	10-19	397	1,282	320	460	1,320	339	605	1,432	312	664	1,472	371	1,165	1,468	393
	20-29	1,926	4,837	1,765	2,419	5,248	2,377	3,834	5,999	2,390	4,075	6,322	3,489	5,893	6,819	4,118
	30-39	3,542	7,678	3,207	4,110	8,318	4,154	4,761	9,479	4,326	5,915	10,382	6,700	8,419	10,981	7,757
	40-49	8,696	11,585	5,858	9,073	12,841	7,446	11,217	14,971	7,860	12,738	16,629	12,487	14,190	17,235	14,772
	50-59	14,364	12,089	7,270	14,837	13,942	8,907	17,382	17,833	9,524	21,723	21,437	15,164	24,553	23,265	18,471
	60-69	16,120	9,092	6,636	17,143	10,333	7,324	20,129	12,830	7,302	24,685	15,543	11,165	26,148	17,565	13,321
	70-79	9,643	3,262	2,692	10,799	3,870	2,933	13,248	4,701	2,941	16,323	5,934	4,657	18,622	6,829	5,567
	≥80	2,639	463	399	2,932	564	419	3,646	665	408	5,064	865	642	5,681	1,020	786
	Total	57,775	50,880	28,212	62,285	57,025	33,961	75,305	68,512	35,119	91,839	79,152	54,744	105,503	85,738	65,254
Overall	<10	1,030	1,348	164	1,312	1,350	151	1,289	1,374	138	1,565	1,301	151	1,950	1,260	160
	10-19	1,164	3,821	1,272	1,253	4,130	1,410	1,590	4,294	1,201	1,668	4,421	1,567	2,627	4,329	1,509
	20-29	5,067	12,770	6,487	5,832	13,812	9,163	8,570	15,946	9,498	9,069	16,546	13,733	14,083	17,192	15,493
	30-39	14,233	23,799	14,129	14,632	25,478	19,294	18,431	29,722	20,325	21,340	32,757	31,294	27,828	33,714	35,611
	40-49	46,816	39,487	24,411	47,880	42,908	31,688	55,253	51,427	33,682	61,986	57,492	51,700	67,691	58,606	59,184
	50-59	64,047	37,697	23,123	69,887	44,001	28,423	83,248	57,542	30,641	101,524	69,984	48,440	108,947	75,188	58,285
	60-69	56,594	25,929	18,266	61,380	29,506	19,591	71,208	37,424	19,338	86,551	45,615	29,194	93,882	51,509	34,068
	70-79	24,088	8,077	5,975	28,119	9,664	6,493	34,498	12,011	6,652	43,537	15,124	10,496	49,299	17,381	12,354
	≥80	5,353	1,103	839	6,182	1,278	871	7,674	1,554	828	10,289	1,965	1,310	11,784	2,299	1,587
	Total	218,391	154,031	94,666	236,476	172,127	117,083	281,761	211,294	122,301	337,531	245,206	187,884	378,093	261,478	218,252

* source: National health insurance corporation, Health Insurance Review & Assessment Service (2005-2009).[25]

Appendix 3. Visit days related to liver disease (units: days)*

		2004		2005		2006		2007		2008	
		Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient
Male	<10	5,692	27,680	6,711	26,891	5,722	24,378	5,053	21,138	6,203	18,952
	10-19	10,976	94,945	10,443	101,588	11,442	94,473	11,354	88,138	15,596	81,746
	20-29	56,396	263,465	61,921	270,812	68,184	284,969	63,217	268,283	89,105	253,298
	30-39	148,411	534,410	142,771	539,370	148,885	547,684	148,058	552,321	174,023	509,669
	40-49	359,687	811,613	338,157	818,865	324,117	812,381	332,751	818,876	328,408	745,111
	50-59	379,690	655,997	390,441	702,979	388,913	738,727	425,417	784,248	420,777	750,531
	60-69	291,327	460,281	293,847	466,725	295,884	477,445	325,286	507,813	339,698	490,348
	70-79	107,784	136,010	117,370	149,483	132,453	161,540	157,713	181,152	171,488	183,802
	≥80	21,688	18,753	25,456	19,991	28,972	21,330	36,670	23,121	44,281	24,343
	Total	1,381,651	3,003,154	1,387,117	3,096,704	1,404,572	3,162,927	1,505,519	3,245,090	1,589,579	3,057,800
Female	<10	4,133	21,446	4,630	21,039	3,911	19,732	3,738	16,914	4,952	15,010
	10-19	4,392	46,719	4,817	46,497	5,129	45,545	5,341	41,822	8,338	39,417
	20-29	22,918	164,036	26,383	169,051	34,004	172,958	31,789	165,890	49,879	161,068
	30-39	38,430	254,414	40,238	256,610	44,263	254,856	45,733	255,251	65,588	241,355
	40-49	81,171	364,587	79,497	375,108	76,986	371,708	83,277	374,921	88,363	350,802
	50-59	104,623	347,362	106,892	378,648	104,206	398,018	113,533	424,837	118,040	419,428
	60-69	117,764	275,289	117,039	281,558	120,951	289,245	131,642	303,633	127,946	302,667
	70-79	78,493	107,839	83,016	114,358	93,210	121,233	105,622	134,964	118,288	138,111
	≥80	24,178	17,151	26,271	18,108	32,923	19,047	42,495	21,401	46,482	22,360
	Total	476,102	1,598,843	488,783	1,660,977	515,583	1,692,342	563,170	1,739,633	627,876	1,690,218
Overall	<10	9,825	49,126	11,341	47,930	9,633	44,110	8,791	38,052	11,155	33,962
	10-19	15,368	141,664	15,260	148,085	16,571	140,018	16,695	129,960	23,934	121,163
	20-29	79,314	427,501	88,304	439,863	102,188	457,927	95,006	434,173	138,984	414,366
	30-39	186,841	788,824	183,009	795,980	193,148	802,540	193,791	807,572	239,611	751,024
	40-49	440,858	1,176,200	417,654	1,193,973	401,103	1,184,089	416,028	1,193,797	416,771	1,095,913
	50-59	484,313	1,003,359	497,333	1,081,627	493,119	1,136,745	538,950	1,209,085	538,817	1,169,959
	60-69	409,091	735,570	410,886	748,283	416,835	766,690	456,928	811,446	467,644	793,015
	70-79	186,277	243,849	200,386	263,841	225,663	282,773	263,335	316,116	289,776	321,913
	≥80	45,866	35,904	51,727	38,099	61,895	40,377	79,165	44,522	90,763	46,703
	Total	1,857,753	4,601,997	1,875,900	4,757,681	1,920,155	4,855,269	2,068,689	4,984,723	2,217,455	4,748,018

* source: National health insurance corporation, Health Insurance Review & Assessment Service (2005-2009).[25]