

# Medical Expenditure of National Health Insurance Attributable to Smoking among the Korean Population

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**Objectives :** The purpose of this study was to determine the population-attributable risk (PAR) and estimate the total medical expenditure of the Korean National Health Insurance (KNHI) due to smoking.

**Methods :** We used data from the Korean Cancer Prevention Study of 1,178,138 Koreans aged 30 to 95. These data were available from 1992 to 2003 and covered a long-term follow-up period among the Korean population.

**Results :** The total medical expenditure of KNHI related to smoking increased by 27% from \$324.9 million in 1999 to \$413.7 million in 2003. By specific diseases, smoking-attributable KNHI medical expenditure was the highest for lung cancer (\$74.2 million), followed by stroke (\$65.3 million), COPD (\$50.1 million), CHD (\$49 million) and stomach cancer (\$30 million). A total of 1.3 million KNHI

patients were suffering from smoking-related diseases in 2003. We predicted rises in total KNHI medical expenditure related to smoking to \$675.1 million (63% increase compared with that of 2003) and in the total number of KNHI patients suffering from smoking-related diseases to about 2.6 million (an approximate 100% increase compared with those in 2003) in 2015.

**Conclusions :** We found a substantial economic burden related to the high smoking prevalence in South Korea.

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**Key words :** Smoking, Medical expenditure, Population-attributable risk, Relative risk, Cohort study

## INTRODUCTION

Annual tobacco consumption has been steadily increasing since 1945 when the Korean Tobacco and Ginseng Public Corporation began the production and purchase of tobacco leaves along with the manufacture and sale of tobacco products. A statistical report from the Institute of Economic Planning reported 265,000 deaths in Korea for the entire year of 1979, including 522 due to lung cancer (369 men and 153 women). These deaths due to lung cancer accounted for only 0.2% of the total deaths for 1979.

However, in 2003, after 24 years, the number of deaths due to lung cancer had increased 24.4-fold (n=12,725; 9,345 men and 3,380 women), to 5.2% of the total deaths, according to the National Statistical Office. The major

explanation for this sudden increase of deaths due to lung cancer is the higher prevalence of tobacco consumption.

Numerous studies found that smoking is the main etiology of several malignant tumors, respiratory diseases and cardiovascular diseases [1-6]. After recognizing the serious health consequences and national burden of smoking, many countries sought to reduce its prevalence rate using several measures such as tobacco price raise and public campaigns. In order to maximize the outcome of these government efforts against tobacco consumption, we need to investigate the empirical evidence for anti-smoking policy, including smoking-attributable diseases and their economic burden. Although a few studies have investigated the diseases and national burden due to smoking in Korea [7-10], they

could not use the Korean longitudinal data more than 10 years in estimating the population-attributable risk (PAR) of smoking that is needed to calculate the national burden attributed to smoking. Therefore, the present study attempts to predict how smoking is influencing the total annual medical expenditure in the Korean National Health Insurance (KNHI) by using 11 years of longitudinal data and KNHI benefit statistics.

The purpose of this study was to determine the smoking PAR and estimate the total annual KNHI medical expenditure due to smoking. The total annual KNHI medical expenditure means the total annual money paid by both the KNHI as benefits and patients as co-payments in order to purchase the medical services included in the KNHI's statutory benefit services catalogue. KNHI has population coverage of about 97%, with the remaining 3%

being covered by National Medical Aid.

## METHODS

### I. Study Data and Smoking-Related Diseases

We used the data from the Korean Cancer Prevention Study (KCPS) of 1,329,525 Koreans aged 30 to 95 years who participated in biennial health examinations of NHI Corporation (NHIC) to estimate the relative risk and smoking PAR in given diseases caused by smoking. These data have been available from 1992 until the present and they included long-term follow-up among the Korean population. We used the data of health examinations, which were collected during the period from 1992 to 1995 from civil service workers and private school teachers and their dependants. We then followed these participants for 11 years, from 1992 to 2003, to study the effects of smoking on different smoking-related diseases. After excluding missing variables, the final study sample comprised 1,178,138 individuals (804,937 men and 373,201 women). The most important diseases caused by smoking are shown in Table 1.

### II. Method for Estimation of Smoking-Attributable KNHI Medical Expenditure

The total medical expenditure and total number of patients with smoking-related diseases in KNHI were calculated by multiplying both the total annual medical expenditure per patient of smoking-related diseases and the number of patients by PAR. Detailed methods on the calculation of PARs for different diseases were reported in our previous research [11-13].

The main outcome variable was the incidence of smoking-related diseases. For those individuals with more than one event during the follow-up period from January 1993 to December 2003, we included only the first

**Table 1.** Pattern of the total medical expenditure of Korean National Health Insurance (KNHI) attributed to smoking

Diseases	RRs <sup>*</sup>	PAR <sup>†</sup>	Smoking-attributable KNHI medical expenditure				
			1999	2000	2001	2002	2003
Larynx cancer	6.13	70.22	4,158,833	3,941,237	5,318,255	5,242,068	5,702,886
Lung cancer	3.67	55.07	43,945,169	49,894,367	61,362,504	67,963,582	74,208,482
Esophageal cancer	3.66	54.97	7,433,888	7,058,287	8,404,301	8,955,082	10,091,705
Bladder cancer	2.10	33.53	4,002,579	3,810,586	4,790,639	5,388,081	5,906,777
Oral cavity & pharynx cancers	1.95	30.38	3,377,981	3,562,146	4,474,921	624,756	5,598,686
Stomach cancer	1.16	19.23	23,190,266	22,388,326	24,767,954	26,874,333	30,004,653
Pancreatic cancer	1.37	14.63	2,127,933	2,507,391	2,976,035	3,272,133	3,693,318
Liver cancer	1.37	14.40	12,175,217	12,262,967	14,775,351	15,549,972	17,021,043
Cervical cancer	1.91	10.29	2,258,967	2,212,324	2,927,838	2,996,407	3,149,640
Endometrial & ovarian cancers	1.82	9.25	1,848,261	1,993,703	2,515,692	2,729,696	3,021,313
Small intestine cancer	1.19	7.87	1,902,043	1,869,761	2,218,547	2,212,934	2,559,742
Prostate cancer	1.17	7.29	678,637	636,481	764,157	839,452	1,031,557
Kidney cancer	1.13	5.64	11,168,091	12,554,545	15,976,871	19,195,038	22,889,677
Colon cancer	1.12	5.06	1,771,147	1,764,132	2,190,252	2,476,531	3,073,230
Cerebrum cancer	1.08	3.55	358,896	389,727	449,540	438,716	495,642
Rectal cancer	1.05	2.20	927,696	994,545	1,168,412	1,286,075	1,484,989
Breast cancer	1.10	1.24	571,284	556,957	707,139	815,436	970,187
Coronary heart disease	1.90	29.23	41,374,889	37,019,721	38,371,479	41,541,787	49,019,630
Stroke	1.53	19.64	50,593,301	52,256,745	54,723,890	57,413,233	65,277,673
COPD	2.08	33.06	53,220,843	53,352,642	51,291,321	54,311,739	50,145,502
Tuberculosis	1.57	20.78	10,600,933	9,533,323	9,764,273	9,399,275	9,697,765
Cirrhosis	1.41	15.89	19,850,283	17,801,529	17,925,068	17,976,060	19,217,698
Leukemia	1.25	10.38	2,578,443	2,692,760	3,066,983	3,423,728	4,247,190
Diabetes	1.25	10.30	24,750,496	24,404,144	22,178,546	23,289,622	25,150,652
Smoking-related treatment costs			324,866,074	325,458,347	353,109,968	374,215,776	413,659,637
Treatment cost for patients over 30 years of age			7,350,461,531	7,776,651,880	9,027,692,210	9,416,465,971	10,140,029,913
Total treatment cost			10,736,992,800	11,353,972,461	13,003,040,462	13,295,785,177	13,789,870,695

\*Relative Risks, †Population-Attributable Risk (PAR); adjusted for age, sex, alcohol drinking, exercise, and body mass index

event in our statistical analyses. Nonfatal and fatal outcomes were ascertained from data on the NHIC claim and death certificate, respectively. We examined KNHI medical costs incurred among smokers to treat four major disease categories (cancer, cardiovascular, respiratory, and gastrointestinal disease; see tables 2, 3 and 4) proven to be caused by smoking [13,14].

Since our assumption of the occurrence of smoking-related outcomes was made based on people aged over 30 years old, we excluded the data of participants aged less than 30 years from our analysis. The following formulas were used in the calculations:

$$\text{Number of patients suffering from smoking-related diseases} = \sum (\text{total patients (inpatient + outpatients) for a given disease among people over 30 years of age} \times \text{PAR of Smoking}) \text{----- Formula 1}$$

$$\text{Number of hospitalization suffering from smoking-related diseases} = \sum (\text{total hospitalization for a given disease among people over 30 years of age} \times \text{PAR of Smoking}) \text{----- Formula 2}$$

$$\text{hospitalization for a given disease among people over 30 years of age} \times \text{PAR of Smoking} \text{----- Formula 2}$$

$$\text{Smoking-attributable KNHI Medical Expenditure} = \sum (\text{KNHI Medical Expenditure for a given disease among people over 30 years of age} \times \text{PAR of Smoking}) \text{----- Formula 3}$$

In these formulas, PAR = Smoking Rate x (Relative Risk - 1) / [Smoking Rate x (Relative Risk - 1) + 1], based on the reported smoking rate in 1990.

The predicted number of patients and the KNHI medical expenditure attributed to smoking until 2015 were calculated using a regression analysis based on available data from 1999 through 2003. The following formula was used:

$$\text{Predicted KNHI Medical Expenditure} = \text{Intercept (a)} \times \text{Regression Coefficient (b)} \times \text{Estimated Year} \text{----- Formula 4}$$

The monetary data are presented in US dollars at an exchange rate of 1 US dollar to 1,000 Korean won. All results are presented with combined genders.

## RESULTS

### I. Smoking-Related Diseases and Population-Attributable Risk (PAR)

There were a total of 24 smoking-related diseases (Table 1). The PAR was the highest for laryngeal cancer (70.22%), followed by 55.07% for lung cancer, 54.97% for esophageal cancer and 33.53% for bladder cancer. Both smoking-attributable and relative risks were used in conjunction to estimate the medical expenditure and the number of patients with smoking-related diseases.

### II. Pattern of the Total Medical Expenditure of KNHI Attributed to Smoking

The total KNHI medical expenditure attributed to smoking increased by 27.3% from \$324.9 million in 1999 to \$413.7 million in 2003, while the total expenditure for all diseases increased by 28.4% from \$10.7 billion to \$13.8 billion (Table 1). By specific diseases, smoking-attributable KNHI medical expenditure for lung cancer was the highest (\$74.2 million), followed by stroke (\$65.3 million), chronic obstructive pulmonary diseases (COPD) (\$50.1 million), coronary heart diseases (CHD) (\$49 million) and stomach cancer (\$30 million). The proportion of smoking-attributable total KNHI medical expenditure was about 4.1% of the total KNHI medical expenditure spent by people over 30 years of age in 2003.

### III. Pattern of the Total KNHI Hospitalization Costs Attributed to Smoking

Table 2 shows the pattern of the total KNHI hospitalization costs attributed to smoking by disease and year. Overall, the total KNHI hospitalization cost attributed to smoking was

**Table 2.** Pattern of the total hospitalization costs of Korean National Health Insurance (KNHI) attributed to smoking

Diseases	RRs*	PAR <sup>†</sup>	Smoking-attributable KNHI medical expenditure				
			1999	2000	2001	2002	2003
Larynx cancer	6.13	70.22	2,768,301	2,677,163	3,549,596	3,263,463	3,576,090
Lung cancer	3.67	55.07	36,417,366	41,868,584	51,024,976	53,866,235	57,721,820
Esophageal cancer	3.66	54.97	6,196,739	5,841,866	6,894,879	7,200,099	8,043,472
Bladder cancer	2.10	33.53	2,916,135	2,741,524	3,430,327	3,697,717	4,007,779
Oral cavity & pharynx cancers	1.95	30.38	2,262,126	2,486,756	3,018,730	24,063	3,635,831
Stomach cancer	1.16	19.23	15,943,799	16,772,436	20,039,649	21,360,538	23,535,645
Pancreatic cancer	1.37	14.63	1,839,351	2,155,321	2,503,469	2,694,999	2,979,016
Liver cancer	1.37	14.40	10,081,319	10,222,645	12,491,364	12,777,218	13,735,755
Cervical cancer	1.91	10.29	1,571,544	1,510,600	2,002,846	2,034,017	2,090,938
Endometrial & ovarian cancers	1.82	9.25	1,631,700	1,751,403	2,179,513	2,341,678	2,575,852
Small intestine cancer	1.19	7.87	1,648,685	1,646,920	1,984,435	1,941,183	2,208,962
Prostate cancer	1.17	7.29	269,748	253,605	325,682	361,343	434,037
Kidney cancer	1.13	5.64	2,071,928	2,417,531	2,973,609	3,289,346	3,868,254
Colon cancer	1.12	5.06	1,264,063	1,340,440	1,778,548	1,974,745	2,472,724
Cerebrum cancer	1.08	3.55	310,666	344,362	391,570	375,404	414,727
Rectal cancer	1.05	2.20	631,654	732,522	895,857	968,528	1,100,672
Breast cancer	1.10	1.24	325,537	322,641	446,474	499,008	568,727
Coronary heart disease	1.90	29.23	22,305,570	22,069,238	28,754,753	32,258,365	38,130,226
Stroke	1.53	19.64	37,857,443	41,708,185	47,651,943	49,987,876	57,078,127
COPD	2.08	33.06	15,406,717	17,779,383	18,252,991	20,247,224	18,356,922
Tuberculosis	1.57	20.78	5,930,077	5,680,511	6,281,034	6,155,461	6,393,268
Cirrhosis	1.41	15.89	8,485,871	8,631,018	9,682,882	9,196,626	9,948,147
Leukemia	1.25	10.38	2,300,855	2,419,648	2,780,931	3,106,763	3,227,863
Diabetes	1.25	10.30	5,314,294	5,852,741	6,647,543	6,989,108	7,259,816
Smoking-related hospitalization costs			185,751,487	199,227,040	236,010,602	246,611,006	273,364,943
Hospitalization cost for patients over 30 years of age			2,779,751,378	3,027,796,494	3,656,221,140	3,790,765,760	4,267,084,003
Total hospitalization cost			3,720,540,254	3,974,258,850	4,636,375,400	4,722,948,828	5,265,229,300

\*Relative Risks, <sup>†</sup>Population-Attributable Risk (PAR); adjusted for age, sex, alcohol drinking, exercise, and body mass index

\$185.8 million in 1999, \$199.2 million in 2000, \$236.0 million in 2001, \$246.6 million in 2002 and \$273.4 million in 2003. The total KNHI hospitalization cost attributed to smoking in 2003 increased by 47.1% compared to the cost in 1999. The total KNHI hospitalization cost attributed to smoking for lung cancer was the highest (\$57.7 million), followed by stroke (\$57.1 million). The total KNHI cost of hospitalization for all diseases increased by 41.5% from \$3.7 billion in 1999 to \$5.3 billion in 2003. The proportion of the total KNHI hospitalization costs attributed to smoking was 6.4% in 2003.

### IV. Changes in the Number of the KNHI Patients Suffering from Smoking-Related Diseases

Trends in the number of the KNHI patients suffering from smoking-related diseases are shown by specific disease and year in Table 3. The number of the KNHI patients suffering

from smoking-related diseases increased 1.4-fold from 961,814 in 1999 to 1,347,161 in 2003. However, the total number of KNHI patients suffering from any disease increased by only 14.5% from 35,515,327 in 1999 to 40,667,936 in 2003. Among the KNHI patients suffering from smoking-related diseases, the most common disease in 2003 was COPD (728,909), followed by diabetes (144,606) and CHD (134,423). The proportion of KNHI patients suffering from smoking-related diseases was 6.1% of the total number of KNHI patients over 30 years of age in 2003.

### V. Changes in the Number of Hospitalizations of KNHI due to Smoking-Related Diseases

Table 4 shows the trend in the number of hospitalized patients of KNHI due to smoking-related diseases by disease and year. The total number of hospitalized patients of KNHI due to smoking-related diseases increased by

23.1% from 79,176 in 1999 to 97,492 in 2003. However, the total number of hospitalized patients of KNHI due to any disease increased by 16.5% from 3,115,736 in 1999 to 3,629,064 in 2003. Of the hospitalized patients of KNHI in 2003, 16,450 were due to CHD caused by smoking, 14,425 to COPD and 13,095 to stroke. The proportion of hospitalized patients of KNHI due to smoking-related diseases was about 4.0% in 2003.

## VI. Predictions of the Medical Expenditure and the Number of Patients with Disease Attributed to Smoking in KNHI

We estimated the projected number of patients suffering from smoking-related diseases as well as the total medical expenditure in KNHI for 2004 to 2015 through regression analysis using the data from 1999 to 2003 (Table 5). The total KNHI medical expenditure attributed to smoking was estimated to increase by 63%, from \$413.7 million in 2003 to \$675.1 million in 2015. Moreover, it is predicted that there will be about 2,637,817 patients in 2015, which can be expressed as a 96% increase.

## DISCUSSION

In the present study we attempted to estimate the total number of patients of KNHI suffering from smoking-related diseases and the total medical expenditure attributed to smoking in KNHI from 1999 through 2003 among the Korean population using an epidemiologic approach: PAR. The estimated total KNHI medical expenditure due to smoking was \$413.7 million in 2003. After extrapolation of these data, we predicted that the total KNHI medical expenditure in 2010 would be \$562.0 million, rising to \$675.1 million in 2015. Kang et al. reported that the direct medical costs for treating smoking-related diseases among patients over 35 years of age were estimated to be about \$194.25 million in 1998 [14]. According to the results of the research by

**Table 3.** Change in the number of patients of Korean National Health Insurance suffering from smoking-related diseases

Diseases	RRs*	PAR <sup>†</sup>	Number of patients suffering from smoking-related diseases				
			1999	2000	2001	2002	2003
Larynx cancer	6.13	70.22	4,418	4,130	5,007	4,950	5,139
Lung cancer	3.67	55.07	25,149	27,677	30,571	33,348	34,667
Esophageal cancer	3.66	54.97	3,632	3,681	4,037	4,296	4,641
Bladder cancer	2.10	33.53	3,963	4,083	4,639	5,104	5,584
Oral cavity & pharynx cancers	1.95	30.38	3,621	4,299	5,011	5,213	6,189
Stomach cancer	1.16	19.23	15,958	16,623	18,679	19,873	21,098
Pancreatic cancer	1.37	14.63	1,244	1,365	1,526	1,707	1,807
Liver cancer	1.37	14.40	7,437	7,733	8,521	9,059	9,310
Cervical cancer	1.91	10.29	2,759	2,693	3,145	3,018	2,974
Endometrial & ovarian cancers	1.82	9.25	1,352	1,571	1,907	1,926	1,963
Small intestine cancer	1.19	7.87	1,025	1,086	1,235	1,316	1,395
Prostate cancer	1.17	7.29	653	683	832	989	1,249
Kidney cancer	1.13	5.64	2,529	2,712	3,098	3,495	3,880
Colon cancer	1.12	5.06	1,297	1,396	1,660	1,881	2,142
Cerebrum cancer	1.08	3.55	180	206	223	234	234
Rectal cancer	1.05	2.20	564	619	721	805	896
Breast cancer	1.10	1.24	449	477	587	665	740
Coronary heart disease	1.90	29.23	90,707	100,294	114,132	122,198	134,423
Stroke	1.53	19.64	49,868	57,211	64,689	72,511	79,804
COPD	2.08	33.06	526,175	583,788	658,945	751,521	728,909
Tuberculosis	1.57	20.78	31,589	30,178	31,555	31,304	28,914
Cirrhosis	1.41	15.89	101,456	101,140	111,406	120,407	125,916
Leukemia	1.25	10.38	561	528	623	800	681
Diabetes	1.25	10.30	85,228	100,465	116,377	131,375	144,606
Number of smoking-related Patients $\Sigma$			961,814	1,054,639	1,189,126	1,327,995	1,347,161
Number of patients over 30 years of age			15,489,758	16,587,119	20,312,019	21,584,342	22,153,346
Total number of patients in all age groups			35,515,327	37,021,528	39,038,224	40,692,795	40,667,936

\* Relative Risks, <sup>†</sup>Population-Attributable Risk (PAR); adjusted for age, sex, alcohol drinking, exercise, and body mass index  $\Sigma$  (total patients (inpatient + outpatients) for a given disease among people over 30 years of age x PAR of Smoking)

Kang et al. the direct medical cost was 194.25 million dollars (6.57%) out of 2,956.75 million dollars for the total smoking-related economic cost. The direct non-medical cost was less than 1% of the total smoking-related economic cost and the remaining economic costs (90. 6%) were due to the loss caused by the premature deaths.

The changes in smoking prevalence have a direct, but delayed, effect on the medical costs. In Korea, the smoking prevalence rose from 1980 to 2000, but has subsequently decreased since 2000. The present study used the smoking prevalence data from 1990 when the smoking prevalence was high in Korea. The study hypothesized that the loss due to smoking in 1990 would last for over 25 years and that the ending year for the loss due to smoking in 1990 would be 2015. The effects of the dramatic drop in smoking prevalence since 2000 in Korea would appear after 2020. In the present study we estimated the total KNHI

medical cost only due to smoking-related chronic illnesses. If the study included smoking-related acute illnesses, the total KNHI medical costs due to smoking would be much more burdensome.

This study suffered several limitations, which need to be considered. First, the total KNHI medical expenditure in this study was calculated by combining the cost paid by KNHI and the statutory cost co-paid by the patient in the utilization of KNHI-covered medical services. Therefore, in the calculation of the total KNHI medical expenditure, we did not include the costs spent on medical services not covered by KNHI. Kim et al. reported in 2004 that the cost paid by the patient for medical services that are not covered by KNHI accounted for about 20% of the total medical expenditure in South Korea [15]. To calculate the total medical expenditure including the cost for medical services that are not covered by KNHI, the total KNHI medical expenditure

must be multiplied by 1.25. Furthermore, to detail completely the total annual medical expenditure in Korea, the medical expenditure spent by beneficiaries of the Medicaid program, containing about 3% of the Korean population, needs to be considered.

Second, the size and validity of the relative risk (RR) and PAR to estimate the total medical expenditure were limited. Other studies from the US and UK were more powerful in terms of the study period (more than 50-year follow-up), and they also produced more reliable (higher) RR and PAR results [5,16,17]. However, our study results were generated from an 11 year-cohort study, which may have been a factor in the difference in results. The lower rate of RR and PAR in the study can be explained by the short follow-up. Studies reported by Doll et al. showed that a longer follow-up period produces a higher RR and PAR. The RR for lung cancer was 8.0 after 20 years of follow-up, and increased approximately two-fold (RR=14.9) in the 40-year follow-up. However, the size of data in the present study was 200-fold bigger than those of the US or UK studies that enrolled only about 5,000 participants. Even though the follow-up period of this study was only 11 years, the large sample of the present study increased the statistical power to calculate the risk for different outcomes.

Nevertheless, the present study is important due to the high burden of smoking-related diseases, high prevalence (about 50%) of smoking among Korean men, and skyrocketing prevalence among Korean women. According to the latest study with similar methodology, Kim et al. reported a direct medical cost related to smoking in 2001 of \$233.1 million, which increased 1.77-fold to \$413.7 million in 2003 [10]. Meng [18] reported 24,388 deaths related to smoking in 1985, among adults aged over 30 years in Korea. The most recent studies have reported that there were 46,208 deaths related to smoking in 2003 [13].

In general, the relative risks of smoking on

**Table 4.** Change in the number of hospitalized patients of KNHI due to smoking-related diseases

Diseases	RRs <sup>*</sup>	PAR <sup>†</sup>	Number of hospitalizations suffering from smoking-related diseases				
			Unit: person				
			1999	2000	2001	2002	2003
Larynx cancer	6.13	70.22	1,008	1,013	1,175	1,144	1,133
Lung cancer	3.67	55.07	9,958	10,493	11,319	11,981	12,329
Esophageal cancer	3.66	54.97	1,429	1,368	1,461	1,521	1,588
Bladder cancer	2.10	33.53	1,210	1,223	1,395	1,507	1,632
Oral cavity & pharynx cancers	1.95	30.38	765	769	804	799	853
Stomach cancer	1.16	19.23	5,023	5,107	5,577	5,886	6,120
Pancreatic cancer	1.37	14.63	521	564	593	651	681
Liver cancer	1.37	14.40	2,795	2,899	3,108	3,296	3,421
Cervical cancer	1.91	10.29	602	560	619	587	551
Endometrial & ovarian cancers	1.82	9.25	319	379	406	424	449
Small intestine cancer	1.19	7.87	439	453	498	512	529
Prostate cancer	1.17	7.29	140	136	171	203	228
Kidney cancer	1.13	5.64	674	723	807	908	1,012
Colon cancer	1.12	5.06	372	396	467	530	616
Cerebrum cancer	1.08	3.55	68	71	73	75	76
Rectal cancer	1.05	2.20	174	189	212	234	256
Breast cancer	1.10	1.24	98	102	124	142	156
Coronary heart disease	1.90	29.23	9,400	9,771	12,153	14,198	16,450
Stroke	1.53	19.64	14,197	14,983	16,383	17,832	19,095
COPD	2.08	33.06	14,729	16,765	15,838	17,598	14,425
Tuberculosis	1.57	20.78	3,987	3,850	3,958	3,998	3,724
Cirrhosis	1.41	15.89	5,621	5,539	5,555	5,734	5,759
Leukemia	1.25	10.38	200	207	229	391	265
Diabetes	1.25	10.30	5,449	5,680	5,914	6,453	6,297
Number of smoking-related Hospitalization $\Sigma$			79,176	83,241	88,838	96,602	97,492
Number of hospitalization over 30 years of age			1,784,610	1,904,741	2,184,564	2,288,831	2,444,127
Total number of hospitalization in all age groups			3,115,736	3,207,812	3,446,163	3,519,827	3,629,064

<sup>\*</sup>Relative Risks, <sup>†</sup>Population-Attributable Risk (PAR); adjusted for age, sex, alcohol drinking, exercise, and body mass index  $\Sigma$  (total hospitalization for a given disease among people over 30 years of age x PAR of Smoking)

diseases in Asian countries, including South Korea, are lower than those observed in western countries during the same time intervals [12]. Therefore, the total medical expenditure of KNHI due to smoking might be underestimated, possibly due to differences in historical smoking patterns between Korea and western countries. Smoking prevalence increased after World War I in the US and UK, but only after World War II in Asian countries, resulting in a 40-year lag in health consequences. Thirty years ago the average age at which a person started smoking was 25 years, but this has been reduced to be 15 years nowadays [19]. According to a survey on tuberculosis prevalence, the average daily cigarette consumption in South Korea increased from 12 cigarettes in 1980 to 17 in 1985 [20]. The same trend has occurred in China where the average daily cigarette consumption increased from one cigarette in

1952 to 16 in 1996 [21].

We used our own Korean data to estimate the total and disease-specific RR and PAR for treatment prevalence and mortality from smoking-related diseases. Continuing to study this long-term cohort will yield more accurate

**Table 5.** Predictions of the total medical expenditure and the number of patients with diseases attributed to smoking in Korean National Health Insurance (KNHI), from 2003 to 2015

Year	Smoking-attributable	
	Total number of patient, 1,000 person	Total KNHI treatment cost, 1,000 US\$
2003	1,347 (100)	413,659 (100)
2004	1,489 (106)	426,165 (103)
2005	1,593 (118)	448,799 (108)
2006	1,698 (126)	471,434 (114)
2007	1,802 (134)	494,069 (119)
2008	1,907 (142)	516,703 (125)
2009	2,011 (149)	539,338 (130)
2010	2,116 (157)	561,972 (136)
2011	2,220 (165)	584,607 (141)
2012	2,324 (173)	607,241 (147)
2013	2,429 (180)	629,875 (152)
2014	2,533 (188)	652,510 (158)
2015	2,638 (196)	675,144 (163)

data regarding the risks of smoking by specific diseases, and these data will be useful base sources for other studies. In this regard, our study provides evidence of the strong need to develop a national policy for the effective reduction of tobacco consumption in South Korea.

## SUMMARY & CONCLUSIONS

Our study provided empirical evidence of potential savings that Korea could achieve by implementing effective tobacco control policies by quantifying the total medical expenditure from NHI attributable to smoking.

In conclusion, we found that in addition to a high smoking prevalence, there is a substantial economic burden related to smoking in South Korea. If we do not initiate a nationwide action for controlling tobacco consumption, the total medical expenditure will continue to increase in the future.

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