

Effects of husbands' smoking on the incidence of lung cancer in Korean women

Sun Ha Jee,^a Heechoul Ohrr^b and Il Soon Kim^b

Background	Although smoking remains uncommon among Korean women, lung cancer mortality is rapidly escalating.
Methods	We investigated the effects of spousal smoking in 160 130 Korean women, aged 40–88, who received health insurance from the Korea Medical Insurance Corporation (KMIC). Exposure data were collected during medical examinations conducted between April 1992 and June 1994. The primary outcome variable was the incidence of lung cancer defined by hospital admissions between July 1994 and December 1997. Standardized rates for the incidence of lung cancer were assessed according to the smoking habits of their husbands.
Results	At baseline (n = 160 130), 53.9% of husbands were smokers and 23.3% were ex-smokers, while 1.1% of wives (n = 1756) were current smokers and 0.6% (n = 938) were ex-smokers. During follow-up, 79 cases of lung cancer occurred among non-smoking wives (n = 157 436). Wives of heavy smokers were found to have a higher risk of developing lung cancer. The husbands' smoking habits did not affect their wives' risk of developing other cancers such as those of the stomach, liver and cervix, but they did affect breast cancer, which has a significantly higher risk in relation to the longer duration of husbands' smoking. In Poisson regression models, adjusting for the age of both husband and wife, socioeconomic status, occupation, residency and vegetable intake, the rate ratio (RR) of lung cancer in non-smoking wives was 1.9 (95% CI : 1.0–3.5) in current smokers and 1.3 (95% CI : 0.6–2.7) in ex-smokers. The RR of lung cancer was 3.1 (95% CI : 1.4–6.6) in wives of husbands who had smoked for 30 years or more compared with wives of non-smoking husbands.
Conclusion	In Korea, the incidence of lung cancer is higher among non-smoking women whose husbands smoke, and a dose-response relationship seems to exist.
Keywords	Husbands' smoking, lung cancer, non-smoking wives
Accepted	11 February 1999

Lung cancer mortality has been reported as the most rapidly increasing cause of death among Koreans. Rates increased from 2.1/100 000 in 1980 to 28.0/100 000 in 1996 among men and from 1.4/100 000 in 1980 to 6.9/100 000 in 1996 among women.¹ This increase in lung cancer mortality is persistent in men and women despite the fact that few women smoke, while the prevalence of smoking among Korean adult men is 72%.² Other risk factors for lung cancer such as radon and asbestos are

uncommon. Thus, passive smoke is a probably a cause of lung cancer in women.

Cigarette smoke, in particular passive smoke, is widely recognized as a major risk factor for lung cancer in Western countries.^{3–4} Nonetheless, few studies have examined the relationship between passive smoking and lung cancer in East Asian countries, where the prevalence of smoking is reportedly among the highest in the world.^{5–6} The possible health consequences of long-term exposure to cigarette smoke should be studied thoroughly among non-smoking wives of smokers because the side-stream and second-hand smoke from cigarettes contain various toxic substances, including carcinogens.^{7–8}

In this report, the effect of passive smoking on lung cancer was studied by following 157 436 non-smoking wives aged 40 and over and measuring their risk of developing lung cancer according to the smoking habits of their husbands.

^a Departments of Epidemiology and Disease Control, Graduate School of Health Science and Management, Yonsei University, Seoul, Korea.

^b Department of Preventive Medicine and Public Health, Yonsei University College of Medicine, Seoul, Korea.

Reprint requests to: Sun Ha Jee, Department of Epidemiology and Disease Control, Graduate School of Health Science and Management, Yonsei University, PO Box 8044, Seoul 120–749, Korea. E-mail: jsunha@yumc.yonsei.ac.kr

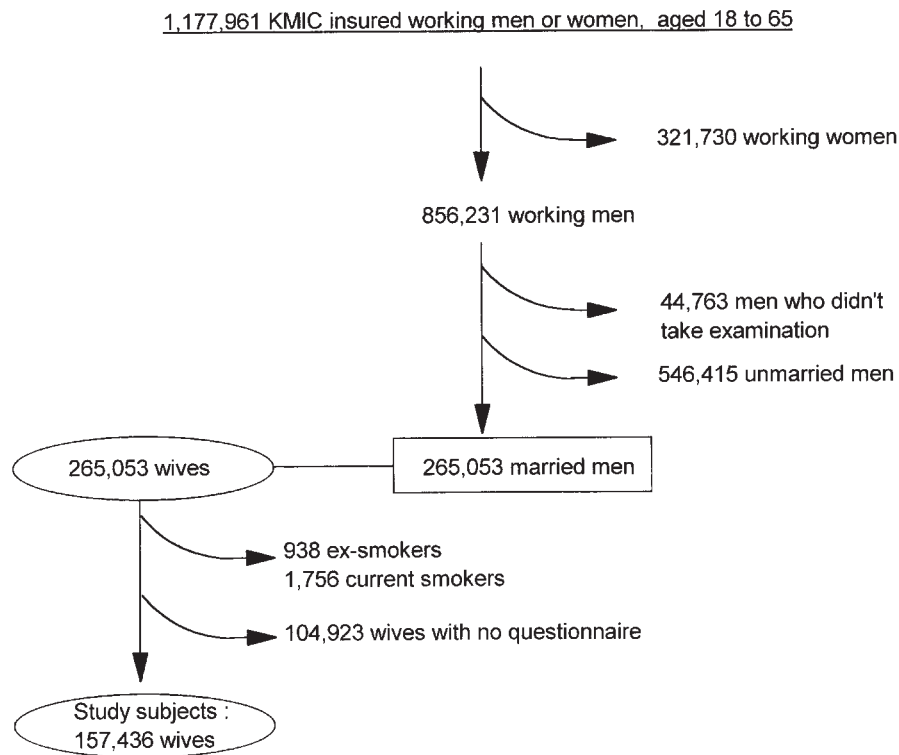


Figure 1 Study samples analysed

Materials and Methods

The Korean Medical Insurance Corporation (KMIC) provides health insurance to civil service workers, teachers and their dependants. For the entire Korean population of approximately 43 million in 1992, 4 603 361 (10.7%) people were insured by KMIC. Of the 4 603 361, 1 177 961 are insured workers (predominantly men, 856 231) and 3 425 400 are dependants. All insured workers are required to participate in biennial medical examinations performed by KMIC. The examination is optional for dependants. In 1992, 94.4% of workers completed biennial examinations. Approximately 35% of dependants completed the biennial examinations. Among 856 231 male workers, 265 053 took medical examinations and were married. A total of 158 927 non-smoking wives aged 40 or over completed the examination and were thus included in the study (Figure 1).

Data collection

The KMIC biennial examinations are conducted in a standardized fashion by medical staff at local hospitals. In 1992, examinations were conducted at 416 hospitals. A questionnaire was given to each participant 3–4 days before examination.⁹ In the 1992 and 1994 questionnaire for insured workers, and in the 1993 questionnaire for dependants, participants were asked to describe their smoking habits (including the number of cigarettes smoked per day and the duration of cigarette smoking in years), along with other health habits, including vegetable consumption and alcohol drinking. The completed questionnaires were reviewed and edited by trained staff. All Korean people have a unique 13-digit identification number that identifies their hospital

admissions. Also, KMIC has a computerized system for managing discharge data that doctors submitted to KMIC for reimbursement of medical care services.

Using data collected in the 1992 examinations, men were classified as current smokers if they had been smoking for at least one year, non-smokers if they had never smoked, and ex-smokers if they had once smoked but had quit. Smoking data in 1994 were used as a validation check on smoking status. If the duration and amount smoked were reported for both 1992 and 1994, averages of those reports were used for final analysis. If a non-smoker in 1992 became a current smoker in 1994, we checked the duration of smoking and classified him as non-smoker in cases of short duration (<1 year). Current smokers were further classified by the average number of cigarettes smoked per day (1–19 and ≥ 20 cigarettes/day) and the duration of smoking (1–29 and ≥ 30 years). We used the medical care premium as a proxy variable for socioeconomic status because the premium was calculated based on income. Occupations of husbands were classified as blue and white collar. Blue collar was defined as technical and daily jobs with low incomes. Residency was classified as rural or urban. Wives were grouped into three broad vegetable consumption categories based on self-reported diet habits: low, moderate and high intake.

Lung cancer occurrence (ICD-9, 162) was ascertained from diagnosis on discharge summaries. For those individuals with more than one discharge event, we used the first event (onset) in our analysis. The follow-up period was from July 1994 to December 1997.

Table 1 Age-adjusted rate of lung cancer per 100 000 person-years and adjusted rate ratio of lung cancer, by smoking habits of husbands: KMIC Study, 1992–1997

Husbands' smoking	No.	Cases of lung cancer	Rate/100 000 person-year ^a	Age-adjusted RR ^{b,c}	95% CI ^b	Multivariate-adjusted RR ^d	95% CI
Smoking status							
Non-smoker	36 109	12	4.4	1.0		1.0	
Ex-smoker	36 802	16	6.5	1.3	0.6–2.7	1.3	0.6–2.7
Current smoker	84 525	51	12.5	2.0	1.1–3.8	1.9	1.0–3.5
No. of cigarettes among current smokers							
1–19	72 254	35	12.5	2.1	1.1–4.0	2.0	1.1–3.9
≥20	12 271	16	13.3	1.6	0.8–3.5	1.5	0.7–3.3
<i>P</i> for trend					<i>P</i> < 0.1		<i>P</i> < 0.1
Period (year) among current smokers							
1–29	53 881	36	11.0	1.7	0.9–3.3	1.6	0.8–3.0
≥30	30 644	15	21.1	3.3	1.6–7.0	3.1	1.4–6.6
<i>P</i> for trend					<i>P</i> < 0.01		<i>P</i> < 0.01

^a Age-adjusted rate by directed method using 1995 Korean National Census Population.

^b RR = rate ratio; CI = confidence interval.

^c Adjusted for the age of both husbands and wives.

^d Adjusted for the age of both husbands and wives, socioeconomic status, residency, husband's vegetable consumption, and husband's occupation.

Statistical analysis

Standardized morbidity rates for lung cancer among non-smoking women calculated by smoking habits of husbands. Direct standardization was employed to obtain age-adjusted rates per 100 000 person-years of observation by 5-year age intervals, using the age distribution of the 1995 Korean census as the standard. In univariate analysis, ordinal variables were tested individually for risk trends across categories. A Poisson regression model was used to assess the independent relationship between smoking and lung cancer, controlling for other risk factors.

Results

Among 160 130 spouses, 53.9% of husbands were current smokers and 23.3% were ex-smokers, while 1.1% of wives ($n = 1756$) were current smokers and 0.6% ($n = 938$) were ex-smokers. A total of 79 cases of lung cancer in 157 436 non-smoking wives were recorded during 3.5 years of follow-up (July 1994 to December 1997).

Age-adjusted morbidity rates for lung cancer were 4.4/100 000 person-years when husbands were non-smokers, 6.5 when husbands were ex-smokers, and 12.5 when husbands were current smokers (Table 1). Compared with wives of non-smoking husbands, the wives of husbands who had smoked for ≥30 years had 230% increased morbidity after adjusting for the age of husbands and wives (age-adjusted rate ratio [RR] = 3.3, 95% CI: 1.6–7.0). In terms of the amount of husbands' smoking, wives whose husbands smoked ≥20 cigarettes/day seemed to have an increased risk for lung cancer (age-adjusted RR = 1.6, 95% CI: 0.8–3.5), however tests for trend were not statistically significant, probably because of the small number of cases. Other characteristics of husbands, such as occupation, alcohol and vegetable consumption, did not affect morbidity from lung cancer in their wives. The RR of discharge from lung cancer were 1.0 and 1.4 (95% CI: 0.8–2.6), respectively, when husbands' occupations were white collar or blue collar. Common characteristics

of wives, such as socioeconomic status and residency were not associated with wives' morbidity from lung cancer.

The independent effects of smoking on lung cancer were examined in Poisson regression models that simultaneously controlled for the age of husbands and wives, socioeconomic status, residency, occupation, and vegetable consumption. Compared with wives of non-smoking husbands, the RR for developing lung cancer in non-smoking wives were 1.9 (95% CI: 1.0–3.5) in current smokers and 1.3 (95% CI: 0.6–2.7) in ex-smokers. Compared with wives of non-smoking husbands, the wives of husbands who had smoked for ≥30 years had an increased risk of lung cancer (RR = 3.1, 95% CI: 1.4–6.6).

The husbands' smoking habits seemed to have no effect on their wives' risk of developing other major cancers, such as cancers of the cervix ($n = 203$), stomach ($n = 197$), and liver ($n = 83$), but they did affect breast cancer ($n = 138$). The risk of developing emphysema and asthma ($n = 142$) also seemed to be higher among the wives of smokers, and the effect was statistically borderline significant for ex-smokers ($P = 0.08$), but not for current smokers ($P = 0.33$) (Table 2). Compared to non-smoking husbands, there was an increased risk of breast cancer among the wives of current smokers (>30 years) (RR = 1.7, 95% CI: 1.0–2.8, $P = 0.035$) (data not shown).

Discussion

In a population where smoking is uncommon among women, this prospective, observational study demonstrated that husbands' smoking was an independent risk factor in their wives' lung cancer. Compared to non-smokers, the RR of developing lung cancer in non-smoking wives were 1.9 (95% CI: 1.0–3.5) in smokers and 1.3 (95% CI: 0.6–2.7) in ex-smokers. Continued exposure (>30 years) to their husbands' smoking increased morbidity from lung cancer in non-smoking wives up to about threefold.

The fact that there was a statistically significant dose-response relationship between the duration of husbands' smoking and

Table 2 Rate ratios^a (95% confidence interval) for selected causes of morbidity in women according to the smoking habits of husbands

Causes of morbidity	Husbands' smoking habit		
	Non-smoker	Ex-smoker (95% CI)	Current smoker (95% CI)
Emphysema, asthma (n = 142)	1.0	1.5 (0.9–2.4)	1.2 (0.8–1.9)
Cancer of cervix (n = 203)	1.0	0.9 (0.6–1.3)	0.9 (0.6–1.2)
Stomach cancer (n = 197)	1.0	1.0 (0.7–1.5)	0.9 (0.6–1.2)
Breast cancer (n = 138)	1.0	1.2 (0.8–1.8)	1.3 (0.9–1.8)
Liver cancer (n = 83)	1.0	0.8 (0.5–1.50)	0.7 (0.4–1.1)

^a Rate ratios were determined by Poisson regression after adjusting for the age of both husbands and wives, socioeconomic status, residency, husband's vegetable consumption, and husband's occupation.

their wives' morbidity from lung cancer suggests that these findings were not chance results. Instead, they indicated that the duration of smoking among smokers is a more predictable indicator for exposure to passive smoke than the amount smoked.

We found that smoking was the only characteristic of husbands which affected their wives' morbidity from lung cancer. This result was similar to Hirayama's study.¹⁰

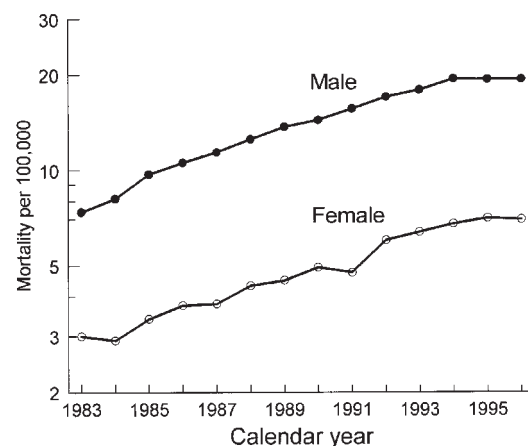
To determine whether such an effect was limited to lung cancer, a similar analysis was conducted with other causes of morbidity. In relation to breast cancer, it might be prevalent-incidence bias. One way to overcome this bias was to perform analysis using past history of smoking (i.e. duration of smoking). We found the risk of developing breast cancer by duration of husband's smoking (>30 years) was significant. Although there was a relation between husbands' smoking habits and morbidity from breast cancer in their wives, the effect of passive smoking was strongest for lung cancer. Passive smoking did not seem to increase the risk of developing cancer of the stomach, cervix or liver.

The evidence on passive smoking and respiratory health was recently reviewed by the USEPA (1992)³ and Wu (1997)⁴. This review confirmed that environmental tobacco smoke (ETS) is causally-linked to lung cancer. The present findings tend to be in general agreement with previous studies.^{10–12} In Hirayama's study, the RR of developing lung cancer was 2.0 for current smokers, which is quite similar to the RR of 1.9 (95% CI: 1.0–3.5) for current smokers in this study. In other studies, the corresponding RR were 1.6 ($P < 0.01$) for Sandler (1985),¹¹ 1.5 (95% CI: 0.8–2.8) for Dalager (1986)¹² and 1.5 ($P < 0.05$) for Zaridzw (1998).¹³ However, Hirayama's (1981) study¹⁰ used a multi-centre prospective design, which did not provide for the duration effect of husbands' smoking. As well, the studies of Sandler (1985)¹¹ and Dalager (1986)¹² used a case-control design, which did not provide the best opportunity for determining whether a relationship existed. Therefore, when we interpreted the results from case-control studies, we had to be concerned about whether an association was true or due to the misclassification of smoking habits.¹⁴ Even prospective studies could be influenced by such misclassification bias. However, it is unlikely that this prospective, observational study was affected by relevant biases because exposure, including smoking habits, was questioned in husbands and wives independently. Because of the low prevalence of smoking among Korean women, we could not determine the risk association between lung cancer and smoking in women.

The strengths of this study included high follow-up rates, large sample size, and repeated measures of smoking habits,

leading to high precision of the exposure estimates. To increase the generality of the study results, nationwide representative data sets were used.

The potential limitations of the study included the relatively brief duration of follow-up, inclusion of individuals with prevalent lung cancer in the cohort, and reliance on diagnoses from discharge summaries. Although the duration of follow-up in our analyses was just 3.5 years, the large size of the cohort (>150 000 participants) provided sufficient statistical power, even in subgroup and dose-response analyses. The inclusion of people with antecedent lung cancer events could potentially lead to biased estimates. However, the impact of prevalent lung cancer was diminished because individuals who experienced cancers between June 1992 and June 1994, the years of baseline data collection, were excluded. Reliance on diagnoses from hospitalizations may have introduced random and systematic errors. Random error would tend to diminish the study's power to detect associations. Systematic error could alter the distribution of events and perhaps risk factor-disease relationships if the errors were related to exposure status. However, the consistency of our findings suggests that major systematic errors related to the coding of lung cancer were unlikely. In relation to the validity of diagnosis, most hospitals required pathological examination to confirm cancer diagnosis. One earlier study reported distribution of morphological types of non-smoking Korean women lung cancer patients: adenocarcinoma, 50.3%; squamous cell, 27.2%; small cell carcinoma, 11.3%; and other and mixed types, 11.2%.¹⁵

**Figure 2** Age-adjusted mortality for lung cancer in Korea (1983–1996)

Finally, most KMIC enrollees might be a selection bias in the study population. KMIC workers tend to be middle-class individuals who may be healthier than the general population in Korea, possibly because of their education and employment status. Overall, the results from this cohort study should be relevant to other East Asian populations.

The age-adjusted mortality rates for lung cancer have been sharply increasing for both men and women in Korea (Figure 2).¹⁶ As only a small fraction of Korean women with lung cancer smoke cigarettes, the reasons for their mortality from lung cancer being comparable with men have remained unclear. This study appears to explain why mortality from lung cancer in Korean women is escalating, particularly among wives whose husbands smoke, even though the rate of women's smoking is negligible.

In conclusion, the results of this study indicate that the incidence of lung cancer is higher among non-smoking women whose husbands smoke, and a dose-response relationship seems to exist.

References

- ¹ National Statistical Office. *Annual Report on the Cause of Death Statistics*. Republic of Korea, 1980–1996.
- ² *Prevalence of Smoking in Korean Adults* The Korea Gallup Report. 1994; **12**:16.
- ³ Environmental Protection Agency. *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*. US EPA office of research and development, Office of Air and Radiation. EPA/600/16–90, 1992.
- ⁴ Wu AH. Environmental tobacco smoke II: lung cancer. In: Steenland K, Savitz DA. *Topics in Environmental Epidemiology*. New York: Oxford University Press, 1997.
- ⁵ Yuan JM, Ross RK, Wang XL, Gao YT, Henderson BE, Yu MC. Morbidity and mortality in relation to cigarette smoking in Shanghai, China. *JAMA* 1996;**275**:1646–50.
- ⁶ Kiyohara Y, Ueda K, Fujishima M. Smoking and cardiovascular disease in the general population in Japan. *J Hypertens* 1990;**8**(Suppl.5): S9–S15.
- ⁷ US Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. Washington DC: DHHS Publication No. (CDC) 89-8411, 1989.
- ⁸ White RJ, Froeb FH. Small-airway dysfunction in nonsmokers chronically exposed to tobacco smoke. *N Engl J Med* 1980;**302**: 720–23.
- ⁹ Jee SH, Appel LJ, Suh Il *et al.* Prevalence of cardiovascular risk factors in South Korean adults: results from the KMIC study. *Ann Epidemiol* 1998;**8**:14–21.
- ¹⁰ Hirayama T. Non-smoking wives of heavy smokers have a higher risk of lung cancer: a study from Japan. *Br Med J* 1981;**282**: 183–85.
- ¹¹ Sandler DP, Everson RB, Wilcox AJ. Passive smoking in adulthood and cancer risk. *Am J Epidemiol* 1985;**121**:37–48.
- ¹² Dalager NA, Pickle LW, Mason TJ *et al.* The relation of passive smoking to lung cancer. *Cancer Res* 1986;**46**:4808–11.
- ¹³ Zaridzw D. Smoking husband ups wife's lung cancer risk. *Intern J Cancer* 1998;**75**:355–58.
- ¹⁴ Lee PN. Lung cancer and passive smoking: association of an artifact due to misclassification of smoking habits? *Toxicol Lett* 1987;**35**: 157–62.
- ¹⁵ Jee SH, Kim IS, Suh Il *et al.* Projected mortality from lung cancer in South Korea, 1980–2004. *Int J Epidemiol* 1998;**27**:365–69.
- ¹⁶ Ohr H, Kim IS, Jee SH, Shon TY. Smoking and female lung cancer by morphological types, a case-control study. *Korean J Epidemiol* 1992; **14**:151–59.