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Smoking and Total Mortality: Kangwha Cohort Study, 6-year Follow-up

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The relationship between smoking and total mortality was examined in a community residents population sample of 2,848 men and 3,543 women aged 55 years or over in Kangwha County, Korea during 1985-1991. A total of 1,436 deaths occurred during a 6-year follow-up among the sample of 6,382. The relative risk (RR) of total mortality was 1.4-fold higher in ex-smokers and 1.3 fold-higher in current smokers than in non-smokers among men. The relative risk of total mortality was highest for the 55-59 year old age group both in ex-smokers and in current smokers. PAR for total mortality attributed by smoking were estimated to be 26% for ex-smokers and 25% for current smokers in men. The biggest RR (2.1) and PAR (49%) were observed among those who smoked less than 19 cigarettes per day compared to non-smokers in males. Smokers who began to smoke at age 18 or before showed RR 1.8, and PAR 38% in men. Smoking was the most important variable related with total mortality second only to hypertensiveness not including preventable ones among men in multivariate analyses. Men who began to smoke at ninteen years of age or before had RR 1.5 for total cancer mortality. Women showed the similar picture as males in risk factors composition and in relative risks, with a low association strength, however.

Key Words: Cohort study, Smoking, Mortality

The first Surgeon General's Advisory Committee on Smoking and Health released in 1964 concluded in the final report that "Cigarette smoking is causally related to lung cancer in men; the magnitude of the effect of cigarette smoking outweighs all other factors. The data for women, though less extensive, point in the same direction." The committee also found that male cigarette smokers had a 70-percent excess mortality rate over men who had never smoked and that female smokers also had an elevated mortality rate, although less than that of males.

Another the U.S. Surgeon General's report published in 1979, identified cigarette smoking as one of the most significant sources of death and disease during the last two decades. They reported that more than one of every six American deaths is the result of cigarette smoking. And smoking is responsible for an estimated 30 percent of all cancer deaths, including 87 percent of lung cancer, the leading cause of cancer mortality; 18 percent of stroke deaths; and 82 percent of deaths from chronic obstructive pulmonary disease.

Although cigarette smoking is known to cause coronary heart disease and cancer in middle age (Department of Health and Human Services 1982; 1983), the issue of whether long-term smokers who survive to old age remain at a higher risk of death

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than non-smokers continues to be debated. For example, among those free of clinical coronary disease, no relation between cigarette smoking and the incidence of coronary heart disease or mortality from it was reported in the Framingham Heart Study (Hermanson *et al.*, 1988; Cupples and D' Agostino, 1987) after 30 years of follow-ups. In contrast, an increased risk of coronary heart disease due to smoking that persisted from middle to older ages was reported in men of Japanese ancestry in the Honolulu Heart Program (Benfante *et al.* 1989).

But most of the prospective studies with big sample sizes reported similar results that smoking increases the risk of death particularly from cancer at all ages (Hammond, 1966; Doll and Peto, 1976; Cederlof *et al.*, 1977; Doll *et al.*, 1980; Doll and Peto, 1981; Agner, 1985; LaCroix *et al.*, 1991). Although extensive data are available relating mortality to smoking habits from many other countries there has been little researches conducted in Korea which seem to have a unique culture particularly in smoking behavior. Choi *et al.* (1986), Choi (1988), and Choi *et al.* (1989) estimated odds ratios of smoking for liver, and lung cancers in case-control studies. Meng (1988) calculated smoking attributable risks for mortality of Korean adults based on the relative risk of smoking for mortality reported by Hirayama (1987) who studied the relation between smoking and mortality among Japaneses. Meng had to use Hirayama's data because there were no prospective study data about smoking and mortality.

We suspect that smoking is one of the most important risk factors related to premature deaths and cancer mortality in Korea too. But we lack research showing the magnitude of the smoking hazard in specific measures. We conducted a prospective investigation of the association between cigarette smoking and 6-year mortality among 2,848 men and 3,543 women 55 years of age or older who lived in Kangwha county, Geonggi-province, Korea. With this data, we could address in cohort study design the role of cigarette smoking and its behavior in the following: total mortality among those over 55 to 74 or over 75 of age; and mortality from cancer both in the absolute and relative risks in relation to smoking.

METHODS

Data collection

The data used in this study is 'the Kangwha cohort'. 'The Kangwha cohort' is a prospective cohort data comprising 2,848 male and 3, 543 female Kangwha residents aged fifty-five or more as of March 1985 to whom a personal health interview and a health examination survey were carried out. This Kangwha cohort was set up from the registered Kangwha residents aged fifty-five or more which amounted to 3,938 males and 5,440 females at that time. The interview and health examination completion rate was 72.1% in males and 65.1% in females respectively.

Information was collected on demographic characteristics, medical history, health behaviors, particularly smoking and drinking behaviors, health status, pulse, blood pressure, weight, height, and some other health related factors. Twenty-six well trained interviewers who were college students or high school graduates accomplished data collection for a period of one month after one-week long training. The follow-up of the Kangwha cohort was conducted biannually by death certificates, computerized citizenship registers searches, death allowance registers in medical insurance companies, and household or neighbor interview surveys in person or by telephone lead to get a more than 95.0% follow-up rate for the first six year observation period.

In this study, we evaluated the relation of smoking with six-year mortality from all causes and all cancers (ICD IX: codes 140-208).

Data analysis

Smoking variables were smoking status − current, former, or never−, age began to smoke, and smoking amount. Other variables such as age, health status, hypertensiveness, pulse, and exposure to pesticide were controlled as confounding variables found to be confounders which were statistically associated with both total mortality and any one of the smoking variables. In univariate analysis, person-year were calculated in every age group and used as the denominator. Both raw and age-standardized total mortality rates were calculated. The direct age standardization method was used according to the age distribution of each gender. The population attributable risk (PAR) originally suggested by Levin in 1953 and its computation method organized by Cole and MacMahon in 1971 was calculated to show 'how much proportion would have been avoided but for the presence of the agent or the trait?' In this article the agent is smoking and prevalence of smoking comes from the total smoking prevalence of each gender.

Logistic regression analysis were used as a multivariate analysis in this study. Persons diagnosed with cancer in their past medical history were excluded in cancer mortality analysis.

RESULTS

Figure 1 shows the gender and age structure of the study population at baseline in 1985, and in 1991. Among the cohort of 2,848 men 814 (28.6%) and among the cohort of 3,543 women 635 (17.9%) deaths occurrred over a 6-year follow-up.

Figure 2 shows the gender and age-specific mortality rates of both the Korean national and the Kangwha cohort data. Mortality rates of the former are higher than the latter from the ages of over seventies in both gender. The causes of death during the follow-up period of this study, from 1985 to 1991, is shown in table 1 where only 51% of the male deaths and 36% of the female deaths have the known causes. Among them malignant neoplasms are the most common causes of death followed by cerebrovascular diseases in both sexes.

Table 2 displays the distribution of back-

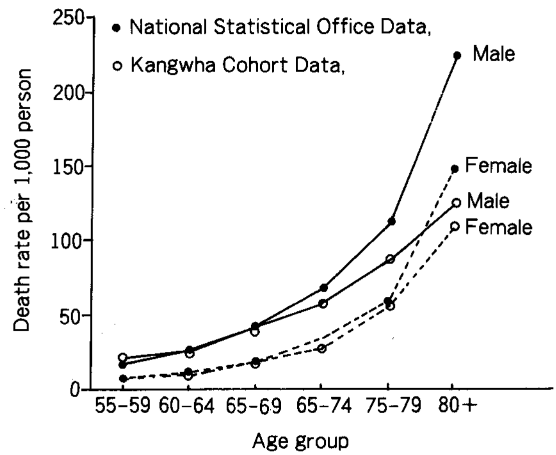

Fig. 2. *Age and gender specific death rates of the Kangwha cohort data (1985-90) and the National Statistical Office data (1988).*

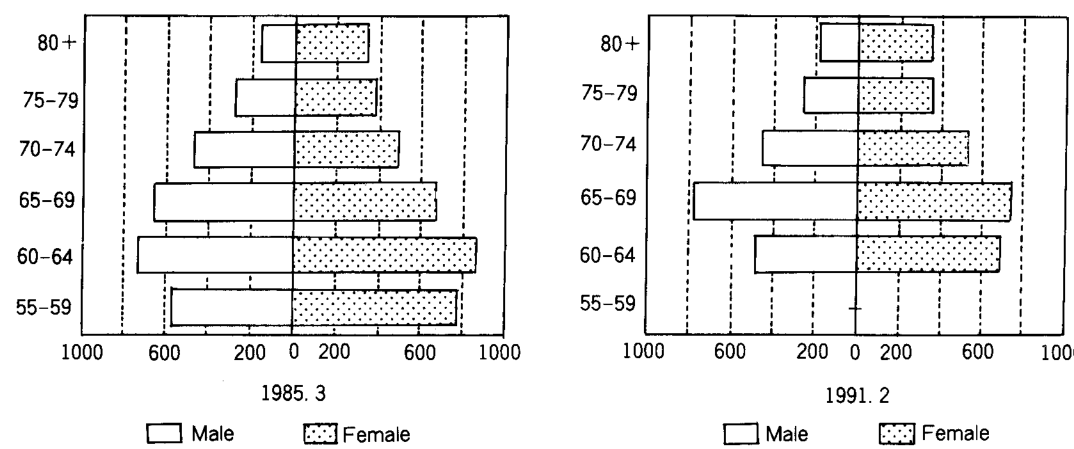

Fig. 1. *Age and gender structure of the Kangwha cohort, 1985. 3. and 1991. 2.*

ground characteristics and risk factors for each of the smoking categories in males. The current smokers had higher pulse rates and higher drinking rates on the average. The non-smokers had the lowest rate of marriage and the lowest exposure rate to pesticides.

Table 1. Causes of death among men and women, March 1985-February 1991
Unit: No. of case (%)

Cause of death	Men	Women	Total
Pulmonary tuberculosis	10 (1.2)	4 (0.6)	14 (1.0)
Malignant neoplasm	151(18.7)	55 (8.8)	206(14.3)
Diabetes mellitus	8 (1.0)	2 (0.3)	10 (0.7)
Hypertensive disease	27 (3.3)	16 (2.5)	43 (3.0)
Cerebrovascular disease	64 (7.9)	51 (8.1)	115 (8.0)
Cardiorespiratory failure and other forms of heart disease	7 (0.9)	7 (1.1)	14 (1.0)
Pneumonia, asthma	6 (0.7)	6 (1.0)	12 (0.8)
Gastrointestinal and liver disease	11 (1.4)	5 (0.8)	16 (1.1)
Renal failure	10 (1.2)	6 (1.0)	16 (1.1)
Others	120(14.9)	73(11.6)	193(13.5)
Unknown	394(48.8)	403(64.2)	797(55.5)
Total	808(100.0)	628(100.0)	1,436(100.0)

Table 2. Background characteristics distributions by smoking status, Kangwha cohort 1985. 3., males

	Non-smoker	Ex-smoker	Current smoker	Total	F, x^2 value
	No. (%)	No. (%)	No. (%)	No. (%)	
Number	591(21.4)	192(6.9)	1,980(71.7)	2,763(100.0)	
Age(SD)[a]	66.5(7.9)[a]	65.7(6.5)[a]	66.4(7.3)[a]	66.4(7.4)[a]	1.0
Marital status					
married	482(82.0)	167(87.4)	1,748(88.3)	2,397(86.9)	
others	106(18.0)	24(12.6)	231(64.0)	361(13.1)	16.1**
Chronic disease					
present	269(45.5)	104(54.2)	878(44.3)	1,251(45.3)	
absent	322(54.5)	88(45.8)	1,102(54.7)	1,512(54.7)	6.8*
Pesticides					
exposed	343(58.1)	130(67.7)	1,311(66.2)	1,784(64.6)	
not exposed	247(41.9)	62(32.3)	669(33.8)	978(35.4)	13.4**
Drinking status					
drinker	227(38.4)	113(58.9)	1,374(69.4)	1,714(62.0)	
non-drinker	364(61.6)	79(41.1)	606(30.6)	1,049(38.0)	186.4***
Blood pressure					
hypertensives	170(28.8)	46(76.0)	1,392(70.8)	1,958(71.3)	
not hypertensives	420(71.8)	146(76.0)	1,392(70.8)	1,958(71.3)	2.3
Health status					
poor	322(54.5)	116(60.4)	1,167(59.0)	1,605(58.1)	
others	269(45.5)	76(39.6)	811(41.0)	1,156(41.9)	4.3

a: Standard deviation
*: $p<0.05$ **: $p<0.01$ ***: $p<0.001$

Table 3. Age specific mortality rate and relative risks for smoking status among males

Age group	Non-smoker			Ex-smoker				Current smoker			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R.
55~59	335	3	9.0	101	4	39.6	4.4	1,058	24	22.7	2.5
60~69	1,674	36	21.5	585	20	34.1	1.6	5,704	176	30.9	1.4
70~79	1,103	53	48.0	392	24	61.2	1.3	3,937	263	66.8	1.4
80+	413	36	87.2	72	6	83.3	1.0	1,133	104	91.8	1.1
Total	3,525	128	36.3	1,152	54	49.6	1.4	11,832	567	47.9	1.3
Age-adjusted[a]			35.5			48.3	1.36			47.9	1.35
PAR[b]			–				26.0%				25.1%

a: Age-adjusted rates using the total male population as the standard
b: Population Attributable Risk by Cole and MacMahon (1971)

Table 4. Age specific mortality rates and relative risks by age began to smoke among males

Age group	Non-smoker			≥30				18~29				18≤			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R
55~59	335	3	9.0	111	2	18.0	2.0	837	24	28.7	3.2	169	2	11.8	1.3
60~69	1,674	36	21.5	907	25	27.6	1.3	4,004	142	35.5	1.7	756	27	35.7	1.7
70~79	1,103	53	48.1	760	44	57.9	1.2	2,109	175	83.0	1.7	660	64	97.0	2.0
80+	413	36	87.2	173	21	121.4	1.4	500	64	124.0	1.4	238	25	105.0	1.2
Total	3,525	128	36.3	1,951	92	47.4	1.3	7,450	405	54.4	1.5	1,823	118	64.7	1.8
Age-adjusted[a]			35.6			45.9	1.3			59.2	1.7			60.5	1.7
PAR[b]						20.9%				38.1%				38.1%	

a: Age-adjusted rates using the total male population as the standard
b: Population Attributable Risk by Cole and MacMahon (1971)

But the chronic disease prevalence and the exposure rate to pesticides were highest in ex-smokers. All the variables mentioned in table 2 except blood pressure were significantly associated with the smoking status. However, all the variables above were associated with mortality of the Kangwha cohort population.

The relative risk of death rate was 1.4-fold higher in ex-smokers and 1.3-fold higher in current smokers than in non-smokers among Kangwha cohort males (Table 3). The relative risks of death rate were highest for the 50~59 year old age group both in ex-smokers and in current smokers. There was a tendency for the higher age groups to have lower relative risks.

The beginning ages for smoking are considered in Table 4. There was a strong positive association between mortality and the beginning age for smoking. Those who began to smoke before 18 years of age have the highest total mortality rate which is 1.8 times that of non-smokers. Smokers who started smoking after 30 years of age have the smallest mortality (RR=1.3) among smokers. It also was observed that relative risks for mortality are higher in relatively younger

Table 5. Age specific mortality rates and relative risks by smoking amounts among males

Age group	Non-smoker			Less than 19 cigarettes				20~39 cigarettes				40 or more cigarettes			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R
55~59	335	3	9.0	64	2	31.3	3.5	202	4	19.8	2.2	791	20	25.3	2.8
60~69	1,674	36	21.5	336	19	56.6	2.6	1,242	40	32.2	1.5	3,830	129	33.7	1.6
70~79	1,103	53	48.1	505	45	89.1	1.9	848	60	70.8	1.5	2,110	190	90.1	1.9
80+	413	36	87.2	212	25	1117.9	1.4	252	34	134.9	1.5	457	52	113.8	1.3
Total	3,525	128	36.3	1,117	91	81.5	2.2	2,544	138	54.2	1.5	7,188	391	54.4	1.5
Age-adjusted[a]			32.9			68.0	2.1			50.0	1.5			55.8	1.7
PAR[b]						49.2%				30.6%				38.1%	

a: Age-adjusted rates using the total male population as the standard
b: Population Attributable Risk by Cole and MacMahon(1971)

Table 6. Stepwise multiple logistic regression analysis for total mortality among males

Variables	R.R.	95% C.I.
Age	1.10	1.08~1.11
Ex-smoker	1.53	1.04~2.26
Current smoker	1.47	1.17~1.85
Poor health status	2.15	1.78~2.60
Hypertension	1.62	1.34~1.96
Exposure to pesticide	0.79	0.66~0.95

Goodness of fit test chi-sq=2.498 p=0.962

age groups than in older groups. These patterns are true among the three age-began-to-smoke groups.

The associations between mortalities and daily smoking amounts is presented in Table 5. Smoking amounts show some inconsistent associations with mortality rates. The group with the least daily smoking amount had a mortality rate 2.2 times higher than that of non-smokers; however another two groups with more smoking amounts showed relative risks of 1.5. We also find the tendency for

Table 7. Age specific mortality rates and relative risks by smoking status among females

Age group	Non-smoker			Current smoker			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R
55~59	1,843	7	3.7	239	8	33.4	9.0
60~69	7,009	91	13.0	1,718	26	15.1	1.2
70~79	3,625	125	34.5	1,621	75	46.3	1.3
80+	1,597	154	96.4	935	99	105.9	1.1
Total	14,074	377	26.8	4,513	208	46.1	1.7
Age-adjusted[a]			29.4			38.3	1.3
PAR[b]							14.4%

a: Age-adjusted rates using the total male population as the standard
b: Population Attributable Risk by Cole and MacMahon (1971)

the relative risks to be greater in the relatively younger age than in older ones throughout the three smoking amounts groups.

Table 6 shows a stepwise multiple logistic regression analysis with all-cause mortality as the dependent variable and age, smoking status, self-recognized health status, hypertension, and history of exposure to pesticides as independent variables among males. Calculated in this manner the OR for all the variables except history of exposure to pesticide were greater than unity. The self-recognized health status is the variable with the biggest value of OR 2.15, hypertension 1.62, ex-smoker 1.53, current smoker 1.47, and exposure to pesticides 0.79 which acted as a protecting factor. The age, calculated as a continuous variable, showed a value of 1.10 as its OR. The relative risk of mortality rate of current smokers was 1.7 in females, but the age-adjusted value is 1.3. There is a tendency for the younger age groups to have higher relative risks than younger ones (Table 7).

Females almost have the same picture as males both in risk factor composition and value of OR except pulse and age at first delivery (Table 8). The selfrecognized health status has the biggest values of OR 1.93, hypertension 1.69, ex-smoker 1.51, age at first delivery (less than 19 years old) 1.43, current smoker 1.32, and high pulse rate (80 or more per minute) 1.29. Age calculated as an interval variable has the OR of 1.14 in the model.

Table 9 shows age specific cancer mortality rates and relative risks for smoking status in males. The relative risk of cancer mortality is 1.3-fold higher in smokers than in non-smokers. There are no differences of relative

Table 8. Stepwise multiple logistic regression analysis for total mortality among females

Variables	R.R.	95% C.I.
Age	1.14	1.12~1.15
Ex-smoker	1.51	0.98~2.53
Current smoker	1.32	1.00~1.61
Health status (poor)	1.93	1.58~2.36
Hypertension	1.69	1.38~1.07
Pulse (80 or more)	1.29	1.01~1.65
Age at first delivery (less than 19)	1.43	1.15~1.78

Goodness of fit test chi-sq=4.486 P=0.821

Table 9. Age specific cancer mortality rates and relative risks by smoking status in males

Age group	Non-smoker			Smokers[a]			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R
−74	2,674.5	18	6.7	10,108.5	89	8.8	1.3
75+	880.0	6	6.8	2,923.5	25	8.6	1.3
Both	3,554.5	24	6.8	13,032.0	114	8.7	1.3

a: Age-adjusted rates using the total male population as the standard

Table 10. Age specific cancer mortality rates and relative risks by age began to smoke in males

Age group	Non-smoker			20 years old or more				19 years old or less			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R	Person year	No. of death	Rate per 1,000	R.R.
−74	2,674.5	18	6.7	7,814.0	69	8.8	1.3	2,308.5	20	8.7	1.3
75+	880.0	6	6.8	2,058.0	12	5.8	0.9	861.5	13	15.1	2.2
Both	3,554.5	24	6.8	9,872.0	81	8.2	1.2	3,170.0	33	10.4	1.5

Table 11. Age specific cancer mortality rates and relative risks by smoking status in females

Age group	Non-smoker			Smokers[a]			
	Person year	No. of death	Rate per 1,000	Person year	No. of death	Rate per 1,000	R.R
−74	11,965.0	29	2.4	3,240.5	11	3.4	1.4
75+	3,660.5	7	1.9	2,063.5	2	1.0	0.5
Both	15,625.5	36	2.3	5,304.0	13	2.5	1.1

a: Includes both current smokers and ex-smokers

risk between the two age groups. The relative risks of cancer mortality for the beginning age of smoking are shown in table 10. Those who began to smoke before nineteen years of age had higher relative risk (RR= 1.5) than those who began to smoke at twenty years of age or over (RR=1.2). Among females (Table 11), there are no big differences in cancer mortality between smokers and non-smokers (RR=1.1).

DISCUSSION

"The Kangwha cohort" the first cohort set up in Korea is a group of persons who share the residing place of Kangwha County, Keonggi-province and age fifty-five years old or more as of 1985. The authors understand that these persons are quite stable in their residing place as the result of the Kangwha Health Demonstration Project for the last ten years. The interview and health examination survey completion rates of 72.1% for males and 64.8% for females are not high, however. These rates are quite understandable considering that the target number of population was taken by the number in citizenship registery of Kangwha county. A good proportion of the people registered here are actually residing in other places which are well known in Kangwha rural situations.

The 95.0% follow-up rate is quite good. This rate is comparable to the rates of the studies of the Doll (1971) 99.7%, Doll *et al* (1970) 96.2%, and Brown and Chu (1983) 89.9 %. To assess the validity of the death finding mechanism of this data, we confirmed the survivorship of one quarter (1,592 persons) of the total number of the cohort (6,382) by interview survey in person. No error was detected in the information we got during the last six-year follow-up. The twenty-six interviewers who surveyed some 6,000 persons for the period of one month were trained for the survey for a week including two days for actual interview practice during which three persons were excluded for better quality of the survey.

The main concern of this study, the relation of smoking with total mortality, leads to focus on smoking related variables, namely, smoking status, age began to smoke, and smoking amounts. But we do not know, however, to what extent persons changed their smoking habits during the study period. Thus observed differences in mortality levels between 'smokers', 'ex-smokers' or 'non-smokers' describe differences among groups with different smoking habits at the beginning of the study. The results then may need to be interpreted in the light of possible changes in habit during the study period. Short of a resurvey, there is no way of telling just how many persons changed their smoking habits and in what ways. In view of the age distributions of our cohorts it seems reasonable to assume that relatively few non-smokers began smoking during the study.

It is probable that a number of 'current' smokers stopped smoking during the course of the study and also that a number of 'ex-smokers' took up smoking again during the course of the study. An NCHS report (Ahmed and Gleeson, 1970) indicates substantial changes in cigarette smoking habits between 1955 and 1966 but these occurred mainly in the under 55 age groups. Considering that the cohort of this study only included persons aged 55 or more, this problem might be a minor one, if at all.

In the analysis of the data we always calculated rates and estimates of comparative effect separately according to age and gender since the smoking patterns and mortality rates differed markedly. While calculating age group specific mortality rates, total mortality rates were age-standardized according to the age distribution of the entire cohort in each gender at the time of 1987. We calculated the total mortality as well as mortality from cancer by dividing the number of deaths by the accumulated person-years of follow-up in the several given smoking categories. In middle-aged populations, a decrease in relative risk with increasing age has generally been observed, with a concomitant increase in rate differences due to the marked rise in mortality rates with age. To determine whether such patterns extend to older groups, we examined relative risks in two large age categories 55 to 74, and 75 or older in cancer mortality.

In multivariate anlaysis, stepwise logistic regression model analysis was used to control other variables found to be confounding variables which are statistically associated with both mortality and any of the smoking variables. In men, the age standardized total mortality rates of current and ex-smokers were 45.4 and 46.6 per 1,000 persons-year respectively. These results are similar to those of several prospective studies that have shown a relation between current smoking and total mortality in diverse populations including persons 55 or older. In our study, the relative risks of total mortality were 1.4 for both current and ex-smokers compared with nonsmokers in males and was 1.3 for current smokers in females.

In age specific mortality rates there were general tendencies showing a decrease in relative risks with increasing ages both in ex-smokers and in current smokers. And this finding is also observed in females too. The estimated population attributable risks (PAR) for total mortality were 26.0% for ex-smokers and 25.1% for current smokers in males, and 8.6% for current smokers in females. These results are somewhat greater than those of Hirayama's report in 1987, showing male smokers at 16.96% and female smokers 4.98%. These differences might be due to the higher age of this study population than that of Hirayama's.

The relative risks for total mortality among male smokers categorized by the beginning age of smoking are shown in Table 4. It shows that smokers who began to smoke at 18 years of age or earlier have relative risks for total mortality 1.8 and 1.5 for those who began to smoke when they were 18 to 29 years old and 1.3 for those 30 years old or over. These results are also quite similar to that of Hammond's data (Hammond, 1964) reporting 1.42 for those who began to smoke when they were 25 years old or older.

Relative risks for smoking amounts in males are shown in Table 5. This Table indicates that relative risks decrease with increasing age and that the youngest ages, the 55~59 year old group, have the biggest values in all three smoking amount categories. But smokers who smoke less than 19 cigarettes per day showed the biggest relative risks (2.1) which was followed by those who smoke 40 cigarettes per day (RR=1.7).

Relative risks for cancer mortality among current and ex-smokers are shown in Table 9~11 where we examined them in two large age categories 55 to 74, and 75 or older. These relative risks for cancer mortality were similar in both genders showing male 1.3, female 1.4 for the 55 to 74 year old group and male 1.3, female 0.5 for the 75 or older age group. These results for the 55 to 74 year old group are also comparable to those of Rogot and Murray (1980) and Lacroix *et al* (1991) which showed the values of 1.39~1.7. The lack of an association of smoking with cancer mortality at the oldest ages might be explaned by the 'survivorship effect' first described by Pearl (1938) some fifty years ago as "men who smoke and survive to about age 70 are such tough and resistant specimens that thereafter tobacco does them no further measurable harm". This effect was also observed and referred to by Bush and Comstock (1983) in smoking and cardiovascular mortality. In another sense it also might be explained by the so called 'harvesting effect' which Jacobsen *et al* (1992) described "that the surviving men in the older age groups may not be representative of all men initially at risk". For multivariate analysis, we used stepwise multiple logistic analysis to control the effects of confounding variables. Among males, the total mortality rate risk ratio estimates are shown in Table 6. Ex-smokers and current smokers had risk ratios of 1.53 (CI: 1.04~2.26) and, 1.47 (CI: 1.17~1.85) respectively controlling other confounders such as age, health status, hypertensiveness or not, and exposure to pesticides. These values are second only to health status which is not preventable and to hypertensiveness. In our study, the females showed nearly the same findings (Table 8) as in males except in the composition of the confounders.

In general the findings here reconfirm and strengthen the earlier findings of previous prospective studies that showed a relationship between smoking and mortality from all causes and from cancer. The low rate of known causes of death and the relatively short period of follow-up of our data limited the calculation of relative risks for specific cause of death and lowered the statistical power in cancer mortality analysis. The low proportion of known causes of death is this study is unavoidable. The national average proportion of known causes of death in below 50%. A good proportion of the Koreans still pass away without exact diagnoses and treatment in the hospitals though most of the Koreans are covered by a certain type of medical insurance. But these limitations are supposed to be better off with the increasing rate of utilizing medical facilities and by the authors' effort to find out causes of death even among those who didn't seek doctors before their death.

Information gathering about deceased persons can be obtained from their close relatives or neighbors and it has already started from 1990. We therefore expect that we can report better research in the future. We are more or less satisfied with this paper in the point that this is the first cohort study and that this data will improve with time.

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