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Abstract: Smoking Rate Trends in Korean Occupational Groups: Analysis of KNHANES 1998–2009 Data: Tae-Won Jang, et al. Department of Preventive Medicine and Center for Occupational and Environmental Medicine, College of Medicine, The Catholic University of Korea, Korea—Objectives: This study aimed to investigate changes in the smoking rate among Korean adults from 1998–2009 by gender and occupational groups. Methods: Using the data from the first (1998), second (2001), third (2005) and fourth (2009) waves of the Korean National Health and Nutrition Examination Survey (KNHANES), we examined men and women between 25–64 years old. Occupational groups were classified into 3 groups of non-manual workers, 5 groups of manual workers and other workers groups. The other group included the unemployed, students and housewives. Age-adjusted prevalence rates of cigarette smoking were calculated for 10-year age groups in each wave of the KNHANES. Trends in the smoking rate according to occupational groups were estimated. Results: Among male workers, decreasing trends in smoking rates were observed in non-manual workers, manual workers, and other workers. The odds ratios and prevalence ratios for the smoking rates of the manual workers comparing the non-manual workers increased from 1998 to 2005, whereas decreased to 1.38 and 1.12, respectively, in 2009. Among female workers, the smoking rates decreased between 1998 and 2001 and increased beginning in 2001. Conclusions: The smoking rate of the manual workers group was still higher than that of the non-manual workers group. Anti-smoking programs specific to each occupational group are needed. (J Occup Health 2012; 54: 452–458)

Key words: Korean, Occupation, Smoking, Trend

Smokers face higher risks of coronary artery diseases, sudden death, arteriosclerosis and hypertensive disease. In addition, smoking also causes malignant tumors such as lung cancer and laryngeal cancer1). The harmful impact of cigarette smoking on health is staggering. Each year, cigarette smoking is responsible for over 438,000 premature deaths in the United States2), leading to 13.2 years of potential life lost for male smokers and 14.5 years lost for females3). Aside from tobacco use being a major cause of death, smokers are known to have greater absences from work, more sick days per year, and health-care costs up to 50% higher than nonsmokers4–6). Smoking of workers in industrial workplaces places an economic burden on employers for the following reasons: increased medical expenses caused by smoking-related diseases, increased absence from work, reduced productivity and contamination of the work environment due to smoking7).

Smoking in the workplace increases the risk of malignant tumors and various types of respiratory diseases by the synergetic effects associated with work-related harmful substances, and is the cause of indirect smoking for nonsmoking workers. Therefore, a smoke-free working environment is crucial for every worker’s health8). Together with increases in recognition of the importance of eliminating smoking in the workplace, many businesses have adapted policies to limit or prohibit smoking in the workplace9–11). Because workers spend a lot of time in the workplac-
es, anti-smoking programs in the workplace have been reported to be effective in reducing the smoking rate in the general population\textsuperscript{12}.

To avoid the economic burden caused by smoking, the Republic of Ireland implemented a comprehensive smoke-free law for all industrial workplaces for the first time in March 2004\textsuperscript{13}. The nations implementing comprehensive smoke-free laws include Norway, Italy, Scotland, England and Uruguay in addition to Ireland\textsuperscript{14}. In the United States, the number of states implementing comprehensive smoke-free laws increased from zero in 2000 to twenty-six in 2010\textsuperscript{15}. The World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) is the first international treaty negotiated under the auspices of the WHO\textsuperscript{16}. The Convention includes a comprehensive ban on all direct and indirect tobacco advertising, promotion and sponsorship in both the traditional media and all other media platforms. In addition, FCTC regulations include universal protection for the public by ensuring that all indoor public places, all indoor workplaces, and all public places are free of secondhand tobacco smoke. This treaty has had a big influence on the implementation of smoke-free workplaces and increasing taxation of tobacco\textsuperscript{17}.

In Korea, the National Health Promotion Act, which specifies smoke-free buildings and zones, was enacted in 1995\textsuperscript{18}. Thereafter, the Korean government made Health Plan 2010 in 2002, and since then, anti-smoking policy has been promoted. The government has developed numerous anti-smoking programs, including public media campaigns, operation of stop smoking clinic and counseling phone line, enhancement of public media campaigns, operation of stop smoking clinic and counseling phone line, enhancement of smoking regulations and monitoring of the smoking rate.

Many studies have examined or reported smoking rate trends in the general population, but few studies have focused on occupational groups. To date, only two studies have examined smoking rate trends among occupational groups by using a representative sample\textsuperscript{19,20}. These studies reported smoking rate trends in certain occupational groups in the United States. However, even in these studies, gender stratified trends were not shown. Furthermore, no Asian studies dealing with trends in smoking rates in working groups are available. Given the high smoking rates in the general population in many Asian countries, research on smoking rate trends according to occupational groups and gender in these countries is needed to identify high risk groups and to intervene properly.

In Korea, Korea National Health and Nutrition Examination Survey (KNHANES), initiated by the Ministry of Health and Welfare and the Center for Disease Control, was conducted for the first time in 1998. Since then, second and third surveys were conducted in 2001 and in 2005, respectively, and the survey became annual after the fourth survey in 2007. The data collected in the survey includes smoking status and occupation type. Using the dataset from the first four waves of the KNHANES, the authors investigated changes in the smoking rate by gender and occupational groups among Korean working adults.

**Subjects and Methods**

Data were derived from the KNHANES conducted by the Korea Center for Disease Control and Prevention. The KNHANES has been performed periodically to evaluate the health and nutritional status of Koreans since 1998. Participants were selected for the KNHANES from among noninstitutionalized civilians with a stratified multistage clustered probability sampling design. This sampling method is certified as producing representative statistics by the Korea Department of Statistics. All of the KNHANES data is available from the KNHANES website\textsuperscript{21}. In the first to third surveys, health examination and health behavior surveys were conducted with 600 primary sampling units (PSUs), and the surveys were carried out every 3 or 4 years. After the fourth survey (2007–2009), the survey became annual using a rolling sampling design that involves a complex, stratified, multistage, probability-cluster survey of a representative sample of the noninstitutionalized civilian population of South Korea. With this method, we were able to calculate estimates for each year (2007, 2008 and 2009, respectively) and all survey years in total (2007–2009). From a total of 3,573 PSUs, 500 PSUs were randomly allocated as follows: 100 in 2007, 200 in 2008 and 200 in 2009, respectively. Twenty households per PSU were randomly derived from those primary sampling units with age and sex stratification\textsuperscript{21}. Samples of each year have their own weights containing information from each year and represent each year’s health status of the Korean population.

This study used data from the first (1998), second (2001), third (2005) and fourth (2009) waves of the KNHANES. Participants aged 24 or less and 65 or over were excluded from this study. The numbers of study subjects were 10,537 men and 10,917 women in 1998, 10,392 men and 10,847 in 2001, 9,389 men and 10,054 women in 2005, and 2,508 men and 3,133 women in 2009.

The variable used as an outcome variable in this study was smoking or nonsmoking, which was measured by answers to the question “Do you currently smoke?” When a subject answered this question with “I smoke everyday” or “I smoke occa-
sionally”, the subject was considered to be a current smoker. The KNHANES categorized the occupation groups into 13 occupation groups for the first survey, 14 occupation groups for the second and third surveys and 11 occupation groups for the fourth survey. The authors compared these occupation groups classified by year and recategorized them into 3 groups of non-manual workers (general managers and government administrators, professionals and office workers), 5 groups of manual workers (service and sales workers, agricultural and fishery workers, craft and related workers, machine operators and elementary occupations) and other workers. The other workers included the unemployed, students and housewives.

Statistical analyses were performed separately for men and women. Age-adjusted prevalence rates of cigarette smoking were calculated for 10-year age groups in each wave of KNHANES data. Smoking rates were directly standardized to 10-year age groups, using the age distribution of the 2005 South Korean census population as the standard population. Confidence intervals (CI) of the age-standardized smoking rates were estimated assuming a Poisson distribution of cases. Prevalence ratios (PRs) were estimated by log-binomial regression. Trends in the OR and PR were estimated by examining the p value for an interaction term of occupations and the variables that identified the year of the data in the model.

SAS 9.2 for windows (SAS Institute, Inc., Cary, NC, USA) was used for statistical analyses.

Our study design was approved by the Institutional Review Board of the Seoul St. Mary’s Hospital (approval ID: KC12EI0369).

Results

Table 1 shows age-standardized prevalence rates of cigarette smoking in South Korean men. The smoking rates among men aged 25–64 decreased over time. Decreasing trends in smoking rates were observed in manual, non-manual and other workers (p<0.001). Decreasing trends in smoking rates were also observed in workers of each occupational group. Among non-manual workers, the smoking rate was lowest in general managers and government administrators in 1998, but, in those groups, the smoking rate was highest in 2009. On the other hand, the smoking rate was dramatically decreased in the professional group (64.8% and 40.6% in 1998 and 2009, respectively).

Among manual workers, the smoking rate in construction and mining workers was the highest in 2001 and 2005. In 1998 and 2009, the smoking

<p>| Table 1. Age-standardized prevalence rates (95% CI), OR and PR of current cigarette smoking: Korean men aged 25–64 from the Korean National Health and Nutrition Examination Survey |
|-------------------------------------------------|------------------|------------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Age-standardized prevalence rates (95% CI), OR and PR of current cigarette smoking: Korean men aged 25–64 from the Korean National Health and Nutrition Examination Survey</th>
<th>1998</th>
<th>2001</th>
<th>2005</th>
<th>2009</th>
<th>p for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>68.9 (68.2–69.6)</td>
<td>68.4 (64.0–65.6)</td>
<td>56.9 (55.8–58.0)</td>
<td>50.1 (49.4–50.8)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Non-manual</td>
<td>63.0 (58.8–67.2)</td>
<td>56.3 (52.5–60.1)</td>
<td>45.7 (41.7–49.7)</td>
<td>42.6 (40.5–44.8)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>General managers and government administrators</td>
<td>56.7 (29.4–84.0)</td>
<td>66.6 (53.6–79.6)</td>
<td>48.0 (25.3–70.7)</td>
<td>42.9 (33.1–52.6)</td>
<td></td>
</tr>
<tr>
<td>Professionals</td>
<td>64.8 (57.3–72.3)</td>
<td>53.0 (46.1–59.9)</td>
<td>43.8 (36.6–51.0)</td>
<td>40.6 (35.3–45.9)</td>
<td></td>
</tr>
<tr>
<td>Office workers</td>
<td>64.5 (55.8–73.2)</td>
<td>59.5 (59.6–69.4)</td>
<td>46.4 (35.3–57.5)</td>
<td>40.2 (34.4–46.0)</td>
<td></td>
</tr>
<tr>
<td>Manual</td>
<td>70.8 (69.7–71.9)</td>
<td>68.2 (66.9–69.5)</td>
<td>61.7 (60.1–63.3)</td>
<td>55.7 (53.4–58.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Service and sales workers</td>
<td>70.4 (63.0–77.8)</td>
<td>68.1 (64.5–71.7)</td>
<td>55.7 (50.3–61.1)</td>
<td>55.5 (54.2–56.9)</td>
<td></td>
</tr>
<tr>
<td>Agricultural and fishery workers</td>
<td>72.4 (67.1–77.7)</td>
<td>68.9 (40.8–97.0)</td>
<td>60.2 (30.9–89.2)</td>
<td>64.3 (54.0–74.6)</td>
<td></td>
</tr>
<tr>
<td>Craft and related workers</td>
<td>67.9 (61.3–74.5)</td>
<td>64.7 (59.7–69.7)</td>
<td>60.9 (54.3–67.5)</td>
<td>55.0 (50.0–60.0)</td>
<td></td>
</tr>
<tr>
<td>Plant and machine operators and assemblers</td>
<td>66.6 (55.9–70.3)</td>
<td>66.6 (58.0–75.2)</td>
<td>64.8 (56.8–72.8)</td>
<td>57.8 (52.2–63.3)</td>
<td></td>
</tr>
<tr>
<td>Elementary occupation (construction and mining)</td>
<td>71.0 (62.8–79.2)</td>
<td>82.4 (75.9–88.9)</td>
<td>68.2 (58.7–77.7)</td>
<td>60.0 (50.5–69.5)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>70.2 (64.7–75.7)</td>
<td>69.7 (60.8–78.6)</td>
<td>59.3 (48.2–70.4)</td>
<td>49.4 (42.9–56.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Unemployment</td>
<td>72.0 (66.6–77.4)</td>
<td>66.7 (56.6–76.8)</td>
<td>59.3 (48.9–73.7)</td>
<td>51.8 (45.2–58.5)</td>
<td></td>
</tr>
<tr>
<td>OR of manual vs. non-manual</td>
<td>1.30 (1.10–1.54)</td>
<td>1.54 (1.28–1.85)</td>
<td>1.81 (1.50–2.18)</td>
<td>1.38 (1.13–1.70)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>OR of other vs. non-manual</td>
<td>1.07 (0.82–1.39)</td>
<td>1.31 (1.00–1.72)</td>
<td>1.29 (0.97–1.72)</td>
<td>1.18 (0.89–1.55)</td>
<td>0.0925</td>
</tr>
<tr>
<td>PR of manual vs. non-manual</td>
<td>1.09 (1.03–1.16)</td>
<td>1.15 (1.08–1.23)</td>
<td>1.28 (1.18–1.40)</td>
<td>1.12 (1.01–1.23)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>PR of other vs. non-manual</td>
<td>1.05 (0.97–1.14)</td>
<td>1.09 (0.99–1.20)</td>
<td>1.11 (0.99–1.26)</td>
<td>1.01 (0.88–1.16)</td>
<td>0.0992</td>
</tr>
</tbody>
</table>

OR=odds ratio; PR=prevalence ratio.
rate was highest in agricultural and fishery workers. The odds ratio (OR) and prevalence ratio (PR) for the smoking rates of the manual comparing the non-manual workers increased from 1998 to 2005, whereas they decreased to 1.32 (OR) and 1.12 (PR) in 2009. There were significant p values for the trends in both the OR and PR of the manual workers comparing the non-manual workers. The differences in the age-standardized smoking rates between manual and non-manual workers were 7.8% in 1998, 11.9% in 2001, 16.0% in 2005, and 13.1% in 2009.

Table 2 shows age-standardized prevalence rates of cigarette smoking in South Korean women. The smoking rates among men decreased over time, whereas the smoking rates among women decreased between 1998 and 2001 and increased after 2001. The trends in smoking rates among non-manual, manual and others workers differed from each other. The smoking rate in office workers increased over time, whereas the smoking rate in the unemployed group decreased over time. Among all occupational groups, the smoking rate was highest in craft and related workers and lowest in professionals in 2009. The OR and PR for the smoking rates of the manual workers comparing the non-manual workers fluctuated over time, whereas the OR and PR between manual and others workers decreased between 1998 and 2001 and increased after 2001.

Discussion

The results of the present study shows the trends in smoking rates in the Korean working population aged 25–64 between 1998 to 2009 and the differences in smoking rates by gender and occupational groups. The smoking rates among male workers aged 25–64 decreased over time (68.9% in 1998, and 50.1% in 2009, respectively). Though this smoking rate is still high compared with other developed countries, the decreasing speed of the smoking rate appears to be remarkable, considering South Korea has had one of the highest male smoking rates in the world for a long time. For example, in the USA, it took 26 years for the percentage of male adult smokers to decline steadily from 51.9% in 1965 to 28.1% in 1991\(^2\). In Japan, it took over 20 years for the percentage of male daily smokers (aged 15 years and older) to decrease from 73.1% in 1979 to 52.0% in 2001\(^3\). In Europe, it took more than 20 years for male smoking prevalence to decrease from 70% to 50% in Denmark and the Netherlands\(^4\). A possible explanation for this dramatic decline in smoking rate may be anti-smoking policy implementation in Korea. A full-scale anti-smoking policy was implemented in Korea at the same time as enactment of the National Health Promotion Act in 1995. The National Health Promotion Act contains details of smoking regulations such as those regulating advertisement of tobacco, those designat-
ing smoke-free buildings and zones, those concerning attachment of age verification device to tobacco vending machines and those concerning imposition of tobacco charges. The anti-smoking campaign began in 1998, focusing on the anti-smoking education and publicity programs, and from 2000, a program to educate management about nonsmoking programs in the workplace was commenced. At the end of 2004, the price of tobacco was increased to reduce the smoking rate and in 2005, government health clinics began to provide programs such as counseling about not smoking and treatment\(^{29}\).

Among male workers, manual workers had shown a higher smoking rate than non-manual workers, and the difference increased from 1998 to 2005 but decreased from 2005 to 2009. It would be possible to explain this tendency as being caused by the increase in tobacco price, which was implemented at the end of 2004. The policy of increasing the tobacco price is a cost-effective means of decreasing the smoking rate in the low income individuals and youth\(^{30}\). Increasing the tobacco price might have affected manual workers who were in a relatively lower income class than non-manual workers. Although the price change was not enough in 2004 (from 2,000 KRW to 2,500 KRW), it might have strongly affected manual workers who had relatively lower incomes. Other measures should be implemented to solve the poor accessibility to quit smoking education and insufficient smoke-free working environments especially for individuals with lower incomes.

Our study shows that the highest smoking rate occurred in male agricultural and fishery workers in 1998 and 2009. In the United States, the smoking rate in agricultural workers was 32.5% in 1987–1994 and 29.6% in 1997–2004, respectively. This occupational group had a higher smoking rate than other occupational groups (in all workers: 27.8% in 1987–1994 and 24.5% in 1997–2004, respectively)\(^{20}\). This is consistent with the results of our study. However, in the European Community Respiratory Health Survey, the smoking rate in farmers was 26.3% in 1992–1993, representing the second lowest rate among the occupational groups\(^{35}\). This study also reported on the smoking rates by occupational groups in several countries of Europe and showed that in men the smoking rate in the professional group was lower while that in the construction and mining group was higher\(^{39}\). In the United States, construction workers had the highest smoking rate\(^{20}\). In the report presented by Ham et al., blue-collar workers had a higher rate of smoking than white-collar workers, and construction workers showed the highest rate of smoking in the United States. The report of Bang and Kim\(^{27}\) also showed that the construction workers had the highest rate of smoking. Similar results were observed in our study in 2001 and 2005.

Although the present study shows that the smoking rate in male workers is still high, decreasing trends in the smoking rates were observed in most occupational groups. However, details of smoking rates were different according to occupational groups. Among manual workers, the smoking rate in service and sales workers decreased by 14.9% from 1998 to 2009, whereas that in plant and machine operators and assemblers decreased by only 8.8%. Among non-manual workers, the smoking rate in general managers and government administrators decreased by 13.8%, whereas the rates in professionals and office workers decreased by 24.2 and 24.3%, respectively. Among non-manual workers, the smoking rate in professionals was highest in 1998, but their smoking rate was the lowest among all occupational groups in 2009. In addition, the smoking rate in manual workers was higher than that in non-manual workers in both male and female workers as well as during the whole period. Smith\(^{20}\) examined the smoking rates in Australia and USA by analyzing the results of national surveys implemented during the period from 1970 to 2005. According to that study, the smoking rate in Australia gradually decreased over time but blue collar workers still had a higher smoking rate than white collar workers; for example, the professionals group presented the lowest smoking rate, while the cleaners and construction workers group had the highest rate. In the United States, the smoking rate was also higher in blue collar workers than white collar workers, and this pattern was continuously maintained\(^{20}\). These findings suggest that low socioeconomic position (SEP), such as manual workers, may be associated with greater smoking rates than high SEP, such as white collar workers. This is consistent with a prior study that showed income was inversely related with smoking rate\(^{29}\). Discrepancies in smoking rates between manual workers and non-manual workers in association with SEP seem to be consistent across different countries.

Although the smoking rate in male Korean workers decreased over time, the smoking rate in Korean female workers showed different tendencies compared with those in male workers. The smoking rate in Korean women decreased from 5.1% in 1998 down to 3.9% in 2001, but it continuously increased since then. Non-manual workers showed an increasing tendency in the smoking rate between 1998 and 2005 and a decrease in smoking rate in 2009. Among manual workers, the smoking rates of the service and sales worker group and craft and related workers group decreased in 2001 compared with 1998, but thereafter they turned to a gradual tendency to increase.
Manual female workers had a higher smoking rate than non-manual female workers. Based on studies of smoking in Asian countries, Korean women may underreport smoking because of cultural prohibition of smoking in women. According to the study reported by Jung-Choi et al.\(^{30}\), comparison of laboratory test results with the results of a self-reported questionnaire survey of smoking status showed that the smoking rate in women identified by a urinary cotinine test was 8% higher than that from the self-reported questionnaire and that 58.9% of female smokers had answered as “Do not smoke”. A potentially underestimated smoking rate by self-report among women may explain in part the different time trends of the smoking rate in Korean women. In addition, in many Asian countries, sociocultural norms and expectations about women’s behavior have been shown to be the major determinant of women’s smoking. Thus, a general liberalization of norms concerning women’s behavior, rather than a particular tobacco policy, may be more important for time trends in women’s smoking rates in Korea\(^{31}\).

This study has a few limitations. First, the question concerning smoking status did not include a time frame for “current smoking”, so the smoking rate might not be accurate. Some workers could be classified as ex-smokers even though they were in the process of stopping smoking. So, time frame is very important. As this survey did not include a time frame, it is possible that the smoking rate was underestimated. However, smoking trend could be still effective and meaningful because the same question was applied in all survey periods. Second, some occupational groups among women were not surveyed in some of the years due to women rarely being in those occupations. For example, general managers and government administrators in all years and plant and machine operators and assemblers in 1998 were not included in our study sample. Third, it is likely that the smoking rate in women may have been underestimated due to the use of self-reported questionnaires. However, since the study aim was to examine the trend over years rather than one single year, the influence of this should be minimal. Forth, the sampling methods used for the first to third and fourth surveys were different. So, this could make the data incomparable. However, each survey has representativeness in the Korean population. So, we thought it is considerably reasonable to compare smoking rates among these years (1998, 2001, 2005, and 2009).

The results of the present study suggest the need for anti-smoking policy differentiated by gender and occupational group. Among men, establishment of an anti-smoking policy is required for the agricultural and fishery workers group, as this group showed the highest smoking rate yet has been neglected from opportunities to receive assistance to quit smoking. Since this occupational group cannot have the benefits of an anti-smoking program in the workplace, it may require different approaches at the government level. Stop smoking programs in the workplace have been reported to be effective for workers in quitting smoking\(^{23}\), and lately, many stop smoking programs are also being implemented in workplaces in Korea. According to the results of this study, the smoking rate in manual workers is still higher than that in non-manual workers; therefore implementation of stop smoking programs targeting manual workers is needed. Furthermore, tailored education programs and media campaigns for smoking cessation targeting the occupational groups with high smoking rates should be developed and implemented both at government level and in the private sector. Although the reliability of smoking rates is problematic in female workers, the lack of decreasing trends in the smoking rate as shown in male workers is worrisome. Research to identify reasons for the increasing trend in smoking rate in women is urgently needed. At the same time, stop smoking programs specifically designed for female workers should be developed and implemented. Programs tailored particularly for the occupational groups with higher smoking rates, such as service and sales workers and plant and related workers, should be developed. The strategies to decrease smoking rates in the workplace should take into account gender and occupational groups.

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