RESEARCH COMMUNICATION

# Secondhand Smoke Exposure among Nonsmoking Adults in Seoul, Korea

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## Abstract

**Despite having one of the highest smoking rates among men, information about secondhand smoke (SHS) exposure among Korean adults is lacking. This study describes SHS exposure among Korean men and women. The results were derived from a population-based, cross-sectional telephone survey conducted with 332 adult nonsmokers in Seoul. Sixty-eight percent of nonsmokers were exposed to SHS during a typical day. Exposure was most common in locations other than home and work, where 57% of respondents were exposed, compared to 26% at home and 25% at work. However, among those exposed, the greatest dose of exposure occurred at work (9 cigarettes/day), followed by at home (6 cigarettes/day). Men were more likely to be exposed to SHS at work than women. For men, lack of home smoking bans and strong belief in traditional Korean values were independently associated with SHS exposure in any location. For women, younger age, family members' smoking (non-spouse), and having fewer sources of anti-SHS messages were independently associated with SHS exposure anywhere. The results highlight the need for strong, comprehensive SHS control measures, such as a complete ban of smoking in all workplaces and public places, as well as public health campaigns to promote home smoking bans and non-smoking norms.**

**Key Words:** Secondhand smoke - environmental tobacco smoke - Korea - smoking ban

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## Introduction

Exposure to secondhand smoke (SHS) is a global public health problem. A growing body of evidence has linked SHS exposure with diseases such as lung cancer, heart disease, emphysema and asthma (U.S. Department of Health and Human Services, 2006). In the United States alone, SHS exposure accounts for more than 50,000 deaths annually among nonsmokers (California Environmental Protection Agency: Air Resources Board, 2005).

Although the Western Pacific Region has a high smoking rate, with almost two-thirds of men smoking (World Health Organization, 2002), little is known about the prevalence of SHS exposure in the adult population in those countries. One of the few studies to document the prevalence of SHS among adult nonsmokers in that region was conducted in China. Gu et al. reported that in 2000-2001, 41% of Chinese nonsmokers aged 35-74 years were exposed to SHS at home (i.e., any household member smoked) and 26% were exposed at work (Gu et al., 2004).

To our knowledge, there are no population-based studies of the prevalence of SHS among adult nonsmokers in the Republic of Korea. The issue of SHS exposure in Korea is pertinent because smoking by Korean men has been a culturally sanctioned behavior and has ranked among the highest worldwide, with a smoking rate of 67% in 2000 (World Health Organization, 2002). Although Korean men's smoking rate has been waning as a result of recent tobacco control measures, it remains higher than most developed countries. Unlike smoking, data on the extent or patterns of SHS exposure among Korean adults have been limited. Kho et al. measured SHS exposure levels among a convenience sample of 23 nonsmoking restaurant employees working in 3 different types of restaurants (wine shops, coffee houses, and traditional Korean cuisine restaurants) in Seoul (Kho et al., 2002). Out of the three, wine shops showed the highest concentration of measured markers of SHS exposure, i.e., indoor air nicotine, area respiratory suspended particulates, and nitrogen dioxide. However, their findings cannot be generalized to the general public and did not address SHS exposure in other locations.

The objectives of the current paper were: 1) to estimate the prevalence and dose of SHS exposure at home, at

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work, and in other locations, among adult nonsmokers in Seoul; and 2) to identify demographic, behavioral and socio-cultural characteristics of SHS exposure. These data are helpful for devising public health strategies to prevent SHS exposure and for providing a baseline to evaluate subsequent changes in tobacco control efforts.

## Materials and Methods

*Sample*

The data came from a larger study of tobacco and health behaviors. Telephone interviews were conducted with 248 male and 252 female adults residing in households that could be contacted by residential telephone in metropolitan Seoul. Seoul, the capital of the Republic of Korea, is one of the largest cities in the world, with over 10 million residents (Seoul Metropolitan Government, 2002). A list of telephone numbers was created by random sampling of residential numbers from 27 Seoul regional telephone directories. Stratified by gender, interviews in targeted households were conducted with the adult with the most recent birthday. During the late summer and early fall of 2002, interviews were conducted by trained staff at Myongi University under the supervision of the project co-investigator. Up to five callbacks were made to each number. Approximately 50% of eligible respondents provided consent and completed the interview. The study was approved by the institutional review board of San Diego State University.

Sampling procedures resulted in a slight overrepresentation (not more than 3%) of younger women and individuals with some college education, and a slight underrepresentation of middle-aged males, college graduates, and females over 40, compared to Korean population data for the Seoul metropolitan area (STAT-KOREA, 2002). The age by gender distribution of sample data did not deviate significantly from that of the population distribution when the survey distribution was standardized to the census distribution.

Respondents were classified as smokers if they had smoked 100 or more cigarettes in their lifetime and were currently smoking (U.S. Department of Health and Human Services, 1996). This paper analyzed the data for 332 respondents who were classified as nonsmokers.

*Survey Items Analyzed*

SHS Exposure. The dependent variable was SHS exposure for nonsmoking adults. Respondents estimated the number of cigarettes to which they were exposed on a typical day in the home, at work and in a car. For all other locations, they reported the weekly number of cigarettes of exposure. Similar reported measures have been shown to be reliable and valid (Maziak et al., 2006; Wagenknecht et al., 1992; Wagenknecht et al., 1993). For "other" locations, weekly exposure was divided by seven to estimate daily exposure. This value was pooled with car exposure, since both contributed to the total SHS exposure to a much smaller degree than either home or work. The prevalence of SHS exposure was defined as the percent of respondents reporting SHS exposure exceeding zero cigarettes/day. The dose of SHS exposure (number of cigarettes/day) was calculated for exposed respondents.

Demographics. Respondents provided information on their gender, age, marital status, occupation, years of education, household income, and whether there were children under 18 years of age in the household.

Behavioral/Socio-cultural factors. Questions were asked about behavioral and socio-cultural variables that might influence SHS exposure. These questions were guided by the Behavioral Ecological Model, and our previous studies of tobacco use among Korean immigrants to the United States (Hofstetter et al., 2004; Hovell et al., 2002). The model suggests that SHS exposure is influenced by personal, environmental, and cultural contingencies.

Respondents were asked whether there were any smokers among their friends whom they saw regularly (yes, no), whether their spouse smoked regularly (yes, no) and whether other family members (parents, siblings, children, grandparents, and aunts/uncles) smoked regularly. Other family member's smoking was dichotomized to "yes" if any family (non-spouse) member smoked regularly, and "no" if none smoked.

Perceived health risk from SHS was measured from two questions: 1) whether they believed it was true or false that "inhaling smoke from other person's cigarettes is harmful to one's health," and 2) "inhaling smoke from someone else's cigarettes causes lung cancer among nonsmokers." Respondents also indicated how concerned they were about their health (not at all/not much versus some/greatly).

Respondents also indicated whether they had received impressions that secondhand smoke was harmful, from each of the following sources during the past three months: television, radio, internet, newspapers/magazines, billboards, and videotapes. The number of different sources was summed to create an anti-SHS media source score.

Respondents were asked where smoking was permitted in their home: nowhere, only certain areas, only special guests allowed to smoke, and anywhere. The reported home smoking policy measure was then dichotomized to smoking allowed, versus no smoking allowed.

Respondents indicated how strongly they believed (strongly believe, believe, somewhat believe, believe a little, do not believe) in traditional Korean values about marriage, family, education, and work. This variable was included because traditional Korean values condone smoking behavior. Belief in traditional values was dichotomized to strongly believe/believe versus somewhat believe/believe a little/do not believe.

*Statistical Analysis*

The data were analyzed in 2007 using SPSS 14.0 (SPSS, Inc., Chicago, IL, 2005). Differences in SHS prevalence were determined by the chi-square test. Two-tailed ANOVA assessed differences among mean dose of SHS exposures.

Multiple logistic regression analyses were conducted to examine correlates of any SHS exposure (yes/no). Women and men were analyzed in separate models because preliminary bivariate analyses suggested

**Table 1. Characteristics of Nonsmoking Respondents**

| Characteristic | | Number[a] | (%) |
|---|---|---|---|
| Gender | Male | 96 | (28.9) |
| | Female | 236 | (71.1) |
| Married | Yes | 227 | (68.4) |
| | No | 105 | (31.6) |
| Job class | | | |
| Not working outside home | | 146 | (47.1) |
| White-collar | | 149 | (48.1) |
| Blue-collar | | 15 | (4.8) |
| Education | | | |
| High school or less | | 231 | (69.8) |
| Some college or above | | 100 | (30.2) |
| Household income (won) | | | |
| < 2,000,000 | | 86 | (37.7) |
| 2,000,000-3,000,000 | | 79 | (34.6) |
| > 3,000,000 | | 63 | (27.6) |
| Children in household | | | |
| | Yes | 143 | (43.1) |
| | No | 189 | (56.9) |
| Concerned about health | | | |
| Not at all/not much | | 98 | (29.5) |
| Some/greatly | | 234 | (70.5) |
| Smoking policy in the home | | | |
| Smoking allowed | | 255 | (76.8) |
| No smoking allowed | | 77 | (23.2) |
| Knows that SHS is harmful | | | |
| | Yes | 330 | (100.0) |
| | No | 0 | (0.0) |
| Knows that SHS causes lung cancer | | | |
| | Yes | 321 | (97.6) |
| | No | 8 | (2.4) |
| [b]Age (years) (Mean (SD)) | | 38.9 | (16.1) |

[a]Some variables do not total 332 due to missing values
[b]SD = standard deviation

differences in their SHS exposure patterns. The initial models included all variables that were significant ($p<0.05$) in the bivariate analyses. Age, education, and number of anti-SHS sources were used as continuous variables. The independent variables were removed one at a time until only significant ($p<0.05$) variables remained. Age was forced in the final model. Interactions between gender and other independent variables in the final model were tested. None of the interactions were statistically significant.

## Results

*Respondent Characteristics*

Respondents' mean age was 39 years (Table 1). The population was predominantly female (71%), married (68%), and had high school or lower education (70%). Most respondents (78%) had a spouse, family member or friend who smoked (not shown). Although most respondents were somewhat or greatly concerned about their health and knew the health risks of SHS, only 23% prohibited smoking in the home.

*Overall SHS Exposure*

Sixty-eight percent of nonsmokers were exposed to SHS either at home, work or another location on a typical day. Among those exposed, the average dose was 5 cigarettes per day. Seventy-four percent of men were exposed to SHS, to an average of 4 cigarettes per day, while 66% of women were exposed, to an average of 5 cigarettes per day.

*SHS Exposure by Location*

At home, 26% of nonsmokers were exposed to SHS. The dose at home averaged nearly 6 cigarettes per day and was similar for men and women. At work, 25% of nonsmokers were exposed to SHS. Men were more likely to be exposed to SHS at work than women (35% versus 19%, respectively, $p=0.046$). Work exposure averaged over 9 cigarettes per day, and was similar for men and women. In other locations, 57% of nonsmokers were exposed to SHS. Women were exposed to more cigarettes than men in "other" locations (1.4 versus 0.5 cigarettes/day, respectively, $p=0.011$).

*Bivariate Results for Men*

Table 2 shows the prevalence of daily SHS exposure for men and women by location and other characteristics. Among men, SHS exposure at home was more common if they were under 30 years old, not married, not working outside the home, less educated, and if they had family members (non-spouse) who smoked. The presence of children at home, a home smoking ban, and concern about health were protective for men. Strong traditional Korean values were associated with greater SHS exposure at work and in "other" locations. For "other" locations, SHS exposure was also more likely among men with fewer sources of anti-SHS messages.

*Bivariate Results for Women*

As with men, SHS exposure at home was more common among women who were younger, less concerned about their health, if other family members smoked, and if they lacked a home smoking ban. In addition, women whose husbands smoked were more likely to be exposed to SHS at home (56% versus 17%, respectively, $p<0.001$). SHS exposure at work was more common if women held blue-collar jobs and if their friends smoked. In "other" locations, SHS exposure was more likely if women had other family members who smoked, if they had received anti-SHS messages from fewer sources, if they had strong traditional Korean values, and if they had blue-collar jobs.

*Multivariable Results*

Table 3 shows the final multiple logistic regression model for any SHS exposure, for men and women separately. For men, lack of home smoking bans and strong belief in traditional Korean values were associated with higher SHS exposure anywhere, after controlling for other variables in the model. Men who reported strong traditional Korean values had nearly 5 times greater odds of exposure than men with less traditional Korean values. Also, men without home smoking bans had over 5 times the odds of SHS exposure than men with home smoking bans.

Among women, the odds of SHS exposure decreased with older age (adjusted odds ratio [OR]=0.78) and the

**Table 2. Prevalence of Daily SHS Exposure among Nonsmokers, by Gender, Location and Other Characteristics[a]**

| Characteristic | | Men N | Men Home | Men Work | Men Other Locations | Women N | Women Home | Women Work | Women Other Locations |
|---|---|---|---|---|---|---|---|---|---|
| Overall | | 96 | 19% | 35% | 62% | 236 | 29% | 19% | 54% |
| Age (years) | <30 | 44 | 39%** | 57% | 59% | 67 | 33%* | 29% | 57% |
| | 30-50 | 22 | 4% | 43% | 82% | 122 | 32% | 18% | 57% |
| | 51+ | 30 | 0% | 23% | 53% | 47 | 13% | 8% | 45% |
| Married | Yes | 45 | 2%** | 31% | 64% | 165 | 28% | 17% | 53% |
| | No | 51 | 36% | 56% | 61% | 71 | 32% | 32% | 58% |
| Job class | | | | | | | | | |
| Not working outside home | | 37 | 32%** | -- | 60% | 109 | 27% | -- | 61%* |
| White-collar | | 49 | 6% | 39% | 65% | 100 | 31% | 15%** | 47% |
| Blue-collar | | 5 | 20% | 0% | 40% | 10 | 40% | 67% | 90% |
| Education | | | | | | | | | |
| High school or less | | 63 | 27%* | 38% | 62% | 168 | 29% | 24% | 53% |
| High school or above | | 33 | 3% | 33% | 64% | 67 | 27% | 11% | 58% |
| Children in household | | | | | | | | | |
| | Yes | 26 | 4%* | 42% | 69% | 117 | 34% | 15% | 57% |
| | No | 70 | 24% | 31% | 60% | 119 | 23% | 26% | 52% |
| Spouse smokes | Yes | 1 | 0% | 100% | 100% | 72 | 56%** | 23% | 50% |
| | No | 95 | 19% | 34% | 62% | 164 | 17% | 17% | 56% |
| Other family member smokes | | | | | | | | | |
| | Yes | 75 | 24%* | 36% | 65% | 199 | 32%** | 20% | 57%* |
| | No | 21 | 0% | 33% | 52% | 37 | 8% | 19% | 38% |
| Friends smoke | Yes | 92 | 20% | 35% | 64% | 118 | 33% | 28%* | 59% |
| | No | 3 | 0% | 33% | 33% | 117 | 24% | 8% | 50% |
| Smoking policy in the home | | | | | | | | | |
| Smoking allowed | | 65 | 28%** | 44% | 69% | 190 | 35%** | 18% | 56% |
| No smoking allowed | | 31 | 0% | 20% | 48% | 46 | 2% | 25% | 46% |
| # of anti-SHS media sources | | | | | | | | | |
| | 0-2 | 78 | 19% | 41% | 69%* | 190 | 29% | 21% | 61%** |
| | 3-6 | 18 | 17% | 0% | 33% | 46 | 26% | 14% | 27% |
| Concerned about health | | | | | | | | | |
| Not at all/not much | | 29 | 31%* | 38% | 55% | 69 | 39%* | 15% | 54% |
| Some/greatly | | 67 | 13% | 34% | 66% | 167 | 24% | 21% | 54% |
| Strong Korean values | Yes | 51 | 16% | 46%* | 76%** | 101 | 28% | 20% | 63%* |
| | No | 42 | 21% | 18% | 48% | 129 | 29% | 20% | 49% |

[a]SHS=Secondhand Smoke *p<0.05, **p<0.01 for chi-square comparing within characteristic categories for a specified location

number of sources of anti-SHS messages (adjusted OR=0.74). Women whose family members (non-spouse) smoked had an over 3 times greater odds of SHS exposure than women whose family did not smoke.

**Table 3. Adjusted Odds Ratios for any SHS Exposure to Nonsmokers[a]**

| Variable | Adjusted OR (95% CI)[b] |
|---|---|
| Men (N=91) | |
| Age (10-year increase) | 0.89 (0.66-1.19) |
| Strong belief in traditional Korean values | |
| Yes | 4.77 (1.44-15.78)* |
| No | Reference |
| Smoking banned in home | |
| Yes | Reference |
| No | 5.14 (1.70-15.60)* |
| Women (N=234) | |
| Age (10-year increase) | 0.78 (0.64-0.95)* |
| Other family member (non-spouse) smokers | |
| Yes | 3.28 (1.54-6.96)* |
| No | Reference |
| Number of anti-SHS media sources | 0.74 (0.60-0.91)* |

[a]SHS=secondhand smoke [b]Odds ratios adjusted for all other variables in the model shown; CI=confidence interval; *p<0.05

## Discussion

On a typical day, SHS exposure was common among this sample of nonsmokers in Seoul, with more than two-thirds exposed at home, work, or in other locations. These results can be best compared to a parallel study of SHS exposure among nonsmoking Korean Americans in California, United States, based on the same survey questions and conducted during the same timeframe (Hughes et al., 2008). Exposure patterns were similar in both samples, but the prevalence and dose of SHS exposures were consistently higher among Koreans. For example, the overall SHS exposure for the Seoul nonsmoking sample was 68%, versus 31% for California. This finding was expected considering California's lower smoking prevalence, more stringent restrictions on smoking in the workplace and public places, and higher prevalence of home smoking bans. It is likely that SHS exposure among nonsmokers in Seoul has diminished since 2002, due to ongoing tobacco control initiatives. While the estimates in this study provide a baseline, SHS exposure should be monitored in future studies to assess the impact of tobacco control activities.

The daily dose of exposure among Seoul nonsmokers

who were exposed to SHS was considerable – averaging 9 cigarettes at work, 6 cigarettes at home, and 1 cigarette in other locations. The cumulative exposure to SHS from years of exposure of this magnitude is cause for public health concern.

As found in studies from different parts of the world, such as China, Syria, and Spain (Gu et al., 2004; Maziak et al., 2006; Nebot et al., 2004), men in our study were more likely than women to be exposed to SHS at work, and women were more likely than men to be exposed at home, although the difference was not statistically significant for the home location in the present study. The prevalence of SHS exposure at work in the Seoul sample was similar to China's (26%) (Gu et al., 2004). Compared to women, the higher percentage of nonsmoking men exposed to SHS at work may have been due to their greater interaction with other male workers, many of whom probably smoked given the high prevalence of smoking among men. For women, there were general social disincentives to smoke, and it is likely that they interacted with other female nonsmokers at work since Korean women are less likely to smoke than men.

The present study is one of few to examine the independent effect of multiple variables on SHS exposure. The multivariable results indicated that for men in the Seoul sample, lack of home smoking bans and strong belief in traditional Korean values were associated with SHS exposure. A protective effect of smoking bans for men has also been observed in Syria (Maziak et al., 2006). For male Korean nonsmokers, smoking bans within their homes provided a smoke-free zone, thus lowering the probability of being exposed at home. Consistent with the cultural influences within the framework of the Behavioral Ecological Model, it is plausible that Korean men who espoused traditional values would be exposed to smoking because traditional Korean culture encouraged male smoking. Until recently, smoking in work and social situations was customary for men (Kim et al., 2005). The cultural influences on SHS exposure have also been observed among Korean Americans in California (Hughes et al., 2008). Like their traditional Korean counterparts, Korean American men who were less acculturated, i.e., maintained more of their Korean culture, were more likely to be exposed to SHS.

For women, the multivariable results showed that younger age, family members' (non-spouse) smoking and receiving anti-SHS messages from fewer sources were independently associated with SHS exposure. Younger age has also been associated with SHS exposure in nonsmokers in other countries (Martinez-Donate et al., 2005; Moussa et al., 2004; Skorge et al., 2007). Perhaps social contingencies changed with older age such that women became more assertive, gained higher status, and were not in social situations in which smoking was more likely such as bars. The finding that different factors influenced SHS exposure for men and women is consistent with gender-based contingencies concerning smoking and other behaviors that are embedded in Korean culture. The dominant role of men in Korean society combined with respect for family members may help explain why women's exposure was influenced by other family member's smoking. Similarly, among Syrian women, the number of household members who smoked was positively associated with SHS exposure (Maziak et al., 2006). The protective role of anti-SHS sources among Korean women is encouraging. Few studies have examined the influence of anti-SHS sources on SHS exposure. Among Korean Americans in California, the number of anti-SHS media sources was not associated with SHS exposure (Hughes et al., 2008). The different results between the Seoul and Korean American studies may be due to the novelty of the Korean media campaign which was in progress while the Seoul survey was conducted, whereas in California Korean Americans may not have understood the media messages which were only in English.

The study limitations include a cross-sectional design, which limits causal inferences. SHS exposure was determined by asking respondents the number of cigarettes of SHS exposure to which they were exposed in each location, which, although an improvement from asking if a spouse smoked, may have been subject to recall or reporting biases. Although not ideal, self-report has been shown to correlate sufficiently well with other measures such as cotinine levels (Hovell et al., 2000). While verification of SHS exposure was not feasible in this study, it should be considered for future studies, but it should be noted that use of more objective markers such as cotinine have their own limitations such expense, a short half-life and lack of information about the location where exposure occurred. The data were collected in 2001-2002 and provide a baseline for future studies. Although more recent SHS exposure data is lacking, it is expected that the prevalence of SHS exposure has decreased as smoking rates have declined. The generalizability of the results may be limited to households with telephones. Finally, non-response bias was possible, although the sample, while limited in size, was similar in composition to the census population (STAT-KOREA, 2002).

This is the first study to document that SHS exposure was widespread among nonsmokers in Seoul, as the Korean tobacco control campaign was ramping up in 2002. On a positive note, almost all respondents were aware of the health risks of SHS. The higher levels of awareness of SHS may have been due to the anti-smoking campaign underway while the survey was being conducted and to highly publicized speeches by one of Korea's popular comedian, Lee Jo il, who spoke out against smoking after he was diagnosed with lung cancer.

The high levels of SHS exposure warrant increasingly progressive measures to reduce SHS exposure at home, work and other locations. According to our results, to more fully protect Korean men, interventions should be focused on individuals with more traditional values and should promote home smoking bans. For women, anti-SHS messages should be delivered via multiple media sources, targeting younger women and women whose family members smoke. As of July, 2006, smoking was banned in office buildings and factories with total floor area larger than 1000 square meters (Korean Association of Smoking and Health, 2006). To prevent workplace exposure for all Koreans, the law should be expanded to a complete ban

on smoking in all workplaces, and should provide for enforcement measures and smoking cessation programs. With regard to SHS exposure in locations other than work or home, non-smoking areas in restaurants and karaoke bars are mandated by law. However, a complete ban on smoking in all restaurants and bars is needed because they are more effective than partial measures (Nebot et al., 2005; Repace, 2004a; Repace, 2004b). The fact that knowledge of the dangers of SHS was almost universal among the Seoul sample suggests that there were other personal and cultural barriers to avoiding SHS exposure. Therefore, tobacco control measures should be accompanied by public campaigns to promote home smoking bans and to de-normalize smoking, especially around others.

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