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Decrease in the urine cotinine concentrations of Korean non-smokers between 2009 and 2011 following implementation of stricter smoking regulations

Ju Hyoung Park[a], Chae Kwan Lee[a,*], Kun Hyung Kim[a,*,1], Byung Chul Son[a], Jeong Ho Kim[a], Chun Hui Suh[a], Se Yeong Kim[a], Seung Do Yu[b], Sue Jin Kim[b], Wook Hee Choi[b], Dae Hwan Kim[c], Yeong Beom Park[d], Seok Hwan Park[e], Soo Woong Lee[f]

[a] Department of Occupational and Environmental Medicine, College of Medicine & Institute of Environmental and Occupational Medicine, Inje University, Busan, Republic of Korea
[b] Environmental Health Research Division, National Institute of Environmental Research, Inchon, Republic of Korea
[c] Department of Occupational and Environmental Medicine, Inje University Haeundae Paik Hospital, Busan, Republic of Korea
[d] Department of Food Processing and Bakery, Gangwon Provincial College, Gangnung 210-804, Republic of Korea
[e] Department of Environmental Engineering, Sewon University, Cheongju, Republic of Korea
[f] Department of Microbiology and Immunology, College of Medicine, Inje University, Busan 614-735, Republic of Korea

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ABSTRACT

This study aimed to determine if there was an association between the implementation of smoking regulation policies and the urine cotinine concentrations of Korean non-smokers. The subjects of this study were 4612 non-smoking Korean citizens (aged 19 or older) selected from the first stage of the Korean National Environmental Health Survey conducted by the National Institute of Environmental Research from 2009 to 2011. Cotinine concentrations in urine were measured by GC–MS (limit of detection: 0.05 ng/mL). Changes in the urine cotinine concentration were analyzed using a weighted general linear model and linear regression and values were shown as geometric mean (GM). The GM urine cotinine concentration decreased over time (2.92 ng/mL in 2009, 1.93 ng/mL in 2010, and 1.25 ng/mL in 2011). The total decrease in the subjects' urine cotinine concentration between 2009 and 2011 was 2.79 ng/mL, representing a relative decrease of 54.7%. The decrease in GM urine cotinine concentration in each subgroup ranged from 2.17 ng/mL to 3.29 ng/mL (relative decreases of 46.4% and 62.8%, respectively), with the largest absolute reductions in subjects in the following groups: females, aged 40–49 years, detached residence type, no alcohol consumption, employed, secondhand smoke exposure. All groups had negative regression coefficients, all of which were significant ($p < 0.001$). Our results provide indirect indicators of the effectiveness of smoking regulation policies including the revision of the National Health Promotion Act in Korea.

Introduction

Secondhand smoke is composed of side stream smoke (the smoke released from the burning end of a cigarette) and exhaled mainstream smoke (the smoke exhaled by the smoker). While secondhand smoke has been referred to in the past as environmental tobacco smoke (ETS), the term "secondhand" smoke better captures the involuntary nature of the exposure (U.S. Department of Health and Human Services, 2006a). Cigarette smoke contains more than 4000 chemical compounds. The National Toxicology Program (NTP) estimates that at least 250 chemicals in secondhand smoke are known to be toxic or carcinogenic (U.S. Department of Health and Human Services, 2006a). In addition, secondhand smoke has been designated as a known human carcinogen (cancer-causing agent) by the U.S. Environmental Protection Agency (EPA), the NTP, and the International Agency for Research on Cancer (IARC), and an occupational carcinogen by the National Institute for Occupational Safety and Health (NIOSH) (U.S. Department of Health and Human Services, 2006b).

Worldwide, 40% of children, 33% of non-smoking males, and 35% of non-smoking females are known to be exposed to

* Corresponding authors. Tel.: +82 51 890 6761; fax: +82 51 895 1323.
E-mail address: lck3303@daum.net (C.K. Lee).
[1] Co-corresponding author contribute equally to this study.

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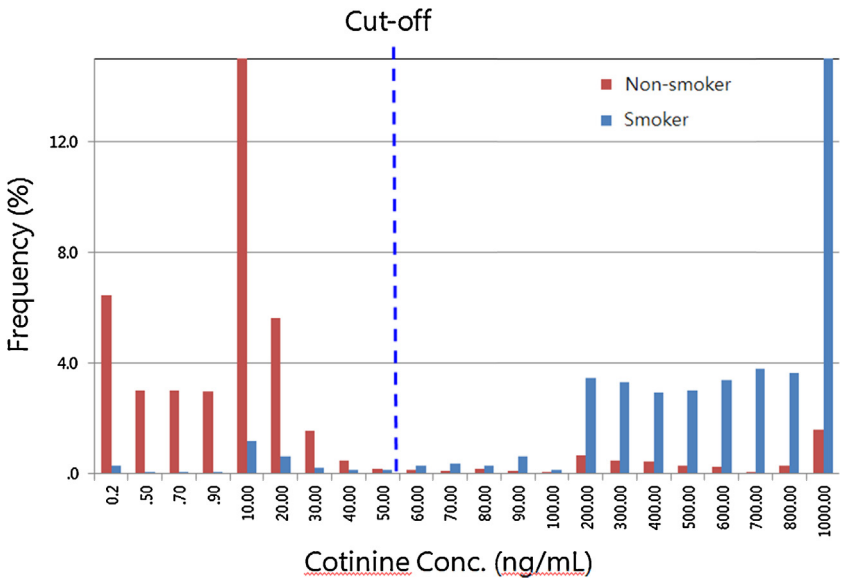

Fig. 1. Cumulative frequency of distribution and cut-off point between smokers and non-smokers in Korea. Cut-off point for urine cotinine, 53.0 ng/mL; ROC curve sensitivity, 97.1%, specificity, 95.1%.

secondhand smoke (King et al., 2012). Breathing secondhand smoke for even a short time can have immediate adverse effects on the cardiovascular system, interfering with the normal functioning of the heart, blood, and vascular systems in ways that increase the risk of heart attack (Mannino et al., 1997; Institute of Medicine, 2009; U.S. Department of Health and Human Services, 2014). Secondhand smoke contains numerous chemicals that can rapidly irritate and damage the lining of the airways. Even brief exposure can trigger respiratory symptoms, including cough, phlegm, wheezing, and breathlessness. Brief exposure to secondhand smoke can trigger an asthma attack in children with asthma. Infants who are exposed to secondhand smoke after birth are also at greater risk of SIDS (U.S. Department of Health and Human Services, 2006c). Children exposed to secondhand smoke are also at an increased risk for acute respiratory infections, ear problems, and more severe asthma. Smoking by parents causes respiratory symptoms and slows lung growth in their children (U.S. Department of Health and Human Services, 2006d).

In Korea, the National Health Promotion Act was enacted in 1995; it was revised a number of times to strengthen measures to reduce smoking levels. A revision in 2010 enabled local governments to designate certain areas within their jurisdiction where the public gather or travel as non-smoking zones. A revision in 2011 extended the range of smoke-free public facilities (Korean Ministry of Government Legislation, 2014a,b,c). Smoking restriction policies are closely related to smoking rates and subsequent secondhand smoking rates (Giovino et al., 2000; Sims et al., 2012). Comparing the changes in smoking policies in Korea with reports for other countries, this study examined changes in the urine cotinine concentration of Korean non-smokers and indirectly evaluated the effectiveness of Korean smoking policies using data from the first stage of the Korean National Environmental Health Survey conducted by the National Institute of Environmental Research (NIER) from 2009 to 2011.

Subjects and methods

Selection of the study population and data collection

The raw data were taken from the first stage of the Korean National Environmental Health Survey conducted by the NIER from 2009 to 2011 (Korean Ministry of Environment, 2011), which encompassed 6311 subjects (aged 19 or older) of 3413 households in 350 enumeration districts nationwide. The districts were selected based on the 2005 Population and Household Census by Statistics Korea.

Initially, 4853 of the potential 6311 subjects were selected by excluding 40 with missing data and 1418 who reported that they smoked. Then, 241 subjects were excluded because their urine cotinine concentrations were higher than the cut-off point (≥53.0 ng/mL), so they were considered as smokers. The remaining 4612 were the final subjects. The cut-off point (53.0 ng/mL) was determined using the Receiver Operating Characteristics (ROC) curve and had a sensitivity of 97.1% and specificity of 95.1% (Fig. 1).

Data on the subjects, including sex, age, residence type, alcohol consumption status, employment status, income (Korean Won/month), education (less than high school, High school, College or higher) and exposure status of secondhand smoke, are collected from an one-on-one interview with pre-training community surveyors using a structured questionnaire in the community health center. The subgroups in each category were classified in accordance with a guideline for the survey on the basis of the questionnaire. Age range of survey participants was aged 19 or older. Age groups were divided by 10 years. The residence types were classified as detached house, tenement (more than two detached houses together in lower than four-story building) and apartment complex. The alcohol consumption status was classified as drinkers and non-drinkers by a question "Do you drink?" The employment status was classified from the subjects' selection from the major categories of the sixth version of the Korean Standard Classification of Occupations (KSCO): those who answered to items numbered from 1 to 9 were considered as employed, while the remainders, except those in the armed forces, were considered as non-employed. The part-timers and casual workers are considered as full time workers. Current smokers were classified as those who regularly smoke at least one cigarette per a day or those whose urine cotinine concentrations are higher than the cut-off point (≥53.0 ng/mL) even if they were answered as non-smokers. Among the non-smokers, information concerning exposure to SHS was obtained by using one question: "Have you experienced inhalation of smoke from another person's cigarette (ETS exposure)?" Based on the answers, we classified the exposure to SHS: "No" classified as non-secondhand smokers and "Yes" considered as "secondhand smokers"