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The Environment Modifies the Relationship Between Social Networks and Secondhand Smoke Exposure Among Korean Nonsmokers in Seoul and California

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Abstract

This study compared risks of secondhand smoke exposure (SHSe) among Korean nonsmokers in Seoul, South Korea and California, United States. Social networks were hypothesized to contain more smokers in Seoul than in California, and smokers were hypothesized to produce more secondhand smoke in Seoul than California, as Seoul's policies and norms are less restrictive. Telephone interviews were conducted with Korean adults in Seoul (N = 500) and California (N = 2830). In all, 69% (95% confidence interval [CI] = 64-74) of Koreans and 31% (95% CI = 29-33) of Korean Americans reported any SHSe. A total of 44% (95% CI = 40-47) of Korean family members smoked versus 29% (95% CI = 28-30) of Korean American family members (t = 7.84, P < .01). A 25% to 75% increase in the proportion of family members that smoked corresponded with a 13% (95% CI = 5-21) higher probability of any SHSe among Koreans compared with 6% (95% CI = 2-10) among Korean Americans. Network interventions in combination with policies and/or health campaigns may help reduce SHSe globally.

Keywords

cross-cultural communication, smoke exposure, global health, population health, smoking/tobacco/drug abuse

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Introduction

Secondhand smoke exposure (SHSe) is a leading contributor to the global disease burden. About 603 000 deaths were attributed to secondhand smoke (SHS) worldwide in 2004, including 379 000 from ischemic heart disease, 165 000 from lower respiratory infections, 36 900 from asthma, and 21 400 from lung cancer.[1] This total represents approximately 1% of global mortality.[1] Evidence continues to strengthen between SHSe and numerous diseases.[2,3] Among lifetime nonsmokers, sufficient evidence exists to infer a causal relationship between SHSe and lung cancer.[2-5] The relationship between SHSe and breast cancer among younger, primarily premenopausal women who have never smoked is also consistent with causality.[3,5]

As the number of smokers in one's social network increases, it is plausible that SHSe will tend to increase. Tobacco control policies that restrict smoking to private spaces,[6] and health campaigns that move social norms to be less tolerant of public smoking,[7] have reduced SHSe in public places. At the same time, smokers who are increasingly restricted from smoking in public may smoke more in private places such as homes or cars, thereby exposing their social network members to similar levels of SHS. The ways in which social networks interact with tobacco control policies and social norms and how this interaction may be undermining the effectiveness of current SHSe abatement strategies has not been thoroughly explored. The South Korean and Korean American populations are ideal for evaluating this potential interaction as they respectively reside in regions with disparate tobacco control policies and social norms regarding smoking.

South Korea has an exceptionally high male smoking prevalence, 63% of South Korean men versus 4% of women.[8] The South Korean government owns and operates the tobacco market.[9] As a result, there are limited tobacco control policies.[10] The 1995 National Health Promotion Act, South Korea's first dedicated tobacco control policy, aimed to restrict public smoking,[11] but most provisions were poorly enforced.[10] South Korean social norms tacitly encourage smoking early in adulthood, especially among businessmen. As a result, nonsmokers, who are mostly women, are vulnerable to SHSe.[12]

There are more than 1.5 million Korean Americans living in the United States and approximately one fourth live in California,[13] where contrasts in smoking norms and policies are starkest. The 1988 California Tobacco Control Program (CTCP) provided comprehensive policy-oriented tobacco control. Californians also have the strongest antismoking sentiment,[14] and the second-lowest smoking prevalence in the United States.[15] Korean American men in California are less likely to smoke than their Korean counterparts, 31% versus 63%, although Korean American women smoke at similar rates, 4% respectively.[16]

Ecological frameworks[17] have promoted a multilevel perspective in preventive medicine by emphasizing mediating and moderating dynamics across levels of social aggregation and guide this investigation. First, social factors at lower levels of aggregation (proximal determinants) may mediate the association between social factors at higher levels of aggregation (distal determinants) and health. For example, immigration to California and exposure to California's tobacco control policies and antismoking social norms may reduce SHSe, but part of this reduction may be a result of smoking levels in an individual's social network being reduced as a consequence of penalties promoting cessation and expansion of an ego's network to include more nonsmokers. As a result, this study hypothesized that there would be less opportunity for exposure to SHS in California than in Seoul (hypothesis 1). Second, distal determinants may moderate more proximal determinants. For example, because there are stronger laws and social norms protecting nonsmokers from SHSe in California, social network members who smoke will not smoke as often in the presence of nonsmokers as they would in an environment that is more tolerant of (or amenable to) smoking such as Seoul. As a result, this study hypothesized that the same network smoking prevalence will be associated with more SHSe in Seoul than in California (hypothesis 2).

As power dynamics shift with immigration, so does risk of exposure to SHS. Korean and Asian cultures are generally hierarchical. In South Korea, elders occupy positions of high social status and youth have restricted autonomy, whereas in California relationships are more equitable. As a result, this study hypothesized when the smoker has relatively higher social power (eg, fathers vs sons) compared with nonsmokers, SHSe will be higher in Seoul (hypothesis 3).

Materials and Methods

Interviews were completed with 500 adults in Seoul. A random digit dial sample of numbers from the 27 telephone districts was produced by randomly sampling from directories proportional to the number of listings in each telephone region. A constant was then added to each number and the list was randomly sorted. Interviews were conducted by trained graduate students, supervised by a co-investigator, at Myongji University during 2002. Up to 5 callbacks were made until interviews were completed, the intended participant refused, or the number was found to be nonresidential. Sample demographics were representative for Seoul as detailed elsewhere.[18] The cooperation rate in Seoul was 41%.

Interviews were completed with 2830 Korean Americans in California. The sampling frame was drawn from telephone numbers associated with common Korean surnames (N = 108 843). The electronic list was purchased from a commercial firm and was initially derived from telephone directories, marketing registries and warranty cards. All respondents confirmed they were Korean. English or Korean was used during the interview based on the respondent's preference. Up to seven callbacks were made. The cooperation rate was 86%, and 90% of respondents were first-generation.

Respondents within each household were randomly selected using the most recent birthday procedure. Sample demographics were representative of Koreans in California as detailed elsewhere.[19] Institutional review boards at San Diego State University and Myongji University approved all study procedures.

Measures

The survey instruments were developed in English and translated into Korean with the assistance of co-investigators in Seoul and California. The process included repeated fore and back translations, focus groups, and questionnaire piloting.

Any SHSe and SHS volume—each respondent who answered "yes" to any SHSe was then asked "how many cigarettes are you exposed to in the home . . . in the car . . . at work . . . at other locations . . . during a typical day?"—which captured threshold and dose–response patterns. The measure of SHS volume was calculated as the sum across these reports following validated approaches.[20]

In egocentric network approaches, the respondent (or "ego") reports linkages to his or her social ties, with the sum of these ties comprising the network. A pregenerated list of familial relationships, for example, "do any of the following . . . eg, your spouse . . . your mother . . . currently smoke cigarettes" was used to ascertain individual ties. Family smoking models were measured by computing the proportion of smokers among all familial ties (familial network). Smoking dummy indicators were also computed for each relationship. Participants had a mean of 3.9 relationships in California and 3.8 in Seoul. Respondents also estimated whether "all, most, some, a few, or none" of their friends smoked, and responses were coded into 3 dummy variables for all/most, some/few, and none. The latter indicates the prevalence of smoking among friendship ties, which are more difficult to ascertain.

Statistical Analysis

Analyses were restricted to 334 nonsmokers (not having ever smoked 100 cigarettes and not currently smoking every day or some days) in Seoul and 2331 in California, since estimates of SHSe are confounded with self-reports of cigarettes smoked. Differences between Korean and Korean Americans' network characteristics were explored using independent 2-sample *t* tests assuming unequal variances; this analysis is in reference to hypothesis 1 that Korean and Korean Americans have different smoking patterns in their networks. Predictors of SHSe were evaluated for proportion of family members who smoke and which members of the family smoke (eg, father smokes or not) and friends' smoking behavior using separate logistic or least squares regression by sample and predictor, including adjustment for gender, education, and age. A Wald test of the null hypothesis for all the friends' smoking indicators was used in a single regression. A single equation with an interaction term by sample was used to test for differences in the associations between Seoul and California. This corresponds to hypothesis 2 that the same network smoking prevalence will be associated with more SHSe in Seoul than in California. Predictions for SHS volume (the self-reported number of cigarettes exposed to) were computed using a logarithmic transformation to constrain right skewness. Predicted probability of any SHSe or expected number of cigarettes exposed to were derived from each multivariable analysis by simulation using 1000 randomly drawn estimates from a sampling distribution with mean equal to the maximum likelihood point estimates and variance equal to the variance covariance matrix of the estimates, with covariates held at their mean values.[21]

Results

Secondhand smoke exposure was more common in Seoul. About 69% (95% confidence interval [CI] = 64-74) of Koreans and 31% (95% CI = 29-33) of Korean Americans reported any SHSe ($t = 13.88$, $P < .01$). Koreans with any SHSe were also exposed to more cigarettes ($t = 4.40$, $P < .01$) than Korean Americans, 4.87 (95% CI = 3.95-5.80) versus 2.66 (95% CI = 2.31-3.00) cigarettes per day (Table 1).

Opportunities for SHSe were higher in Seoul than California, consistent with hypothesis 1. About 44% (95% CI = 40-47) of Korean family members smoked versus 29% (95% CI = 28-30) of Korean Americans ($t = 7.84$, $P < .01$), and 16% (95% CI = 12-20) of Koreans reported all/most of their friends smoked versus 7% (95% CI = 6-8) among Korean Americans. Smoking among wives was rare and indistinguishable in Seoul and California ($t = 0.30$, $P < .76$), but smoking among husbands was common, 44% (95% CI = 36-51) in Seoul and 27% (95% CI = 24-29) in California.

Family Smoking Models Affect SHSe

Smoking in familial networks was associated with greater levels of SHSe among Koreans than among Korean Americans consistent with hypothesis 2. A change in the proportion of family members who smoke from 25% to 75% was associated with a 13% (95% CI = 5-20) higher probability of any SHSe among Koreans (Figure 1A). This association was 117% stronger among Koreans than among Korean Americans, as the expected increase in the probability of any SHSe was 6% (95% CI = 2-10) among Korean Americans. The same, 25% to 75%, increase in the proportion of family members who smoke was associated with exposure to 1.19 (95% CI = 0.69-1.73) more cigarettes on a typical day among Korean Americans (Figure 1B).

Table 1. Sample Characteristics.[a]

	Seoul, South Korea			California, United States		
	Mean	95% CI	n	Mean	95% CI	n
Any SHS exposure[b]	0.69	0.64, 0.74	334	0.31	0.29, 0.33	2339
SHS volume[b]	4.87	3.95, 5.80	230	2.66	2.31, 3.01	730
Smoking models[b]	0.44	0.41, 0.47	333	0.3	0.29, 0.31	2338
Husband[b]	0.44	0.36, 0.51	169	0.27	0.24, 0.30	1101
Wife	0.02	−0.02, 0.06	47	0.01	0.01, 0.02	749
Sibling[b]	0.53	0.47, 0.58	315	0.42	0.40, 0.44	2225
Grandparent[b]	0.54	0.47, 0.61	206	0.34	0.31, 0.36	1403
Parent[b]	0.54	0.48, 0.60	315	0.36	0.34, 0.38	2065
Son/daughter	0.21	0.16, 0.27	205	0.16	0.14, 0.17	1765
Friends smoking . . .						
None[b]	0.36	0.31, 0.41	332	0.47	0.45, 0.49	2322
A few/some	0.48	0.42, 0.53	332	0.46	0.44, 0.48	2322
Most/all[b]	0.16	0.12, 0.20	332	0.07	0.06, 0.08	2322
Male[b]	0.29	0.24, 0.34	334	0.39	0.37, 0.41	2339
Years of education[b]	12.85	12.49, 13.21	330	14.85	14.73, 14.97	2257
Age[b]	38.93	37.21, 4.66	334	48.29	47.66, 48.92	2337

Abbreviations: 95% CI, 95% confidence interval; SHS, secondhand smoke.
[a]Numbers in cells are means, associated 95% CIs, and useful sample size for each concept. SHS volume is the typical number of cigarettes to which respondents were exposed-at home, work, in the car, and other places based on self-reports.
[b]Significant differences in means between Seoul, South Korea and California, United States using independent 2-sample *t* tests assuming unequal variances; $P < .05$.

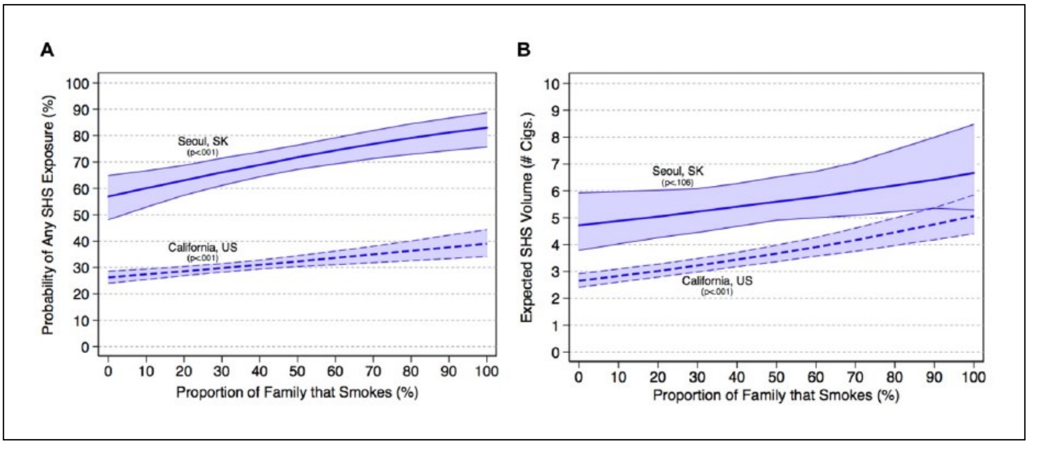

Figure 1. Family smoking models are associated with more secondhand smoke exposure (SHSe)
(A) The predicted probability of any SHSe and (B) the expected SHS volume among persons with any SHSe, with 95% confidence intervals by proportion of family that smokes, including adjustment by gender, age, and education held at their means.

Consistent with hypothesis 3, smokers with higher social power in Korea were associated with larger increases in SHSe than in California. Koreans who reported having smoking husbands, parents, and grandparents had a higher probability of any SHSe, ranging from 13% (95% CI = 1-26) to 18% (95% CI = 2-32) compared with those with husbands, parents, and

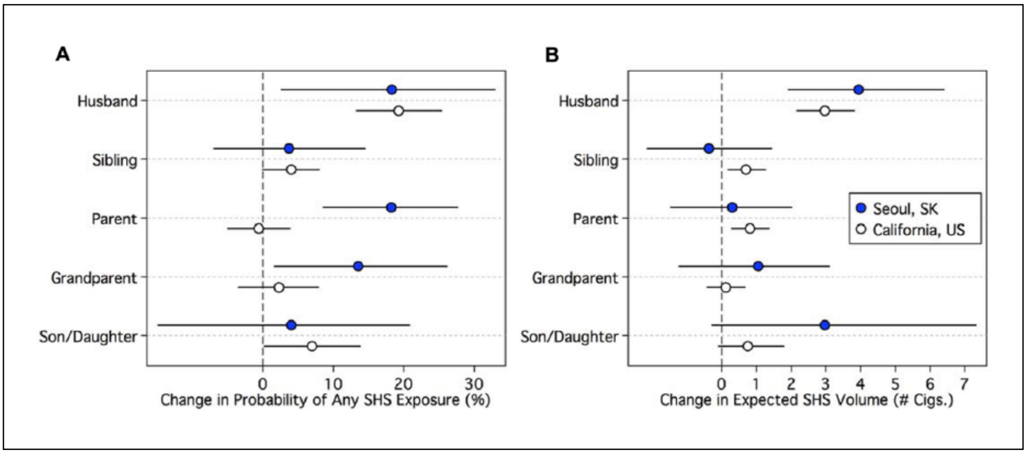

Figure 2. Dyadic patterns within family smoking models and secondhand smoke exposure (SHSe)
(A) The change in predicted probability of any SHSe and (B) the change in expected SHS volume among persons with any SHSe, with 95% confidence intervals by specific members of the family smoking versus not smoking, including adjustment by gender, age, and education held at their means. An overlapping confidence interval with zero indicates statistical insignificance.

grandparents who did not smoke. Korean Americans who reported having smoking husbands, siblings, and son/daughters had a higher probability of any SHSe, ranging from 7% (95% CI = 1-13) to 19% (95% CI = 13-25; Figure 2A) compared with those with husbands, siblings, and sons/daughters who did not smoke. Among Koreans with any SHSe, having smoking son/daughters and husbands were insignificantly associated with exposure to 2.97 (95% CI = −0.29 to 7.33, $P < .07$) and 3.94 (95% CI = 1.90-6.42) more cigarettes on a typical day (Figure 2B). Among Korean Americans, having smoking husbands, siblings, parents, and son/daughters ($P < .08$) were insignificantly associated with more SHS volume, ranging from 0.70 (95% CI = 0.17-1.27) to 2.97 (95% CI = 2.15-3.83) more cigarettes per day.

Friends' Smoking Influences on SHSe

Smoking among friends was associated with a higher probability of any SHSe and more SHS volume among both Koreans ($\chi^2_{(2)}$=5.83, $P < .05$; $\chi^2_{(2)}$=3.25, $P < .04$) and Korean Americans ($\chi^2_{(2)}$=48.00, $P < .01$; $\chi^2_{(2)}$=21.66, $P < .01$). Among Koreans, the probability of any SHSe when respondents had no smoking friends was about 61% (95% CI = 52-70) versus 73% (95% CI = 65-79) when some/few and 75% (95% CI = 63-85) when most/all of their friends smoked. Among Korean Americans, the probability of any SHSe when respondents had no smoking friends was 23% (95% CI = 20-26) versus 34% (95% CI = 31-37) when some/few and 48% (95% CI = 40-57) when most/all of their friends smoked (Figure 3A). If no friends smoked, Koreans were exposed to 4.56 (95% CI = 3.56-6.00) cigarettes per day versus 5.64 (95% CI = 4.50-7.01) when some/few and 7.33 (95% CI = 5.12-10.13) when most/all of their friends smoked (Figure 3B). The expected SHS volume for Korean Americans when respondents had no smoking friends was 2.76 (95% CI = 2.42-3.13) cigarettes per day versus 3.17 (95% CI = 2.84-3.48) when some/few and 5.61 (95% CI = 4.72-6.65) when most/all of their friends smoked. Consistent with hypothesized expectations (hypothesis 2), patterns of any SHSe ($z = 3.35$, $P < .01$) and SHS volume ($t = 5.89$, $P < .01$) differed so that any smoking among Koreans' friends were similarly associated with SHSe. A dose–response relationship was observed among Korean Americans' friends,

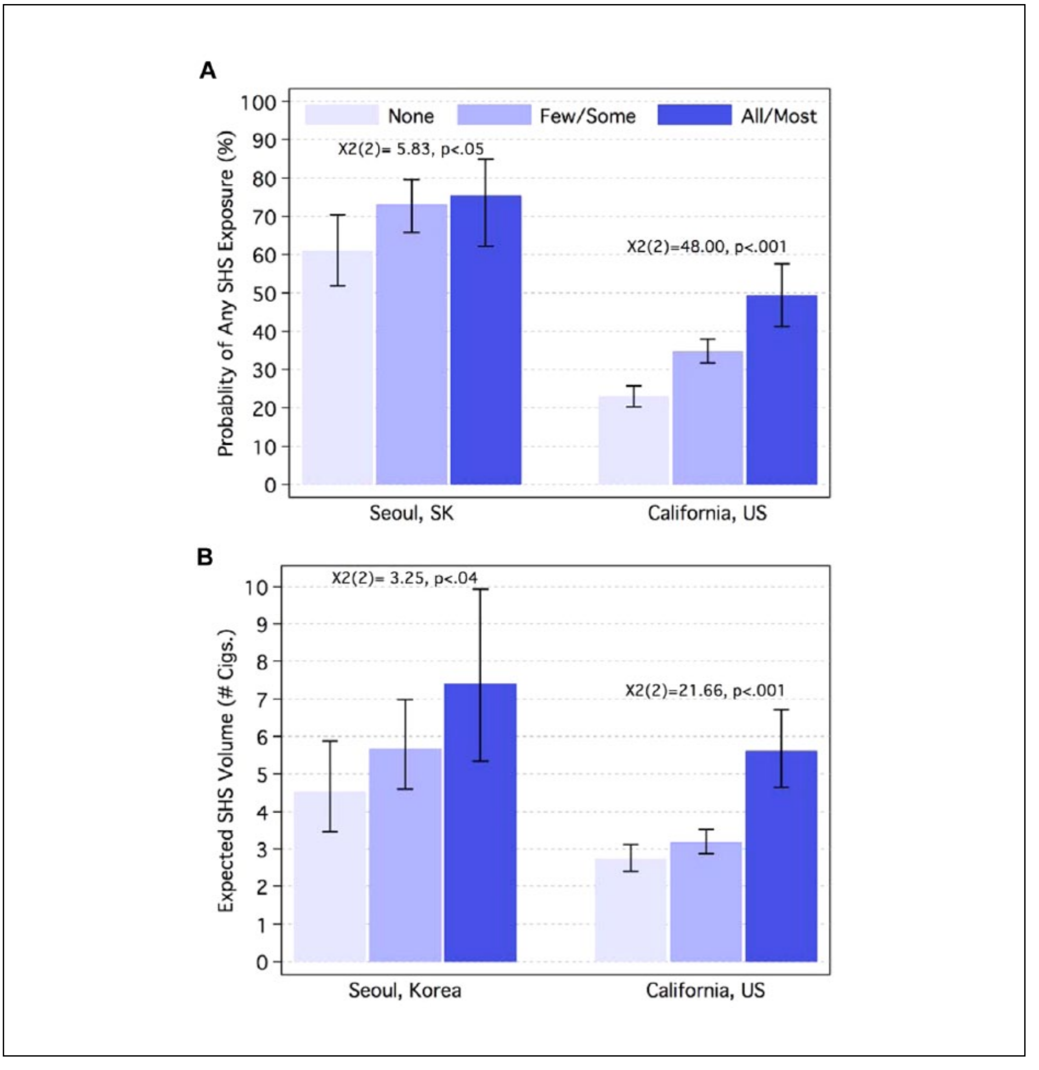

Figure 3. Friends' smoking is associated with more secondhand smoke exposure (SHSe)
(A) The predicted probability of any SHSe and (B) the expected SHS volume among persons with any SHSe, with 95% confidence intervals by self-reports of the amount of friends smoking, including adjustment by gender, age, and education held at their means.

suggesting exposure to California's tobacco control policies and nonsmoking social norms protected against a moderate prevalence of smoking among friends, whereas in Seoul, if some/few or most/all of their friends smoked, SHSe risk was equivalent among the groups.

Discussion

Ecological frameworks suggest that, in part, differences in SHSe between Seoul and California may be explained by how social networks interact with differences in tobacco control policies and social norms. Our results largely supported these claims. Consistent with hypothesis 1, smoking was much less common in Korean Americans' networks than in Koreans' networks. The associations between network smoking or friends' smoking and SHSe varied between Seoul and California consistent with hypothesis two, suggesting that smoking among Korean Americans was associated with smaller increases in SHSe than smoking among Koreans. Patterns suggest elders typically have more of an impact on SHSe among Koreans than Korean Americans, possibly a reflection of higher social power as hypothesized (hypothesis 3). This may be the result of cultural differences that afford greater respect for elders or other higher social power in Seoul than among those Korean Americans who have been acculturated to US (or California) norms.

The strengths of this study include a multisite design with consistent measurement of the microsocial environment. To our knowledge, the data in California were derived from the largest representative study of Korean Americans to date. This study also considered any SHSe and SHS volume indicators of SHSe risks. Limitations included self-reported data and a cross-sectional design. Network indicators also relied on a pregenerated list of familial ties. Although families are prominent, this precluded analysis of other relationships beyond the general description of friendships. Comparison of SHSe between Koreans in Seoul and California may be problematic. Koreans who immigrate likely differ from those who do not but sampling in Seoul, the primary source of Korean immigration, may control for these differences. The two samples significantly differed in important respects such as gender, age, and level of education. For example, respondents from the sample in Seoul were younger, less likely to be male, and had less education on average. These differences might affect network patterns. For example, Koreans who choose to immigrate could possibly be less likely to smoke, less likely to live with smokers, or less likely to live with elders. Adjusting for age, gender, and education in analysis likely minimized these limitations and should allow partial insight to how Korean networks will respond to further smoking restrictions in Korea. The results described herein should still be interpreted with caution and further research should be conducted to evaluate the quality of this study's inferences.

Ecological frameworks have been extensively researched, published, and discussed. These claim that the presence of health risk factors and their health impacts depend on the larger sociopolitical setting. This study attempted to empirically evaluate ecological claims through observation of social mechanisms and tested pathways consistent with differences in tobacco control policies and social norms. The stark contrast between environments in California and Seoul may have reduced Korean Americans' networks of smoking resulting in lower exposure to SHS and moderated the impact of smoking on SHSe.

Health researchers have previously focused on socioeconomic status and risk of SHSe among Korean Americans in California,[22] and Koreans in Seoul,[23] and suggested individuals with lower socioeconomic status are exposed to higher levels of SHS. These studies were conducted without regard to ecological frameworks, network pathways, and sociometry. Others have focused on Korean Americans' acculturation.[24] Acculturation, however, is the changing of attitudes, beliefs, and behaviors to be more consistent with the dominant culture. To draw inferences regarding Korean Americans' social environment, it is critical to make simultaneous assessment between South Koreans and their new home.

Associations between networks and health behaviors are increasingly common. Missing foremost, however, has been sufficient consideration of how networks vary across mezzo-social structures. Our findings suggest tobacco control policies and social norms promoted important health effects via the network. These patterns could not have been observed without simultaneous assessment of networks in Seoul and California. It is very likely exposure to the CTCP reduced opportunities for SHSe among familial smokers when their interaction occurred in public places governed by clean indoor air laws. Exposure to these policies and Californians' antismoking attitudes and norms may empower Korean Americans to ask that others not smoke around them, extending even to private settings. On the other hand, restricting people from smoking in public places could drive them to smoke more in private places, like homes, when they are often in the presence of family members. Interventions should be designed to reinforce the message that smoking in anyone's presence is unacceptable and can be deadly.[2]

South Korea was in the process of implementing stronger tobacco control policies at the time our data were collected. In 2005, the South Korean government ratified the World Health Organization Framework Convention on Tobacco Control.[25] Reforms included expansion of antismoking media campaigns, restrictions on tobacco advertising, plain packaging and graphic warning labels on cigarettes, clean indoor air provisions, and abolition of policies that give free, or discounted, cigarettes to military personnel. These policy changes may reduce the smoking prevalence in one's network. Research illustrated that only 19% of homes in Seoul had a complete smoking ban with 65% allowing smoking anywhere in the home.[26] Interventions should be designed first to foster voluntary complete home smoking bans that would ultimately lead to promoting comprehensive clean indoor air laws in South Korea. Training physicians in South Korea to promote smoke-free households during interactions with patients could prove effective in decreasing SHSe.[27] Evidence that smoke-free policies are supported and complied with across Asia suggests norms are changing to be more restrictive of smoking.[28] These restrictions could reduce SHSe in social networks as smokers could feel less comfortable smoking around network members who abstain from cigarettes. In this case, Korean networks might eventually reflect SHS levels more similar to those of Korean Americans.

Interventions focused on married couples are also needed. For example, Korean women with smoking husbands develop lung cancer at twice the rate of women not married to smokers.[29] We found that having a husband who smokes was associated with doubling the likelihood of any SHSe compared to any other relationship. This may stem from cohabitation but it may reflect gender inequality where Korean and Korean American men are in a dominant position to women.

Interventions should emphasize differences in tobacco control policies and social norms between California and South Korea among Korean Americans to clarify the message that smoking is an undesirable and dangerous behavior. Emphasizing change in proximal factors should prove compelling as Korean Americans become more aware of the health risks of smoking and SHSe. California has demonstrated success with advertising campaigns aimed at adults, encouraging them to protect their children from SHSe. A similar message could be directed toward Korean and Korean American men to protect their wives in addition to their children.

Previous social network studies showed that Korean men, compared with women, were 3 times more resistant to family and friends' cessation requests,[18] suggesting a risk of unabated SHSe in the face of smoking discouragement. Interventions must be culturally sensitive to ensure that nonsmokers can avoid exposure to smoke while also ensuring that the powerful, older male smokers do not lose face. Coaching youth to avoid SHSe has been effective in reducing SHSe.[30] Similar intervention strategies may work on both Korean and Korean American youth.

Conclusion

This study presented a partial test of ecological deductions in Seoul and California by outlining network pathways for California's progressive antismoking climate and the CTCP to reduce SHSe among Korean Americans relative to Koreans. Given the strong claims by ecological frameworks and these results, it may no longer be sufficient to focus on a single level of measurement in network studies. This is important for both egocentric and sociometric analyses. Studies should instead account for the upstream factors responsible for the composition of networks and their association with health outcomes. Such an agenda may prove valuable for advancing preventive medicine where access to data across multiple levels of social aggregation, from microgenetic factors to health policies, is rapidly increasing.

Declaration of Conflicting Interests

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