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Original Investigation

Predictors of smoking in cars with nonsmokers: Findings from the 2007 Wave of the International Tobacco Control Four Country Survey

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Abstract

Objective: This study examines the proportion and characteristics of smokers who smoke in cars with nonsmokers across four countries and the potentially modifiable correlates of this behavior.

Methods: Respondents included a total of 6,786 current adult smokers from Wave 6 (September 2007–February 2008) of the International Tobacco Control Four Country Survey, a random digit-dial telephone survey of nationally representative samples of adult smokers in Australia, the United Kingdom, Canada, and the United States.

Results: Reports of smoking in cars with nonsmokers ranged from a low of 29% in Australia and the United Kingdom, to 34% in Canada, and to a high of 44% in the United States. Daily smokers who were from the United States, male, and younger were the most likely to smoke in cars with nonsmokers. Several potentially modifiable factors were also found to be related to this behavior, including smoke-free homes and beliefs about the dangers of cigarette smoke exposure to nonsmokers.

Conclusions: A considerable proportion of smokers continue to smoke in cars with nonsmokers across the four countries, particularly in the United States. Public health campaigns should educate smokers about the hazards of cigarette smoke exposure and promote the need for smoke-free cars. These findings provide a foundation of evidence relevant for jurisdictions that are considering banning smoking in cars.

Introduction

As legislative bans on smoking in public and workplaces have become increasingly widespread in Australia, the United Kingdom, Canada, and the United States, exposure to cigarette smoke now largely occurs in private spaces, such as homes and vehicles (Cunningham, 2009; Cunningham & DeRosenroll, 2008). Numerous studies have now shown that smoking in cars produces dangerously high levels of cigarette smoke (Jones, Navas-Acien, Yuan, & Breysse, 2009; Ott, Klepeis, & Switzer, 2008; Rees & Connolly, 2006; Sendzik, Fong, Travers, & Hyland, 2009; Vardavas, Linardakis, & Kafatos, 2006). Research also shows that there is high public support for bans on smoking in cars carrying children, even among smokers themselves (Hitchman, Fong, Zanna, Hyland, & Basnal-Travers, 2009; Thomson & Wilson, 2008). Following these studies, as of January 2010, approximately 26 jurisdictions in Australia, Canada, and the United States have banned smoking in cars with children, and proposals are currently being considered to do so in the United Kingdom (Cunningham).

Although there have been some studies on smoking in cars with children, there are few that have examined smoking in cars with the broader group of nonsmokers and even fewer that examine the correlates of this behavior (Akhtar, Currie, Currie, & Haw, 2007; Haw & Gruer, 2007; Kegler & Malcoe, 2002; Leatherdale & Ahmed, 2009; Martin et al., 2006; Norman, Ribisl, Howard-Pitney, & Howard, 1999).

The present study aims to fill this research gap through its examination of (a) the number of smokers who smoke in cars with nonsmokers, (b) the characteristics of these smokers, and (c) the potentially modifiable correlates of this behavior. This study was conducted among nationally representative samples of smokers from the 2007 Wave of the International Tobacco Control Four Country Survey (ITC-4). The ITC-4 is a longitudinal cohort survey of adult smokers in Australia, the United Kingdom, Canada, and the United States that began in 2002 (Fong et al., 2006). Because our study included smokers from

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four countries, differences in the above across the four countries were also examined.

As previous studies using data from the ITC-4 Survey found that lighter smokers were more likely to have smoke-free homes and support banning smoking in cars with children, we tested if heaviness of smoking was related to smoking in cars with nonsmokers (Borland et al., 2006; Hitchman et al., 2009). We also tested if smoking in cars with nonsmokers was related to intentions to quit smoking.

In an effort to investigate strategies that could reduce smoking in cars with nonsmokers, we examined correlates of this behavior that could potentially be modified through public education campaigns and/or policy. Modifiable correlates examined included presence of a comprehensive smoke-free law, presence of a law banning smoking in cars with children, knowledge and beliefs about the dangers of cigarette smoke exposure, and smoking rules in the home.

Following previous studies using the ITC-4 dataset that examined correlates of smoke-free homes and support for banning smoking in cars with children, we hypothesized that smokers from the United States and smokers who lived in jurisdictions with no comprehensive smoke-free laws would be the most likely to smoke in cars with nonsmokers (Borland et al., 2006; Hitchman et al., 2009). Following research among smokers in the European Union (EU), we predicted that men would be more likely to smoke in cars with nonsmokers than women (European Commission, 2007). Because we expected a gender difference, we examined if there were any gender differences in characteristics of smokers who smoked in cars with nonsmokers.

Methods

Respondents

A total of 6,786 (sample sizes appearing in text are unweighted) current smokers were selected from Wave 6 of the ITC-4 Survey. Wave 6 was conducted between September 2007 and February 2008, with a response rate of 23.3% and a cooperation rate of 77%. Response rates were calculated using American Association for Public Opinion Research (AAPOR) RR4 2.30. Cooperation rates were calculated using AAPOR COOP4. Selected respondents included Australia (1,767), the United Kingdom (1,597), Canada (1,692), and the United States (1,719). Characteristics of respondents are presented in column 1 of Table 1. The ITC-4 Survey received ethical review and clearance from the Institutional Review Boards or Research Ethics Boards at The Cancer Council Victoria (Australia), Roswell Park Cancer Institute (USA), The University of Illinois at Chicago (USA), University of Waterloo (Canada), University of Stirling (UK), and The University of Nottingham (UK). More details on the ITC Project may be found elsewhere (Fong et al., 2006; Thompson et al., 2006).

Measures

Smoking in cars with nonsmokers

This was assessed by the following question: "When you are in a car or other private vehicle with nonsmokers, do you smoke as you normally smoke, never smoke, or something in-between?" For the main analysis, we coded smokers who said that they smoke as they normally smoke or something in-between as "smoke in cars with nonsmokers" and those who said that they never do as "never smoke in cars with nonsmokers." Frequencies for the breakdown of the three responses are also presented.

Characteristics of respondents

Data on respondents' sex, age, majority/minority group, income, education, and geographic region within country were collected. Ethnicity was measured using procedures similar to each country's census; in the United Kingdom, Canada, and the United States, ethnicity was defined as majority (White) and minority (non-White). In Australia, minority group was defined as language other than English spoken in the home. For respondents in Australia, Canada, and the United States, income was categorized as low = under $30,000, moderate = $30,000–$59,999, and high = $60,000 or higher. For respondents in the United Kingdom, income was categorized as low = less than £30,000, moderate = £30,000–£44,999, and high = £45,000 or higher. Education was standardized as low = high school or less; medium = technical, trade school, community college (some or completed), or some university; and high = at least a university degree. To determine the presence of children, respondents were asked if any children under the age of 18 years lived in their household.

Heaviness of Smoking Index

Heaviness of Smoking Index (HSI) is a seven-category variable that measures low to high nicotine dependence. In accordance with standard procedures, HSI was created by summing two categorical variables: cigarettes/day (0–10, 11–20, 21–30, and >30) and minutes to first cigarette after waking (5 or less, 6–30, 31–60, and >60; Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989).

Intentions to quit smoking

Intentions to quit were measured by asking respondents if they had plans to quit smoking in the next 30 days, the next 6 months, sometime beyond 6 months, or if they had no plans at all to quit.

Cigarette smoke is dangerous to nonsmokers

We asked respondents to indicate their agreement with the statement "Cigarette smoke is dangerous to nonsmokers." The variable was coded as belief that it was dangerous (strongly agree and agree) and belief that it was not (neither agree or disagree, disagree, and strongly disagree).

Secondhand smoke causes lung cancer in nonsmokers

We asked respondents, "Based on what you know or believe, does secondhand smoke cause lung cancer in nonsmokers." Response options were yes or no.

Smoking rules in the home

We asked respondents, "Which of the following best describes smoking inside your home?" Response options were, smoking is allowed anywhere in your home, smoking is never allowed anywhere in your home, and something in-between.

Comprehensive smoke-free laws

Smokers who lived in a state/province/region that had a comprehensive smoke-free law for the entire duration of the survey period were coded as living in a jurisdiction with a comprehensive smoke-free law. A comprehensive smoke-free law was defined as a

Table 1. Characteristics of smokers who smoke in cars with nonsmokers (*N* = 6,755)[a]

Variable	Sample characteristics *n* (%)	% Smoke in cars with nonsmokers	*OR*	95% *CI* of *OR*	*p*
Country					
United Kingdom	1,618 (24)	29	1.00	1.00	Ref
Australia	1,752 (26)	29	1.06	0.87–1.28	.57
Canada	1,684 (25)	34	1.32	1.08–1.60	.0058
United States	1,701 (25)	44	2.12	1.36–1.77	<.0001
Sex					
Female	3,167 (47)	29	1.00	1.00	Ref
Male	3,588 (53)	39	1.55	1.36–1.77	<.0001
Age (years)					
55+	1,596 (24)	24	1.00	1.00	Ref
40–54	2,412 (36)	32	1.47	1.26–1.73	<.0001
25–39	2,173 (32)	39	2.20	1.81–2.67	<.0001
18–24	574 (8)	53	3.94	2.90–5.37	<.0001
Minority status					
Majority	5,977 (88)	34	1.00	1.00	Ref
Minority	778 (12)	35	0.90	1.36–1.77	.33
Education					
Low	3,405 (51)	34	1.00	1.00	Ref
Moderate	2,189 (32)	36	0.99	0.85–1.16	.92
High	1,161 (17)	32	0.89	0.73–1.09	.25
Income					
Low	1,787 (26)	33	1.00	1.00	Ref
Moderate	2,231 (33)	34	0.96	0.81–1.14	.56
High	2,300 (34)	35	0.95	0.79–1.14	.61
No answer	437 (7)	34	1.11	0.86–1.44	.43
Smoking status					
Daily	6,358 (94)	35	1.00	1.00	Ref
Weekly	331 (5)	21	0.41	0.29–0.58	<.0001
Monthly	66 (1)	17	0.33	0.15–0.73	.0065
Children under 18 in the home					
Yes	2,718 (40)	37	1.00	1.00	Ref
No	4,037 (60)	32	0.96	0.83–1.12	.60

Note. *OR* = odds ratio.

[a]All frequencies and data are weighted.

law that bans smoking in public and workplaces with no exemptions. Comprehensive smoke-free laws existed in 7/8 states/territories in Australia (no law in Northern Territory), in all 16 U.K. government regions, in 7/10 provinces in Canada (no laws in Alberta, British Colombia, and Prince Edward Island), and in 18/51 states in the United States (Cunningham & DeRosenroll, 2008). States covered by comprehensive smoke-free laws in the United States included California, Delaware, New York, Maine, Connecticut, Massachusetts, Rhode Island, Vermont, Washington, New Jersey, Colorado, Hawaii, Ohio, Arizona, New Mexico, New Hampshire, and Minnesota. Because presence of a comprehensive smoke-free law is highly associated with country, we also examined the effect of living in a state with a comprehensive smoke-free law among respondents from the United States only.

Laws to ban smoking in cars with children

Because South Australia was the only jurisdiction with a sufficient sample size that had a law banning smoking in cars with children for the entire duration of the survey period (put into enforcement 3 months before surveying), we limited our examination of the effect of such laws to Australia.

Statistical analyses and missing data

SAS v. 9.1 was used to conduct all statistical analyses. The SAS PROCSURVEY LOGISTIC procedure was used to conduct all logistic regression analyses. All variables were treated as categorical with the exception of HSI. The SAS PROC SURVEYFREQ procedure was used to calculate weighted frequency data. All analyses and frequency lists use data weighted on age, sex, and region. For analytic purposes, the weights were rescaled to sum to national sample sizes. Interactions were tested in logistic regression using the method described by Jaccard (2001). Missing data, refusals, and "don't know" responses led to the deletion of 113 cases. Respondents who refused to give their income were retained in a no answer category. In cases where there were a significant number of "don't know" responses or the response "don't know" had significance (health knowledge), "don't know" responses were retained.

Results

Reports of smoking in cars with nonsmokers

Reports ranged from a low of 29% in Australia and the United Kingdom, to 34% in Canada, and to a high of 44% in the United States (never smoke in cars with nonsmokers vs. something in-between/smoke as normal). A full breakdown of the three responses by country is presented in Table 2.

Characteristics of smokers who smoke in cars with nonsmokers across the four countries

In the adjusted logistic regression analysis controlling for demographics, smoking status, and children under 18 in the home, respondents who were from the United States, younger, male, and daily smokers were found to be the most likely to smoke in cars with nonsmokers. These results are presented in Table 1. Adjusted logistic regression analyses of all cross-country comparisons showed that reports of smoking in cars with nonsmokers varied significantly for all comparisons at the $p = .05$ level, with the exception of the United Kingdom and Australia.

HSI and quit intentions

Controlling for respondent characteristics, heavier smokers and those with weaker intentions to quit were found to be more likely to smoke in cars with nonsmokers. These results are presented in Table 3.

Modifiable correlates

Controlling for respondent characteristics, HSI, and quit intentions, we examined if each of the modifiable correlates were related to smoking in cars with nonsmokers in separate logistic regression analyses. These analyses showed that respondents who lived in jurisdictions without a comprehensive smoke-free law, who did not believe that cigarette smoke was dangerous to nonsmokers and could cause lung cancer, and who did not have a smoke-free home were more likely to smoke in cars with nonsmokers. These results are presented in Table 4.

To further examine the effect of living in a jurisdiction with a comprehensive smoke-free law, we ran a second analysis to examine the effect of living in a state with a comprehensive smoke-free law in the United States only, where fewer than 50% of the states had a comprehensive smoke-free law. Controlling for respondent characteristics, HSI, and quit intentions, the previous significant effect of living in a state with a comprehensive smoke-free law on smoking in cars with nonsmokers was reduced to a weak trend, $p = .24$, odds ratio (OR) = 1.18. Forty-one percent of smokers living in states with comprehensive smoke-free laws versus 46% living in states without comprehensive smoke-free laws reported smoking in cars with nonsmokers.

Country and gender differences in smokers who smoke in cars with nonsmokers

We ran all gender by predictor variable and all country by predictor variable interactions in logistic regression to test if predictors of smoking in cars with nonsmokers differed by country or by gender. No significant gender or country interactions were found. A significant country by smoking status interaction was found, $p < .0001$; however, the low number of weekly ($n = 312$) and monthly smokers ($n = 63$) in our sample precluded any meaningful analyses.

Bans on smoking in cars with children

The Australian state of South Australia, the only jurisdiction to ban smoking in cars at the time of the survey, was compared with other Australian states where no such laws existed. Controlling for respondent characteristics, HSI, and quit intentions, no differences in reports of smoking in cars with nonsmokers were found between South Australia and the rest of the Australia, $p = .72$, $OR = 0.92$.

Discussion

Reports of smoking in cars with nonsmokers ranged from a low of 29% in Australia and the United Kingdom, to 34% in Canada, and to a high of 44% in the United States. The lower reports of smoking in cars with nonsmokers in Australia and the United Kingdom could be due to widespread comprehensive smoke-free laws in both countries, along with Australia's long history of advocacy for banning smoking in cars with children and lower dependence on car use in the United Kingdom compared with the other three countries (as measured by use in large cities; Kenworthy & Laube, 1999). The relatively higher reports of smoking in cars with nonsmokers in the United States could be due to higher car dependence and the United States's lower frequency of comprehensive smoke-free laws—at the time of

Table 2. Smokers' reports of smoking in cars with nonsmokers: breakdown of responses ($N = 6,755$)[a]

Country	*n*	% Never smoke	% Smoke as normal	% Something in-between
United Kingdom	1,618	71	5	23
Australia	1,752	71	4	25
Canada	1,684	66	3	31
United States	1,701	56	6	38

Note. [a]Frequencies are weighted.

Table 3. Smoking behavior correlates of smoking in cars with nonsmokers (*N* = 6,755)[a,b]

Variable	Sample characteristics *n* (%)	% Smoke in cars with nonsmokers	*OR*	95% *CI* of *OR*	*p*
Intentions to quit					
In the next 30 days	758 (11)	29	1.00	1.00	Ref
In the next 6 months	1,459 (22)	30	1.06	0.82–1.37	.67
Sometime beyond 6 months	2,511 (37)	34	1.15	0.91–1.46	.23
Not planning to quit	1,947 (29)	39	1.52	1.19–1.94	.0008
Do not know	80 (1)	34	1.42	0.83–2.43	.21
Heaviness of Smoking Index					
0—low dependence	831 (12)	22	1.33	1.26–1.39	<.0001
1	760 (11)	24			
2	1,285 (19)	29			
3	1,864 (28)	36			
4	1,241 (19)	43			
5	566 (8)	46			
6—high dependence	208 (3)	50			

Note. OR = odds ratio.
[a]All frequencies and data are weighted.
[b]Adjusted for demographics in Table 1.

the survey, fewer than 50% of states were covered by comprehensive smoke-free laws, in contrast to nearly 100% of the three other countries (Kenworthy & Laube).

Across the four countries, men were more likely to smoke in cars with nonsmokers than women, replicating a finding from a study of smokers in the EU (European Commission, 2007). It may be that women are more conscientious of exposing nonsmokers to cigarette smoke, particularly if the nonsmokers are children, or that men travel less in cars with children than women. Younger smokers were also more likely to smoke in cars with nonsmokers. The same EU study similarly found that younger smokers were more likely to smoke in cars with nonsmokers (European Commission). Young adults' higher reports of smoking in cars with nonsmokers may be a result of more time spent in cars with a variety of peer group members, as opposed to family members and children. No relation was found between education and income and smoking in cars with nonsmokers.

Table 4. Potentially modifiable correlates of smoking in cars with nonsmokers (*N* = 6,755)[a,b,c]

Variable	Sample characteristics *n* (%)	% Smoke in cars with nonsmokers	*OR*	95% *CI* of *OR*	*p*
Believe that cigarette smoke is dangerous to nonsmokers					
Yes	5,491 (81)	32	1.00	1.00	Ref
No	1,188 (18)	42	1.61	1.35–1.92	<.0001
Do not know	76 (1)	32	1.16	0.67–2.03	.59
Smoking policy at home					
Smoking never allowed anywhere	2,558 (38)	25	1.00	1.00	Ref
Smoking allowed anywhere	1,963 (29)	42	2.28	1.87–2.78	<.0001
Something in-between	2,234 (33)	37	2.03	1.70–2.43	<.0001
Live in state/province with comprehensive smoke-free law					
Yes	5,315 (79)	31	1.00	1.00	Ref
No	1,440 (21)	44	1.24	1.00–1.53	.05
Believe that secondhand smoke causes lung cancer in nonsmokers					
Yes	5,180 (77)	33	1.00	1.00	Ref
No	1,210 (18)	40	1.39	1.16–1.67	.0003
Do not know	365 (5)	31	1.02	0.77–1.35	.91

Note. OR = odds ratio.
[a]All frequencies and data are weighted.
[b]Adjusted for demographics in Table 1 and smoking behavior variables in Table 3.
[c]Modifiable correlates examined independently of each other.

In contrast, an observational study in New Zealand found that smokers in cars in highly deprived areas were more likely to smoke in the presence of nonsmokers (Martin et al., 2006). The finding that those with and without children are just as likely to smoke in cars with nonsmokers follows a study of 6,985 adults in the state of California that found that the presence of children in the home did not predict car smoking bans for smokers (Norman et al., 1999).

Following our prediction, we found that heavier smokers with weaker intentions to quit were more likely to smoke in cars with nonsmokers, as were daily smokers. This finding is consistent with a study of smokers in the EU that showed that daily smokers and those who smoke more cigarettes per day are more likely to smoke in cars with nonsmokers, and a study of smokers in the United States that found that smokers who smoked 10 or more cigarettes/day were less likely to have car smoking restrictions (European Commission, 2007; Kegler & Malcoe, 2002).

For modifiable correlates, we found that smokers who did not believe cigarette smoke was dangerous and could cause lung cancer in nonsmokers were more likely to smoke in cars with nonsmokers. This is consistent with a previous study using the 2002 and 2003 waves of the ITC-4 Survey that showed that smokers who believe that cigarette smoke exposure is dangerous to nonsmokers are more likely to have smoke-free homes (Borland et al., 2006). We also found that smokers who allowed smoking in their homes were more likely to smoke in cars with nonsmokers. This replicates a finding from an ITC-4 Survey 2002–2003 study (Borland et al.). Smokers who lived in jurisdictions without comprehensive smoke-free laws were also more likely to smoke in cars with nonsmokers across the four countries. However, when we looked within the United States, we found no significant effect of statewide comprehensive smoke-free laws. Our analyses were complicated by the fact that (a) some municipalities within provinces/states had their own comprehensive smoke-free laws, (b) presence/absence of comprehensive smoke-free laws was highly correlated with country of residence, and (c) states/provinces had laws in place for varying lengths of time (anywhere from at the outset of survey to more than 5 years before the survey), this weakens the strength of conclusions that can be drawn. Additionally, a 2007 longitudinal study conducted in Scotland found no changes in nonsmoking adults and children's exposure to cigarette smoke in cars after the introduction of comprehensive smoke-free legislation (Akhtar et al., 2007; Haw & Gruer, 2007). However, the utility of comprehensive smoke-free legislation for promoting smoke-free cars should not be discounted; previous studies have linked comprehensive smoke-free legislation with the implementation of smoke-free homes, and our study found that smokers with smoke-free homes are less likely to smoke in cars with nonsmokers (Borland et al.). Additionally, as demonstrated here, the countries with the most widespread comprehensive smoke-free laws and tobacco control programs have the lowest reports of smoking in cars with nonsmokers. Thus, it may be that societal norms are more important than the presence of legislation. No effect of a law banning smoking in cars with children in South Australia was found on reports of smoking in cars with nonsmokers across the Australian states. This may be because we did not specifically ask about when in cars with children.

A possible further limitation of this study is that it relied on self-reports of smoking in cars with nonsmokers. However, studies that examined the validity of self-report as a measure of children's exposure to tobacco smoke, a behavior that would seem even less socially desirable than smoking around nonsmokers, have found that self-reports are valid indictors of the actual level of smoking (Hovell, Zakarian, Wahlgren, Matt, & Emmons, 2000). Significant predictors of smoking in cars with nonsmokers can only said to be correlational as this study used cross-sectional data. We also do not know how often the respondents traveled in cars; thus, some of the effects could be due to those who rarely or never travel in cars saying that they never smoke rather than those who travel a lot and refrain. We also did not ascertain whether respondents' car smoking policies varied depending on whether they were the driver or a passenger or whether the nonsmoking passengers were adults or children.

Conclusions

A sizeable proportion of smokers continue to smoke in cars with nonsmokers across the four countries, particularly in the United States. To reduce nonsmokers' exposure to cigarette smoke in cars, public health campaigns should educate smokers about the dangers of cigarette smoke and promote the need for 100% smoke-free private homes and cars. These campaigns could also consider addressing barriers in implementing car smoking bans as identified by a previous research study, such as how to discuss the ban with the smoker and the false belief that it is safe to smoke if a window is open (Kegler, Escoffery, & Butler, 2008).

Furthermore, the strong guidelines of Article 8 of the *World Health Organization's Framework Convention on Tobacco Control* (2007) encourage the Parties to expand the scope of smoke-free legislation to encompass other locations where the evidence warrants protection World Health Organization (2007). As such, the results of this study in combination with others showing the hazards of cigarette smoke exposure in cars could be used to lend support to legislation banning smoking in cars (Jones et al., 2009; Ott et al., 2008; Rees & Connolly, 2006; Sendzik et al., 2009; Vardavas et al., 2006).

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Declaration of Interests

None declared.

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