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Voluntary Smoking Restrictions: Promises and Challenges in Protecting Nonsmokers

A dissertation submitted in partial satisfaction of the requirements
for the degree of Doctor of Philosophy

in

Public Health (Health Behavior)

by

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The Dissertation of Romina Anne Africa Romero is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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DEDICATION

I dedicate this dissertation to my husband and children.

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2. Penelope J.E. Quintana, PhD, MPH, Georg E. Matt, PhD, Dale A. Chatfield, PhD, Addie L. Brewer, MS, **Romina A. Romero**, **MPH**, Mauricio G. Aguilar Partida, Joy M. Zakarian, MPH. Tobacco smoke pollution of rental cars: air concentrations of nicotine and 3-EP. American Public Health Association, Philadelphia, PA, November 7-11, 2009.

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ABSTRACT OF THE DISSERTATION

Voluntary Smoking Restrictions: Promises and Challenges in Protecting Nonsmokers

by

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Doctor of Philosophy in Public Health (Health Behavior)

University of California, San Diego, 2014
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Background: Adoption of voluntary smoking restrictions continues to increase in US private households and the hospitality industry. Unfortunately, discrepancies regarding their scope, implementation, and enforcement exist, potentially compromising their impact on lowering nonsmokers' exposure to tobacco smoke toxicants. The objective of this dissertation was to examine the role of

voluntary smoking restrictions on reducing secondhand smoke (SHS) and thirdhand smoke (THS) exposure of nonsmokers in private settings.

Methods: Data for this dissertation were taken from three separate existing studies conducted in San Diego, CA, examining (1) SHS exposure among pre-teens (Chapter 2, N=388 families), (2) THS pollution of private homes (Chapter 3, N=100 homes), and (3) smoking policy of rental car companies (Chapter 4, N=6 national companies with N=125 local branches). Data for Chapter 2 were examined using multinomial logistic regression to examine the circumstances under which parent/child dyads agreed on a smoking ban. Data for Chapter 3 were examined using multinomial logistic regression to investigate the role of smoking restrictions and behaviors on THS pollutants in dust and on surfaces. Data for Chapter 4 were examined to describe smoking policies at the corporate level and explore their implementation in local branches.

Results: In Chapter 2, 18.3% of dyads disagreed on the presence of a complete smoking ban. Factors that contributed to this disagreement included residents' smoking behaviors and parents inconsistently asking visitors to smoke outside. In Chapter 3, home smoking rules and compliance with rules were found to affect indoor smoking rates, which in turn influenced THS contamination in dust and on surface. Other factors that impacted THS in dust were home features and remediation efforts. In Chapter 4, four of the six national rental car companies reported an official smoking policy. Lack of training and communication to local branch staff resulted in poor implementation of the official company smoking policies and failure to protect customers from THS exposure.

Discussion: Private indoor settings remain the primary location for exposure to tobacco smoke pollutants for nonsmokers. Voluntary smoking restrictions in private settings can reduce THS contamination and exposure. Residents and management need to define, communicate, and consistently implement smoking restrictions to ensure a true smoke-free environment.

CHAPTER 1

Introduction

Between 2005 and 2012, smoking rates among United States (US) adults declined from 20.1% to 18.1%.[1] Despite declining smoking rates, however, millions of nonsmokers, including children, are still exposed to tobacco smoke emission[2-4]. In 2008, the Centers for Disease Control estimated that 88 million individuals age three and older were exposed to secondhand smoke (SHS).[5] Exposure to SHS remains a considerable source of indoor air contaminants. Healthy People 2020 (HP2020) objectives include reducing exposure to SHS to 38 percent, 41 percent, and 47 percent for adult, 12 to 17 year old, and 3 to 11 year old nonsmokers, respectively.[6] In recent years, several studies[7-10] have drawn attention to tobacco smoke pollutants that remain in indoor environments which may lead to exposure long after cigarettes have been smoked. Also known as thirdhand smoke (THS), this mixture of tobacco smoke toxicants may pose a health risk[11] in addition to those of secondhand smoke exposure[12].

Tobacco smoke emission and secondhand smoke

Cigarette smoke is a complex mixture of thousands of chemicals and remains a considerable source of indoor air pollution.[13] It is comprised of mainstream and sidestream smoke. SHS is derived predominantly from sidestream smoke, but also includes exhaled mainstream smoke and compounds that diffuse through the cigarette wrapper. SHS is chemically and physically distinct from its sidestream precursor due to chemical and physical transformations that occur through mixture and aging.[14] Major components of SHS include: very volatile organic compounds (i.e.

formaldehyde), volatile organic compounds (i.e. N,N-nitrosodimethylamine), semivolatile organic compounds (i.e. nicotine), particulate organic compounds (i.e. benzo[a]pyrene), and gas-phase inorganic compounds (i.e. NH_3).[8]

Home exposure remains the primary source of SHS exposure for nonsmokers. Children are at particular risk because they spend 80% of their time indoors at home.[15] SHS exposure occurs through the involuntary inhalation of sidestream and exhaled mainstream smoke.[12] According to the US Surgeon General, there is no risk-free level of exposure to SHS. Even short exposures to SHS produces pathophysiological changes in adults that increase the risk of a heart attack, result in upper airway changes, and increase asthma attacks in children.[16] Exposure to SHS has been linked to disease and premature death in both adults and children nonsmokers. In nonsmoking adults, exposure has increased the risk of developing heart disease by 15-30 percent[16,17] and of developing lung cancer by 20-30 percent[16].

Thirdhand Smoke

THS is a combination of chemicals that are sorbed and deposited onto surfaces and dust after tobacco has been smoked and then are re-emitted or re-suspended back into the air.[12] Known constituents include: nicotine, 3-ethenylpyridine (3-EP), phenol, cresols, naphthalene, formaldehyde, and tobacco- specific nitrosamines.[12] Tobacco smoke adsorbs into carpets, walls, and fabrics, deposits on surfaces, and accumulates in dust within minutes of emission. Desorption of sorbed vapors occurs hours to weeks post smoking.[8,18] Therefore, nonsmokers may be indirectly exposed to chemicals found in THS long after a cigarette has been smoked.[19] Investigators found that

nicotine contamination in the home reflected current and long-term smoking behavior.[10,19-22]

Human exposure to THS in the microenvironment of homes and cars may occur in a variety of ways such as involuntary inhalation, ingestion, and dermal absorption. Young children are disproportionally at risk for exposure in the home due to their behavioral development and activity level. Children, especially infants and toddlers, spend most of their day indoors at home[23] and are thus more likely to be exposed to indoor contaminants. Hand-to-mouth and object-to-mouth behaviors contribute to indoor contaminant exposure through ingestion, as does infrequent hand washing before food handling and consumption.[24] Also, dermal contact with contaminated surfaces add to the exposure.

Few studies have examined the health effects of THS. Sleiman and colleagues investigated the reaction between nicotine in THS and ambient nitrous acid that led to the production of carcinogenic byproducts. Investigators reported the formation of three tobacco-specific nitrosamines (TSNA), which are potent human carcinogens in unburned tobacco and tobacco smoke.[11] Rehan and colleagues further examined the effects of TSNAs on the developing lung. Their research indicate that 1-(N-methyl-N-nitrosamino)-1-(3-pyridinyl)-4-butanal (NNA), or 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) affected the pathway to signal transduction, regulation of phospholipid and protein synthesis, and cell differentiation leading to pulmonary damage in utero.[25] Additionally, Hang and colleagues found evidence that NNA leads to oxidative stress in human cell lines, suggesting that exposure to THS is genotoxic to human cells.[26] A recent study by Martins-Green revealed that THS affects multiple

organ systems such as the lungs, liver, and skin in animal models, and also contributes to behavioral changes.[27]

Smoking rules and restrictions

Nationwide, smoke-free laws are implemented to protect employees and the public from SHS exposure. Smoke-free laws are those that prohibit smoking in many indoor areas in private workplaces, restaurants, and bars.[28] Restrictions and prohibitions vary in type (e.g., restaurants, bars, private workplaces, or combination of the three), spatial coverage (e.g., indoor, outdoor, within 20 feet of entrances), and largely depend on the jurisdictions enacting the law.[29]

Zhang and colleagues reported that the adoption rate of complete home smoking bans by smoking families increased from 58.1% to 83.3% between 1995 and 2007.[3] Investigators have shown that the presence of young children and nonsmokers[30] as well as the belief that SHS exposure is bad for the health[31] affect the adoption and implementation of home smoking restrictions. Findings by Chen and colleagues show that smoke-free laws had a positive effect on the adoption of smoking restrictions in private residences.[32] Home smoking bans have been reported to increase quit attempts, decrease smoking rates among adults[33] and prevent smoking initiation among teens[34,35].

Unlike workplace and public spaces, smoke-free private homes cannot be mandated by law. Rather, the home's residents must establish them or they are introduced by property management. Home smoking rules refer to a range of informal agreements that restrict who, when, and where tobacco may be smoked with the goal to reduce involuntary exposure of SHS.[16] Public indoor air laws are explicit and have

defined consequences for their violation. In contrast, the scope and nature of home smoking rules[36,37], their implementation, and enforcement[38,39] vary by residence, change over time, and may depend on a variety of circumstances (e.g., persons present, weather). Kegler and colleagues[38] reported that in homes with all nonsmokers, there was an implicit understanding among residents that the home is a nonsmoker home. However, in homes with both smokers and nonsmokers, the decision to restrict smoking was complicated with factors such as who in the household smoked, the reasons for adopting restrictions, and was sometimes met with compromises, disagreement, and tension in some households.[38]

Behavioral Ecological Model

An ecological perspective uses a multifactorial, comprehensive approach to understand the complexity of health behaviors. Specifically, the Behavioral Ecological Model (BEM) acknowledges hierarchical contingencies that impact health behaviors, and ultimately, health outcomes. The BEM posits that behavior occurs in recurring patterns in structured environmental contexts, within which certain social roles and situational conditions disproportionately influence behaviors.[40]The BEM provides the theoretical framework guiding this dissertation.

The BEM focuses on individual interactions with their physical and sociocultural surroundings. Factors that affect all aspects of a health problem not only interact, but are interdependent on each other. According to the BEM, behavior affects and is affected by multiple levels of influence and behavior shapes and is shaped by the environment.[40] The four levels of influence are: (1) individual, (2) local, (3) community, and (4) social/cultural.[40] Individual factors that affect behavior include a

person's knowledge, attitudes, beliefs, and personality traits. Local level factors are those outside of an individual and include relationships with family, friends, neighbors, and colleagues, as well as the built environment. These relationships are essential aspects of social identity and provide important social resources to fulfill social and personal obligations and responsibilities. Community factors are social institutions with organizational characteristics, and formal (and informal) rules and regulations (i.e., policies, laws, media). Social/cultural factors are nationality and culture.[40]

According to the BEM, behavior is influenced by meta-contingencies (i.e. home smoking restriction). A meta-contingency consists of the cultural context, a product created by the group's interlocking behaviors, and selection of the product by an audience.[40] The relationship between people and their environment is dynamic and reciprocal. Wherein individuals are influenced by their surrounding, they in turn have the ability to influence their environment as individuals or as a collective. In the case of smoking restrictions, the anti-tobacco culture creates a desire to implement restrictions for the protection of nonsmokers. Household residents, for example, work together to establish a smoke-free home. Success of the restriction depends upon how well residents abide by the restriction and reinforce one another in its implementation.

Objectives

The following chapters examine correlates and consequences of smoking restrictions in different contexts in San Diego, CA. Chapter 2 investigates reports of home smoking restrictions by residents and characterizes households in which discrepant reports occurred. This chapter examines resident features and behaviors that

affect agreement about the presence of a home smoking ban between pre-teens and their parents. Chapter 3 studies the role of smoking restrictions on THS contamination in smoker homes. Factors that contribute to THS pollution, such as home features, resident smoking behavior, and preventive and remediation efforts, are explored. While Chapters 2 and 3 deal with voluntary smoking restrictions in private homes, Chapter 4 examines smoking policies of rental car companies. This chapter describes the different types of smoking policies developed by six major rental car companies in the US, their implementation in local branches, and their outcomes for customers renting vehicles.

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CHAPTER 2

Do Pre-teens and Parents Agree on Home Smoking Bans?

Abstract

Background: Adoption of voluntary home smoking bans continues to increase in US households. Unfortunately, discrepancies regarding their presence exist among household members. Such disagreements compromise the potential benefits of smoking bans because they interfere with implementation of a ban. The objectives of this study were to: 1) characterize households by smoking ban agreement, and 2) predict which households will disagree about the presence of smoking bans in their homes.

Methods: Data for this study were taken from a randomized controlled trial for SHS reduction in San Diego, CA, between 2004 and 2007. A parent/child dyad was recruited to participate in the study if there was a child 8 to 13 years of age and at least one smoker residing in the home. Research assistants conducted interviews about demographics, tobacco use, SHS exposure, opinions about SHS, and home smoking practices and policies. Multinomial logistic regression was used to identify characteristics of households that agreed or disagreed on the presence of a complete home smoking ban.

Results: Of the 388 dyads who completed the interview, 47.4% agreed on the presence of a complete home smoking ban, 31.2% agreed that there was no complete ban, and 18.3% disagreed on the presence of a home smoking ban. Logistic regression analysis revealed that parent employment and smoking behavior, other residents

smoking inside the home, and parent asking visitors to smoke outside were associated with report agreement.

Conclusion: Researchers interested in investigating home smoking rules should take into account reports by other residents to obtain an accurate account of the home's smoking restrictions.

Introduction

The rate of secondhand smoke exposure (SHS) for nonsmokers declined in the US in the last few decades, particularly for minors.[1] Notwithstanding the decline, the home continues to be the main source of SHS exposure for minors.[1] Despite progress in lowering children's SHS exposure, children residing in smoker homes still have higher cotinine levels than children living in nonsmoker homes.[2] Indoor smoking, lack of home smoking restrictions, inconsistent implementation of home smoking restrictions, and thirdhand smoke may contribute to these persistent exposure patterns.

Home smoking restrictions are voluntary and informal rules established by household residents to reduce indoor smoking and reduce involuntary exposure of secondhand smoke.[2] In contrast to public indoor air prohibitions that are explicit and have defined consequences for their violation, home smoking rules are often poorly defined, communicated, and enforced in homes. Home smoking rules offer some protection from SHS exposure to nonsmokers and children,[2,3] and adoption rates continue to increase in US households[4,5]. It is not entirely clear what prompts parents to implement restrictions on indoor smoking, but early research in this area indicated that parents try to protect their offspring at the most vulnerable stage.[6] Adoption of home smoking restrictions might also be influenced by and parallel larger social

trends, such as smoke-free laws[7] that restrict smoking at work or in public places adopted at the local or state levels.

According to the Behavioral Ecological Model, interlocking contingencies of smoking, from distal (i.e. cigarette sales tax) to proximal (i.e. physiological reaction to nicotine), influence smoking and SHS exposure.[8] Home smoking restrictions are meta-contingencies that guide resident behavior regarding home tobacco use. As such, the behavior of both smoker and nonsmoker reinforce one another and ultimately affect the implementation of the restrictions and play an important role in their success. For example, in comparing households of residents with differing addiction levels, a home with a resident who is highly addicted to cigarettes will be more likely to bend the rules than a resident of a different household with a less severe addiction. Other residents may deem noncompliance to the rules as a sign that there are no restrictions in place.

Past investigations of home smoking rules focused on a single resident's report of type of restrictions and their enforcement. Little has been done to record and examine multiple residents' reports of their home restrictions. Studies suggested that information from a single household member may not accurately provide the entire picture[9] and that information obtained from a second household member provides relevant data on both the children's secondhand smoke exposure and enforcement of a home smoking ban[10]. Mumford and colleagues found that in 1998, members from 12% of households provided inconsistent reports on home smoking ban.[11] Zhang and colleagues confirmed this finding and who discovered a general trend suggesting a significant decrease in report disagreement between parents from 12.5% to 4.6%

between 1995 and 2007.[5] Factors such as race/ethnicity, education, household composition (i.e. number of smokers and children)[11,12], and smoking behavior[11] predicted inconsistent reporting among household members.

Few studies examined report consistencies between an adult and child resident of the same household. Ding and colleagues found that compared to two adult residents, parent and child residents had a higher rate of discrepant report, with 19% of households disagreeing on the presence of a home smoking ban. Investigators found that SHS exposure of children from households with discrepant reports fell between those from homes that agreed on a complete ban and agreed on the lack of a complete ban.[10] Similarly, Nowatzki and colleagues found discrepant reports between parents and adolescent residents, in that parents reported a complete smoking ban and the youth indicated otherwise.[9]

Despite increasing adoption of home smoking restrictions, particularly a complete ban, discrepancies in reporting exist among household members. Thus, it is possible that children living in a home with a complete smoking ban are not entirely protected from SHS exposure. To better understand which households will provide inconsistent reports, I sought to investigate the characteristics of households with discrepant reports. The objectives of this study were to 1) characterize households by smoking ban report agreement and 2) predict which households disagreed about the presence of smoking bans in their homes.

Methods

Participants

Data for this study were taken from a randomized controlled trial for SHS reduction conducted in San Diego, CA. Detailed information on participant recruitment and eligibility can be found in Hovell and colleagues 2011[13]. Briefly, families were recruited as a convenience sample from various local sources between 2004 and 2007. A parent/child dyad was recruited to participate in the study if there was a child 8 to 13 years of age and at least one smoker residing in the home. Of the 18,673 local contacts made, 1,837 families were eligible, and n=388 completed the baseline interview that was used for this study. The parent and child completed interviews separately.

Measures

Demographic and Household information

Demographic information about both parent and child were obtained from the parent questionnaire. Household information such as income, number of residents under 18 years old, number of smoker residents, type of housing situation, and waking hours spent with the child were included in the analysis.

Home smoking rules

Household smoking rules were measured by asking both the parent and child about the types of smoking rules or restrictions in their household. Participants were asked to choose among the following responses: “Smoking is allowed anytime,” “Smoking is ok only for some people, places, or time,” and “No one is allowed to smoke inside, ever.” Previous studies suggest that a partial restriction is not as effective in preventing SHS exposure as a complete ban.[14-17] Therefore, the variable was dichotomized into Complete ban (no one allowed to smoke anytime) and No ban

(all other cases).

Frequency of rules being broken

Parents who reported having any kind of restrictions were asked a follow up question regarding how often home smoking rules were broken. Respondents who said that smoking was allowed any time in the home skipped this item. Therefore, those who said that rules were never broken were combined with respondents who stated that smoking was allowed any time to reduce data loss. Had these respondents not been included in the analysis, about 13% of cases would have been excluded. The final variable was dichotomized into Never broken and Broken due to small cell sizes.

Other residents smoking inside

Respondents were asked if other residents smoked inside the house. Parents were asked to choose from "Yes" and "No," while children were asked about the frequency of indoor smoking, ranging from "A lot" to "Some" and "Not much/none." A variable was created which combined the dyad's responses. The item was categorized into No, Yes, and Discrepant. Respondents were included in the discrepant category if the parent and child responses did not agree (i.e., parent said yes and child said not much/none, and vice-versa).

Asking visitors to smoke outside

All parents were asked how often they asked visitors to smoke outside of their home regardless of whether or not they reported having a smoking ban.

Agreement in reports of home smoking ban

Recorded responses for home smoking restrictions by the parent and child were compared. Report agreement by each parent/child dyad was classified into three

categories: Agree – Complete ban, Agree – No ban, and Disagree. The Agree – Complete ban category consisted of dyads for which both parent and child reported the presence of a complete ban. Likewise, parent/child dyads who reported either no restriction or a partial restriction were categorized into the Agree – No ban. If the parent and child did not agree on the type of home smoking restrictions present in their home, they were categorized in the category Disagree.

Smoking behavior

Two variables were combined to create a smoking behavior variable: parent smoking status and home smoking location. Respondents were categorized as current smokers if they stated they had smoked in the past 30 days.[18] Current smokers were then asked about the frequency of smoking outside when smoking at home. The final variable describing parent smoking status had three levels: Nonsmoker, Smoker, smokes outside, and Smoker, smokes inside.

The child was asked about his/her smoking behavior. None of the children reported smoking in the past 30 days, therefore, this variable was dichotomized to never tried or tried smoking.

Data Analysis

Data were checked for entry errors and missing responses prior to statistical analysis. Some responses were aggregated due to small sample sizes and were recoded for data analysis. Chi square test was conducted to examine differences in participant characteristics across the three home smoking ban report agreement categories. Statistically significant differences and associations at the bivariate level were entered into multinomial logistic regression to predict home smoking ban agreement reporting.

For multinomial logistic regression analysis, the Disagree category was used as the reference group and compared to Agree groups.[5] Odds ratios and 95% confidence intervals were used to determine the significance of a particular variable. All statistical analyses were conducted with SPSS v19.0.0 software.[19]

Results

Participant and household characteristics

Respondents were predominantly the biological mother (84.0%) of the child, with a mean age of 36.6 years, and 67.8% were current smokers. A little over 50 percent of children were females (53.9%) and most never tried smoking (91.5%). The majority of participants rented their home (67.5%), lived with two or more children (58.5%), and a little less than half of all households had two or more resident smokers (43.6%). (Data not shown.)

Report agreement and demographics

Of the 388 families who completed the baseline survey, 184 (47.4%) parent/child dyads agreed on the presence of a complete home smoking ban, 121 (31.2%) agreed on the absence of a complete ban, and 71 (18.3%) had discordant reports of a home smoking ban. Table 2.1 displays participant demographics and household characteristics across the three home ban report agreement categories. Of all variables examined, a few emerged as significant at the bivariate level. The parent's ethnicity/race and employment status was significantly associated with report agreement. Similarly, the child's ethnicity/race and smoking status was significantly associated with report agreement. None of the household variables had a significant relationship with report agreement.

Report agreement and smoking-related practices at home

Parent smoking status

Table 2.2 shows the association between smoking-related behaviors and practices at home and home smoking ban report agreement. All variables significantly correlated with report agreement. With respect to the parent's smoking behavior, a higher proportion of dyads agreed on the presence of a complete ban in households where the parent was a nonsmoker (62.8%) or a current smoker who smoked outside the home (46.8%). Conversely, households where the parent was a current smoker who smoked inside the house had a higher proportion of dyads who agreed on the absence of a complete ban (68.6%) or disagreed about home restriction (17.1%) compared to agreed on the presence of a complete ban (14.3%) (data not shown).

Other smoker residents

Parent/child dyads were asked if other residents smoked inside the home. A little over half of the dyads (55.1%) reported that other residents did not smoke inside the home (data not shown). For dyads who agreed on the absence of a complete ban, 16.5% reported no other residents smoked inside the home, 37.2% reported other residents smoked inside, and 46.3% had discrepant reports. Over half of the dyads (54.9%) that disagreed on a complete home ban reported other residents did not smoke inside the home, compared to only 16.9% that reported seeing other residents smoke inside. In households that agreed on a complete ban, 80.4% of dyads reported no other residents smoked inside the home, 6.0% reported yes, and 13.6% had discrepant reports.

Visitor smoking

Parents were asked about their frequency of asking smoker visitors to smoke outside the home. Overall, a higher percentage of parents reported always asking visitors to smoke outside (58.6%) compared to only asking occasionally (23.5%) and never asking at all (17.9%) (data not shown). In the Agree – No ban category, equal percentages of parents reported always asking and never asking visitors to smoke outside (29.8%). In household that disagreed on the presence of a home smoking ban, more parents (54.9%) always asked visitors to smoke outside compared to occasionally asking (28.2%) and never asking (16.9%). Of respondents in the Agree – Complete ban category, 79.1% of parents reported always asking visitors to smoke outside, while the same number of parents occasionally and never asked visitors to smoke outside.

Rule compliance

The frequency of rules broken was divided between never broken and broken across report agreement. Slightly more parents within the Agree – No ban and Agree – Complete ban categories reported home smoking rules were never broken, 52.9% and 61.4%, respectively. Whereas a little less than half (49.3%) of parents in the Disagree category said home smoking rules in their home were never broken.

Predicting discrepant reporting

Results of the multinomial logistic regression analysis are shown in Table 2.3. Of all variables significant at the bivariate level, parent's employment and smoking-related practices predicted the report category into which households were classified. Parental employment was statistically significant when comparing Agree – Complete ban and Disagree households but not for Agree – No Ban and Disagree households.

Households with an employed parent were twice as likely as households with an unemployed parents to agree that a complete ban was in place than to disagree (OR=2.08, 95% CI =1.12, 3.85).

Smoking-related practices were significant for both comparison groups, but parental smoking status was only significant for the Agree – Complete ban and Disagree comparison. Households with nonsmoker parents were five times more likely than households with parent smokers who smoke inside to be in the Agree – Complete ban category than Disagree (OR=5.23, 95% CI =1.18, 23.14). Parents who were current smokers, regardless of where they smoked, did not significantly differentiate between Agree – Complete ban and Disagree categories. Households where no other residents smoke inside the home were more likely to disagree about a home smoking ban than households with discrepant reporting of other residents' indoor smoking (OR=0.24, 95% CI=0.09, 0.64). Similarly, households with other residents who smoke inside the home were more likely to disagree about a home smoking ban compared to households with discrepant resident indoor smoking (OR=0.31, 95% CI=0.15, 0.66). Households where parents never (OR=0.33, 95% CI=0.13, 0.81) or only occasionally (OR=0.27, 95% CI=0.12, 0.60) ask visitors to smoke outside the home were also more likely to disagree on the presence of a complete home ban compared to household where parents always ask visitors to smoke outside.

As for placement in either Agree – No ban or Disagree categories, only two smoking-related practices predicted group assignment. Households of dyads who reported no other residents smoke inside were six times more likely than households with discordant reporting of resident smoking to agree there is no home smoking ban

than disagree (OR=6.23, 95% CI=2.54, 15.26). Households of dyads who reported other residents smoke inside were four times more likely than households with discordant reporting of resident smoking to agree there is no home smoking ban than disagree (OR=4.91, 95% CI=2.22, 10.87). Also, household where parents never ask visitors to smoke outside were three times more likely than households where parents always ask visitors to smoke outside to agree there is no complete ban than disagree (OR=3.46, 95% CI=1.36, 8.80).

Discussion

Significance

This study examined resident and household features associated with report agreement of home smoking rules and which factors were predictive of discrepant reports. To our knowledge, this is the first study to characterize households of parents with preteen youth that have discrepant reports of home smoking bans. Our findings suggest that resident characteristics such as race/ethnicity, parental employment, and child's smoking status were significantly associated with report agreement. Not surprisingly, parent and resident smoking-related practices were significantly associated with whether a parent/child dyad agreed that a complete ban was present, absent, or if they disagreed, and predicted discrepant reporting.

In comparing Disagree households to Agree – No ban households, only two variables were significant. Households where other residents smoked inside the home and parent never asking visitors to smoke outside were more likely to agree on the lack of a complete ban than disagree on the presence of a ban. Both of these variables

were significant in both models (Agree – Full ban vs. Disagree and Agree – No ban vs. Disagree), indicative of their importance as strong predictors of report agreement.

Unlike previous studies, household demographics and composition did not predict report agreement in this study. Zhang and colleagues found that Hispanic parents were more likely to provide discordant reports than agree to a lack of complete ban compared to other ethnicities.[12] Likewise, Mumford and colleagues found that non-white households were more likely to have discordant reports.[11] Although race/ethnicity was highly correlated with report agreement at the bivariate level, the relationship did not reach significance in the regression model that adjusted for other factors. This relationship may be confounded by other factors such as education, number of children, etc.. Other demographic features such as education[11,12] and number of children residents[11] were predictive of discordant reports in previous studies but not in the current one. Also, previous investigators reported that smoking status of residents were influential in predicting home bans.[11,12] This study's inclusion criteria required that at least one member of the household be a current smoker. Therefore, I could not determine if households of solely none or former smokers had concordant or discordant report.

Moreover, this paper further explored resident smoking practices beyond smoking status compared to extant literature. Households where smoking parents smoked outside of the home were five times more likely to agree on the presence of a complete ban than disagree. The practice of parental outdoor smoking combined with child observation of parent following rules support the presence of a complete ban, and led to consistent reporting. On the other hand, households where other residents

smoked inside the home and parents never or only occasionally asked visitors to smoke outside were more likely to disagree on a home ban. Evidence suggests that children observe indoor smoking by other residents more often than parents.[9] Therefore, observing different behaviors from different adults regarding rule compliance can confuse residents, particularly children, and may lead to discrepant reporting.

Limitations

This study was subject to several limitations. Data used for this study were from the baseline assessment for an intervention study to decrease SHS exposure among youth. This limits inferences about generalizability because the current study does not include the full range of nonsmokers, smokers, and kids who do and don't smoke but those recruited to meet specific criteria. Inherent skip patterns in the questionnaire led to missing data for particular variables of interest. Although methods were employed to retain as many cases as possible (i.e. combining survey items to create a new variable as in the case of parent smoke behavior) to reduce this loss, analysis of individual survey items was not possible.

Implication for future research

Researchers interested in investigating home smoking restrictions should take into account reports by other residents. A second reporter sheds light into the complexities of home smoking restrictions in the home. Interview of a second resident can support or contradict the type of smoking restriction in place and success of implementation and enforcement reported by the first interviewee. Studies in which only one resident was interviewed may not give an accurate account of the true

restriction in the home, potentially overestimating the prevalence of home bans, and the protection afforded by the bans to nonsmokers.

Examination of smoking behavior, in particularly in relation to smoking restrictions, implementation, and enforcement should be studied. This information exceeds residents' current smoking status and type of smoking restriction in the home, and provides insight to how well restrictions work, as well as the challenges and barriers to their success. Additionally, they can inform researchers and public health practitioners of potential targets for intervention.

This paper also illustrates less than perfect meta-contingencies across the families participating. Families that are in agreement about no smoking in the home are theoretically most likely to successfully enforce such a rule (or family policy). Concordance about a complete home ban implies such agreement, probable enforcement regardless which family members are home when a visitor or family member begins to smoke in the home, etc. Discordance suggests that the level of agreement and ease of enforcement is compromised for some smokers (i.e., grandmother is exempt) and/or for some observers (i.e., smokers) from the family group. This inference warrants more systematic assessments of the degree to which family members reinforce one another for adherence to the home ban, including restricting visitors from smoking in the home. Verification could provide support for (or weaken support for) meta-contingencies as a functional explanation of coherent group behavior that leads to a defined outcome or product (e.g. smoke free home).

Of course, more precise assessment of agreements and disagreements for home smoking bans remains warranted as well. If one member of the family detects a

smoker but no others were present to confirm the same violation in the smoking ban, it may lead to controversy about the degree to which there is a full ban. It is also possible that one member might see a cigarette butt in the home and assume this represented a violation of the ban, while others did not see it or did not agree that it was sufficient evidence to assume less than a full ban, etc. Future studies should endeavor to increase the objective measures of smoking in the home, perhaps by use of technology[20] as doing so might also increase honest reports from family members tempted to bend the truth.

Finally, while meta-contingencies newly established or always present in a given family might make home bans more successful, it is not clear how these complex contingencies arise and are sustained. Future studies should track families with and without (apparent) complete bans on smoking in the home in order to determine the events that compromise a complete ban and those that might enhance a ban to the level of completeness.

Chapter 2, in part, is currently being prepared for submission for publication to Nicotine Tobacco Research. Romero RA, Ding D, Matt GE, Quintana PJE, Chambers T, Finlayson T, Hovell MF. Do Teens and Parents Agree on Home Smoking Bans? The dissertation author was the primary investigator and author of this paper. The research was supported by National Institutes of Health grant HL066307 (MFH) and by discretionary funds from the Center for Behavioral Epidemiology and Community Health (MFH, Director).

Table 2.1. Comparison of participant and household characteristics by report agreement

Characteristics	Home Ban Report Agreement		
	Agree - No ban n (%)	**Disagree n (%)**	**Agree – Full ban n (%)**
	Parent		
Mean Age	37.31	36.41	36.14
Race/Ethnicity***			
Hispanic	32 (26.4)	29 (40.8)	95 (51.6)
Non-Hispanic White	40 (33.1)	20 (28.2)	41 (22.3)
Non-Hispanic Black	41 (33.9)	14 (19.7)	33 (17.9)
Non-Hispanic Other[a]	8 (6.6)	8 (11.3)	15 (8.2)
Education			
High school or less	53 (43.8)	38 (53.5)	91(49.5)
High school graduate	68 (56.2)	33 (46.5)	93 (50.5)
Marital status			
Married/living with partner	59 (48.8)	44 (62.0)	108 (58.7)
Other	62 (51.2)	27 (38.0)	76 (41.3)
Employment*			
Not employed	69 (57.0)	45 (63.4)	87 (47.3)
Employed	52 (43.0)	26 (36.6)	97 (52.7)
	Child		
Sex			
Male	65 (53.7)	37 (52.1)	76 (41.3)
Female	56 (46.3)	34 (47.9)	108 (58.7)
Age			
8 to 9	31 (25.6)	29 (40.8)	64 (34.8)
10 to 11	52 (43.0)	20 (28.2)	73 (39.7)
12-13	38 (31.4)	22 (31.0)	47 (25.6)
Race/Ethnicity***			
Hispanic	38 (31.4)	32 (45.1)	104 (56.5)
Non-Hispanic White	27 (22.3)	12 (16.9)	28 (15.2)
Non-Hispanic Black	40 (33.1)	13 (18.3)	32 (17.4)
Non-Hispanic Other[a]	16 (13.2)	14 (19.7)	20 (10.9)
Asthma/Reactive airway disease			
No	89 (74.2)	50 (70.4)	132 (71.7)
Yes	31 (25.8)	21 (29.6)	51 (27.9)
Smoking status**			
Never tried	102 (84.3)	67 (94.4)	174 (94.6)
Tried	19 (15.7)	4 (5.6)	10 (5.4)

[a] "Other" includes: Native American, Asian, Pacific Islander, mixed, unspecified

* $p<0.05$, ** $p<0.01$, *** $p<0.001$ Chi-square

Table 2.1. Comparison of participant and household characteristics across report agreement *(Continued)*

Characteristics	Home Ban Report Agreement		
	Agree - No ban n (%)	**Disagree n (%)**	**Agree - Full ban n (%)**
	Household		
Household income			
<$20,000	60 (49.6)	32 (45.1)	75 (40.8)
$20,000 - <$40,000	43 (35.5)	25 (35.2)	64 (34.8)
$40,000+	18 (14.9)	14 (19.7)	45 (24.5)
Housing status			
Own home	10 (8.3)	9 (12.7)	23 (12.5)
Rent	85 (70.2)	47 (66.2)	123 (66.8)
Other	26 (21.5)	15 (21.1)	38 (20.7)
# of residents <18year old			
1	19 (15.7)	6 (8.5)	24 (13.0)
2-3	61 (50.4)	47 (66.2)	109 (52.2)
4+	41 (33.9)	18 (25.4)	51 (27.7)
# of smoker residents			
0	4 (3.3)	2 (2.8)	14 (7.6)
1	60 (49.6)	35 (49.3)	97 (52.7)
2+	57 (47.1)	34 (47.9)	73 (39.7)
Mean number of waking hours spent with child at home			
Weekday	7.03	7.05	6.57
Weekend	12.05	12.17	12.0

Table 2.2. Parent smoking-related practices at home by report agreement

Characteristics	Home Ban Report Agreement		
	Agree - No ban n (%)	**Disagree n (%)**	**Agree - Full ban n (%)**
Parent smoking behavior***			
Nonsmoker	27 (22.3)	18 (25.4)	76 (41.3)
Smoker, smokes outside	70 (57.9)	47 (66.2)	103 (56.0)
Smoker, smokes inside	24 (19.8)	6 (8.5)	5 (2.7)
Other residents smoke inside the home***			
No	20 (16.5)	39 (54.9)	148 (80.4)
Yes	45 (37.2)	12 (16.9)	11 (6.0)
Discrepant	56 (46.3)	20 (28.2)	25 (13.6)
Frequency of parent asking visitors to smoke outside***			
Never	36 (29.8)	12 (16.9)	19 (10.4)
Occasionally	49 (40.5)	20 (28.2)	19 (10.4)
Always	36 (29.8)	39 (54.9)	144 (79.1)
Frequency of rules broken***			
Never	64 (52.9)	35 (49.3)	113 (61.4)
Broken	57 (47.1)	36 (50.7)	71 (38.6)

*** $p<0.001$ Chi-square

Table 2.3. Predictors of home smoking ban report agreement

Characteristics	Home Ban Report Agreement	
	Agree – No ban[a] OR (95% CI)	**Agree – Full ban[a] OR (95% CI)**
Parent race/ethnicity		
Non-Hispanic White	Ref	Ref
Hispanic	0.48 (0.12, 1.91)	1.11 (0.35, 3.58)
Non-Hispanic Black	1.53 (0.19, 12.67)	1.08 (0.16, 7.28)
Non-Hispanic Other	0.93 (0.22, 3.91)	1.29 (0.33, 5.01)
Employment		
Not employed	Ref	Ref
Employed	1.51 (0.77, 2.98)	2.08 (1.12, 3.85)
Child race/ethnicity		
Non-Hispanic White	Ref	Ref
Hispanic	0.91 (0.22, 3.87)	1.64 (0.46, 5.86)
Non-Hispanic Black	0.74 (0.07, 7.09)	1.38 (0.17, 11.06)
Non-Hispanic Other	0.59 (0.16, 2.17)	0.53 (0.14, 2.02)
Child smoking status		
Never tried	Ref	Ref
Tried	3.26 (0.96, 11.04)	1.06 (0.28, 3.99)
Parent smoking behavior		
Nonsmoker	Ref	Ref
Smoker, smokes outside	0.57 (0.17, 1.94)	5.23 (1.18, 23.14)
Smoker, smokes inside	0.64 (0.21, 1.96)	2.03 (0.49, 8.45)
Other residents smoke inside the home		
No	Ref	Ref
Yes	6.23 (2.54, 15.26)	0.24 (0.09, 0.64)
Discrepant	4.91 (2.22, 10.87)	0.31 (0.15, 0.66)
Frequency of parent asking visitors to smoke outside		
Never	3.46 (1.36, 8.80)	0.33 (0.13, 0.81)
Occasionally	1.80 (0.82, 3.91)	0.27 (0.12, 0.60)
Always	Ref	Ref

[a]Disagree is the referent category.

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CHAPTER 3

Do Voluntary Smoking Restrictions Affect Thirdhand Smoke Pollution in the Home?

Abstract

Introduction: Thirdhand smoke (THS) is the persistent and toxic residue of secondhand tobacco smoke pollutants left on surfaces, in dust, and re-emitted into air. THS contains toxic chemicals like tobacco-specific nitrosamines and is likely to present the highest exposure risk to children. THS has been demonstrated to persist in homes over time. The objective of this analysis was to determine the effect of home smoking restrictions on THS contamination in homes.

Methods: Participants (N=100) were interviewed about their background, smoking behavior, smoking restrictions, cleaning behaviors, smoking related beliefs, and home characteristics. THS was measured based on nicotine levels in surface wipe and house dust samples collected from participants' homes. Tobit regression analyses for left-censored data were conducted to determine the association between THS and smoking restrictions and other covariates.

Results: Controlling for number of smokers, home smoking restrictions ($p<0.001$) and compliance with restrictions ($p<0.001$) were independently associated with indoor smoking, accounting for 27% of variance. Indoor smoking had an independent positive association with all THS measures ($p<0.05$). Square footage of the home and proportion of carpeting showed significant ($p<0.05$) negative relationships with bedroom and living room dust nicotine loading and concentration. Opening windows was negatively associated with THS contamination of indoor dust ($p<0.05$), controlling for smoking rate, carpeting, and square footage of the home.

Conclusion: Home smoking restrictions, compliance, square footage of the home, carpeting, and ventilation can play an important role in lowering THS pollution of smoker homes and thus may educe involuntary exposure to THS toxicants. These findings support efforts to implement increasingly stricter home smoking restriction, combined with efforts to improve compliance (e.g., real-time air-quality feedback).

Introduction

Data based on the Tobacco Use Supplement suggest that adoptions of home smoking bans have reportedly increased from 58.1% to 83.8% ($p<0.01$) between 1995 to 2007 in US households.[1] Residents have adopted voluntary smoking restrictions in their home to protect children and adult nonsmokers from secondhand smoke (SHS) exposure.[1] Although there is evidence that establishing smoking restrictions in the home decreases SHS exposure[2], research on the chemical and physical properties of tobacco smoke and SHS contamination shows that partial smoking restrictions in homes do not completely protect a home from contamination and children from exposure when compared to nonsmoker homes. Thirdhand smoke (THS) consists of residual tobacco smoke pollutants that adsorb to and are deposited onto surfaces, and accumulate in house dust after tobacco has been smoked.[3,4] It can be re-emitted back into the air and may react with ambient oxidants to create more toxic secondary pollutants. Factors influencing sorption include gas-phase concentration of SHS, ventilation, and available surfaces.[5] Desorption of sorbed vapors may occur hours to months post smoking.[6,7] Recent studies suggest that some of these chemicals may react with ozone to create ultra-fine particles and with nitrous acid to form highly mutagenic tobacco-specific nitrosamines (TSNAs) hazardous to human health.[8-10]

Matt and colleagues[11] were the first to study nicotine levels on surfaces and in dust of homes with different smoking restrictions. Three types of households with infants were investigated: (1) mothers who were smokers and allowed near their infant (no restriction, direct exposure group), (2) mothers who were smokers and banned smoking near their infant (complete ban in smoker household; indirect exposure group), and (3) mothers who were nonsmokers and banned smoking near their infant (complete ban in nonsmoker household; no exposure group). Results showed that nicotine levels increased with decreasing smoking restrictions. Smoker homes had air nicotine levels higher than smoker homes with complete smoking bans, which were higher than nonsmoker homes. Surface and dust nicotine levels were higher for smoker homes than smoker homes with a ban, and no nicotine was detected on surfaces and dust of nonsmoker homes.[11]

Though studies examining the properties, contamination level, and health effects of THS are increasing, there are few studies that investigate how THS contamination can be reduced in smoker homes. In light of the evidence that home smoking restrictions may affect smoking behavior, SHS exposure, and THS, this study seeks to understand the contribution of different home smoking restrictions on THS pollution of indoor. Figure 3.1 presents a logic model of the hypothesized relationship between indoor smoking and THS contamination and how this relationship may be affected by the number of smokers, smoking restrictions, complaince with restrictions, physical characteristics of homes, and behaviors that may reduce SHS and THS. Briefly put, I hypothesize that the number of residents who smoke, home restrictions, and compliance with restrictions have a direct effect on the number of cigarettes

smoked indoors, which in turn will affect the amount of SHS, from which THS accumulates on surface and in dust. Additionally, the physical features of the home, as well as preventive and remediation efforts (e.g., opening windows, vacuuming), will directly influence the amount of THS contamination. Based on this model, home smoking restrictions are expected to indirectly affect THS contamination through their influence on indoor smoking rate.

In summary, this paper examines the role of home characteristics, smoking restrictions, and preventive and remediation efforts on THS pollutants in homes of smokers. These homes were part of a larger study in which investigators examined THS persistence after smokers moved out and new occupants moved in.[12]

Methods

Setting and Recruitment

All participants were recruited and all data were collected in San Diego, California as part of a larger quasi-experimental study, comparing 100 smoking and 50 nonsmoker homes before and after occupants moved out.[12] Eligibility requirements for study participation included: 18 years and older, English fluency, lived in the home at least one year, planned to move out within a month and resident had smoked seven or more cigarette/week for the past five/six months indoors (smoker home). Detailed recruitment and selection methods can be found in Matt 2011[12]. The Institutional Review Board at San Diego State University approved the research protocol. Only the 100 smoker homes were included in the analysis reported here.

Measures

Trained research assistants (RAs) conducted in-person interviews at the participant's home. Participants answered questions about their smoking history, home characteristics, household cleaning practices, and background. Participants also reported smoking behaviors of other residents and visitors. RAs also made direct observations for evidence of smoking behavior (e.g. ashtray use, odor) during the interview.

Indoor smoking rate

Participants were asked about the number of cigarettes they and others smoked in the past seven days at home and different locations (e.g., car, outdoors). An indoor smoking rate was calculated to yield the sum of the total number of cigarettes all smokers smoked per week indoors in the home. The outdoor smoking rate was calculated by subtracting the number of cigarettes smoked indoors from the total smoked for the week.

Home smoking restrictions

Home smoking restrictions were ascertained by asking the participants about the types of smoking restrictions in their household. Participants were asked to choose among the following responses: (1) "Smoking is allowed any time, by anyone," (2) "Smoking is usually allowed, with a few restrictions," (3) "Smoking is usually not allowed, with a few exceptions," (4) "Only certain people are allowed to smoke inside your home," and (5) "No one is ever allowed to smoke inside your home, including yourself."

Because of small sample sizes, response categories 3 and 4 were combined to create a new combined category indicating smoking was prohibited with a few

exceptions. The final home smoking restrictions variable, therefore, had four response options: (1) “Smoking is allowed any time, by anyone,” (2) “Smoking is usually allowed, with a few restrictions,” (3) “Smoking is usually not allowed, with a few exceptions,” and (4) “No one is ever allowed to smoke inside your home, including yourself.”

Compliance with home smoking restrictions

Respondents who reported having any kind of restriction were asked a follow up question regarding how often home smoking restrictions were broken. Their choices were: “Never broken,” “Broken on a few occasions,” and “Broken on many occasions.”

Preventive efforts

Preventive efforts were any actions taken to reduce the adsorption, deposition, and accumulation of THS in homes while the smoker was smoking. Data came from the primary participant as well as other smoker residents. All smokers were asked how often a window or door in the room was open to the outside when smoking indoors. Respondents chose from a 6-point Likert scale: “Never,” “Rarely,” “Sometimes,” “Often,” “Almost Always,” and “Always.”

Remediation efforts

Remediation efforts refer to behaviors that may remove SHS and THS pollution after smoking had occurred. This includes ventilation and cleaning practices. Ventilation was comprised of two variables: frequency of opening windows and frequency of fan use. Participants were asked how often they opened windows and used fans in each of the rooms in the home. Respondents chose from a 6-point Likert

scale ranging from “Never” to “Every day.” They were asked about home cleaning activity that occurred in the home over the past 30 days. Open-ended questions regarding frequency of vacuuming/sweeping and dusting the entire house were also asked.

Demographics and home characteristics

RAs obtained information from parents about themselves and their home during the interview. Participants were asked about their background information such as age, income, marital status, race/ethnicity, and education. RAs recorded home size (square footage), and number of rooms, type of flooring (i.e., carpeted, bare floor) and number of total residents, children, and smokers. Lastly, participants were asked if they smelled or noticed tobacco smoke drifting inside the house.

Thirdhand smoke

THS measures used in this study were concentrations of nicotine in dust and on surfaces. RAs collected environmental samples the same day as the interview from the bedroom (participant’s or child’s, if child resident is available) and living room. More details on the THS environmental sample collection and handling can be found in Matt 2011[12] and Quintana 2013[13].

Surface nicotine - Prescreened cotton wipes were wetted with 1.5 ml of 0.1% ascorbic acid, and then wiped over a 100 cm^2 area, such as a wooden door or cabinet in the living room and a bedroom. Wipes were placed in glass vials, transported in coolers, and stored at -20 degrees Celsius until analysis.

Dust - Dust was collected into methanol-washed Teflon bottles using a High-Volume-Small Surface-Sampler (HVS4, CS3 Inc., Venice, Florida, USA). In the

laboratory, dust was sieved with a 150 µm mesh stainless steel sieve, then wetted with 100 µl 10% acetic acid, and stored in amber glass vials at -20 degrees Celsius until analysis.

Laboratory analysis of environmental samples were explained in detail in Matt 2011[12]. Briefly, analysis was by LC-MS-MS using electrospray ionization on a Thermo-Finnigan TSQ Quantum Mass Spectrometer. Isotope dilutions MS techniques used nicotine-d4 to quantify the nicotine concentrations. Wipe nicotine levels were expressed in µg/m^2 and dust nicotine levels were expressed in µg/m^2 (loading) and µg/g (concentration). The lowest observed values for surface and dust nicotine analyses provided the left-censored values for the Tobit regression models. They were: 0.04 µg nicotine/m^2 for bedroom and 0.03 µg nicotine/m^2 for living room wipe samples, 0.2 µg nicotine/m^2 for bedroom and 0.07 µg nicotine/m^2 for living room dust loading, and 0.1 µg nicotine/g for bedroom and 0.2 µg nicotine/g for living room dust concentrations.

Statistical Analysis

Data were checked for entry errors and missing data prior to statistical analysis. Thirdhand smoke indicators and indoor smoking rates were log-transformed to normalize skewed distributions. Continuous variables were mean centered and dummy variables were created for categorical variables.

Statistical analyses were conducted with SPSS v19.0.0[14] and Stata v10.0[15] software. Regression analyses were conducted to determine the association between covariates and indoor smoking rate. Tobit regression for left-censored data was conducted to determine the association between covariates and THS indicators. Tobit

regression analysis was also used to examine interaction effects between any of the covariates and the relationship between indoor smoking and THS pollution.

Results

After describing the participants and their homes, results presented below follow the logic model in Figure 3.1. I will first examine how indoor smoking rate is affected by home smoking restrictions, and then examine how THS in dust and on surfaces is associated with indoor smoking and remediation and preventive behaviors.

Participant demographics, home characteristics, and resident behaviors

Table 3.1 displays participant demographic information and home characteristics. The median age of participants was 37.5 years. Those interviewed were mostly female (75%), and were self-reported to be of White (39%), African American (30%), and Hispanic background (11%). Most participants were single or divorced (75%), had attended some college (69%), and a little over half were employed full or part time (57%). Participant homes were, on average, 587 square feet and with high percentage of carpet coverage (74.4%). Less than half of the participants (43%) stated that they noticed smoke drifting inside the house from the outside. The variance of total number of residents ranged from 13% (three residents) to 35% (four or more residents). As for number of children, slightly more than half did not have children (59%). Similarly, about 58% of the households only had a single smoker.

Table 3.2 displays smoking rate and resident behaviors. On average, 48.4 cigarettes per week were smoked inside the participants' homes. The average outdoor smoking rate by smoking residents was 31.2 cigarettes per week. The distribution of household smoking restrictions were as follows: "Smoking allowed anytime," 23%;

"Smoking allowed, with few restrictions," 46%; "Smoking not allowed, with few exceptions," 25%, and "No one ever allowed to smoke," 5%. Over half of the participants indicated that smoking restrictions were broken (65%). With respect to preventive behaviors, a majority of participants (97%) stated that they opened a nearby window or door to the outside when they smoke inside the home. As for remediation efforts, 91% of the residents opened most of the windows every day and 67% used at least one fan daily. Residents, on average, vacuumed the entire house 8 times and dusted once in the last 30 days.

Role of home restrictions and compliance to indoor smoking

Multiple regression analyses were conducted using home smoking restrictions, frequency of restrictions broken (i.e., lack of compliance), number of children residents, and number of smoking residents as explanatory variables and indoor smoking rate as the response variable. An iterative process removed statistically nonsignificant variables ($p>0.05$) to arrive at a parsimonious model. The final model accounted for 37% of the variance in indoor smoking rate ($F(6, 86)=8.53$, $R^2=0.37$, $p<0.001$). Of the explanatory variables tested, the following three showed statistically significant independent contributions: number of smoking residents, home smoking restrictions, and compliance with restrictions. As the number of smoking residents increased, the indoor smoking rate increased ($t(86)=2.34$, $p=0.021$).

Home smoking restrictions accounted for about 19% of the variance in indoor smoking rate ($F(3, 86)=11.58$, $p<0.001$). The stricter the rule, the fewer cigarettes were smoked inside the home. Further investigations of the pairwise differences between smoking restrictions revealed each of the restrictions differed significantly

from the others. For example, compared to allowing smoking anytime, having a few restrictions was associated with smoking 1.9 cigarettes a week less ($p=0.034$). Restricting smoking with a few exceptions was associated with smoking 3.6 cigarettes a week less ($p<0.001$), and allowing no one to smoke was associated with 12.9 fewer cigarettes a week smoked indoors ($p<0.001$). A similar pattern was found when comparing the other restrictions to each other.

Compliance accounted for about 9% of the variance of indoor smoking ($F(2, 86)=3.98$, $p=0.022$). Indoor smoking rate had a predicted decrease of 2.3 cigarettes a week in homes where restrictions were never broken compared to homes where restrictions were broken on many occasions ($p=0.017$). However, there was no statistical difference in indoor smoking rate between homes where restrictions were broken on a few occasions and restrictions were never broken ($p=0.252$) or restrictions were broken on many occasions ($p=0.082$).

Predictors of THS contamination

Tobit regression models were tested to investigate the association between indoor smoking, home features, preventive and remediation behavior and measures of THS pollution in living rooms and bedrooms of smokers. I first tested a full model that included all variables hypothesized to affect the level of THS in the home. Thereafter, an iterative process removed nonsignificant variables ($p>0.05$) to arrive at a parsimonious final model.

Surface nicotine

Tobit models of surface nicotine levels revealed that indoor smoking rate was the only statistically significant predictor of THS pollution for both bedroom and

living room surfaces (bedroom (t (92)=3.72, p<0.001); living room (t(98)=2.00, p=0.049). The higher the indoor smoking rate, the higher the surface nicotine levels. Additionally, odor drifting from the outside was also statistically significant for living room surface wipes (t(98)=-2.6, p=0.011). Homes in which residents did not smell smoke drifting in from the inside had higher nicotine contamination in living room wipes.

Dust nicotine (loading)

Tobit models of dust nicotine loading revealed that indoor smoking rate, size of home, and opening windows for ventilation were statistically signficiant predictors of THS pollution on bedroom and living room dust. Indoor smoking rate had a positive relationship with both bedroom (t(75)= 4.18, p<0.001) and living room (t(5)= 2.39, p=0.019) dust nicotine loading. Percentage carpeting was also significant for living room dust.

Home features were significantly associated with dust nicotine loading. With regard to bedroom dust loading, size of the home (t(75)=-2.38, p=0.002) had a negative relationship with bedroom dust. Similarly, living room dust loading had a negative relationship with size of the home (t(92)=-3.28, p=0.001) and also a positive relationship with percentage carpeting (t(92)=2.23, p=0.028). Overall, smaller homes and homes with more percentage carpeting had higher nicotine dust loading levels than their counterparts.

Of all preventive and remediation efforts to reduce dust nicotine loading, only one emerged significant. The variable frequency of opening windows had a negative relationship with both bedroom (F(2, 75)=4.66, p=0.012) and living room (F(2,

92)=8.28, p<0.001) dust nicotine loading. In regard to bedroom contamination, there was a statistically significant difference between opening all windows occasionally compared to some windows daily (p=0.034) and to opening most windows daily (p=0.003). There was also a statistically significant difference between opening all windows occasionally compared to some windows daily (p=0.003) and to opening most windows daily (p<0.001) for living room dust nicotine loading. In summary, homes where residents frequently opened windows to ventilate the home had less dust nicotine contamination than homes where windows were occasionally opened.

Dust nicotine (concentration)

Tobit models of dust nicotine concentration revealed that indoor smoking rate, size of the home, percentage carpeting, and opening windows for ventilation were statistically signficiant predictors of THS pollution on bedroom and living room dust. Indoor smoking rate has a positive relationship with both bedroom (t(77)= 3.30, p=0.001) and living room (t(5)=3.90, p<0.001).

Similar to dust nicotine loading, dust nicotine concentrations were significantly associated with home features. Bedroom dust concentration had a negative relationship with percentage carpeting (t(77)=-2.36, p=0.021). As for living room dust concentration, both home size (t(93)=-2.18, p=0.032) and percentage carpeting (t(93)=-2.21, p=0.030) had a negative relationship with living room dust concentration. In contrast to dust nicotine loading, homes with more percentage carpeting coverage had lower dust nicotine concentrations, though the relationship with home size was similar.

Similar to dust nicotine loading, only one variable emerged significant in reducing THS contamination, frequency of opening windows. It had a negative relationship with both bedroom ($F(2, 77)=5.20$, $p=0.008$) and living room ($F(2, 93)=7.08$, $p=0.001$) dust nicotine concentration. There was a statistically significant difference between opening all windows occasionally compared to some windows daily ($p=0.046$) and to opening most windows daily ($p=0.003$). Although there was a statistically significant difference between opening all windows occasionally compared to opening most windows daily ($p<0.001$), there was no difference compared to opening only some windows daily ($p=0.116$). Overall, homes where residents regularly opened windows to ventilate the home had less contamination present than homes with minimal ventilation.

Discussion

Significance

This is the first study to examine the role of smoking restrictions in THS pollution in the homes of smokers. Study findings indicate that the stricter the rules about smoking, the lower the levels of THS pollution in dust and on surfaces of smoker homes. Analyses show that size of homes, percentage carpeting, and ventilation can affect THS pollution that accumulates in household dust. Independent of the number of smokers, home smoking restrictions and better compliance with restrictions was associated with fewer cigarettes smoked inside the home, which in turn lowered THS levels found on surfaces and in dust. Homes with a complete ban showed the lowest indoor smoking rates compared to homes where smoking was allowed. Our findings support a study by Wambolt and colleagues[16] and Matt and

colleagues[11] which found a significant difference in indoor smoking rate for homes with a complete ban compared to homes with any other rule.[11,16] Additionally, there were differences in indoor smoking rates when comparing levels of home restrictions. This suggests that implementing some restrictions are effective in minimizing indoor smoking, and subsequently THS contamination.

In exploring smoking restrictions further, I found that compliance with the smoking restrictions also affects indoor smoking rate and in turn THS accumulation. Homes where restrictions were broken many times had more cigarettes smoked inside than homes where restrictions were never broken, regardless of rule strictness and independent of the number of smokers. These findings emphasize the importance of not just having smoking restrictions, but the necessity of proper implementation and enforcement of these restrictions.

In addition to indoor smoking behavior, smoking restrictions, and compliance, other factors contributed to THS contamination. Controlling for the number of cigarettes smoked, smaller homes showed higher concentrations of nicotine contamination in dust than larger homes. One possible explanation for this is that a smaller home provides less space for nicotine to disperse. Smaller homes contain less furnishings and surfaces for nicotine to adsorb to than larger homes. Therefore, everything else being equal, nicotine concentrations per area are expected to be higher in smaller homes.

Another home feature that influenced dust nicotine levels in the home was percentage carpeting. With regard to dust nicotine loading, homes with more carpet coverage showed increased nicotine loading (i.e., per m^2). However, the contrary was

true for dust nicotine concentration; higher carpet coverage decreased nicotine concentration (i.e., nicotine per gram of dust). The latter finding support earlier lab-based research on nicotine contamination by Singer and colleagues[5] Investigators examined exposure-relevant emission factors (EREF) in the laboratory setting by simulating home and smoking conditions. A lower EREF indicated higher sorption of contaminants. Data revealed that nicotine EREF decreased with increasing furnishing level; the more nicotine can bind to (i.e., carpet, furniture, draper), the lower its EREF.[5]

Study findings indicate that one remediation effort reduced THS contamination, but efforts to completely prevent THS contamination were not successful. Ventilation of the home by opening windows reduced nicotine levels in dust. Despite efforts of residents to prevent THS contamination by opening a nearby window or door during active smoking, nicotine will pollute and remain in dust and surfaces of the home. Additionally, other remediation efforts, such as using a fan, did not reduce contamination. Perhaps fan use merely disperses THS around the home instead of removing it. Similar to findings by Fortmann and colleagues[17], cleaning efforts do not reduce THS contamination.

While larger homes, those with more carpeting, and with increased ventilation had lower dust nicotine loading levels, this was not true for surface nicotine levels. Instead, only higher indoor smoking was associated with higher surface nicotine levels. Findings indicate that nicotine in dust is different than nicotine in wipes. Surface nicotine is resilient in that no preventive or remediation efforts can reduce its

presence. This could also be true because in our study sample, residents dusted the home less frequently than they vacuumed.

Home smoking restrictions have the potential to change resident behaviors. Enforced restrictions have been shown to lower indoor smoking rates, thereby reducing the amount of cigarettes smoked inside the home. Residents should clearly communicate home smoking restrictions to all household members, who the restrictions apply to, and methods of implementation and enforcement to ensure compliance. Although some preventive and remediation methods can reduce the amount of contamination, it is the indoor smoking rate that contributes largely to THS pollution.

Limitations

There are several considerations that may limit the generalizability of and affect the interpretation of findings from this study. Questions about preventive and remediation behaviors required recall of behaviors in the past month, compromising the accuracy and validity of responses. Additionally, most of the participants included in the study were low income living in small homes. Lastly, interviews conducted were in person, and it is possible that participants provided answers they deemed would be socially desirable by tobacco researchers.

Implication for future studies

Future studies on home smoking restrictions would benefit from exploring the interactions of home smoking restrictions with factors that contribute to THS contamination (i.e., home size, carpeting, window use). It would be of interest to find out how well restrictions hold up when compared to these other factors. A replication

study could also determine if some of the current findings endure. In this study, smoke drifting from the outside was predictive of only one THS indicator compared to other predictors. Although the current study suggests that smoking restrictions reduce indoor smoking rate, it would be helpful to determine if residents implemented restrictions specifically to reduce indoor smoking or if residents already exhibited these efforts and defined the restrictions to adapt to their lifestyle. The findings from this study provide some information on potential targets of intervention in reducing THS contamination. In addition to establishing home restrictions, encouraging strict compliance and regularly ventilating the home can help reduce THS pollution.

Chapter 3, in part, is currently being prepared for submission for publication to Nicotine Tobacco Research is being prepared for publication to Nicotine Tobacco Research. Romero RA, Fortmann AB, Quintana PJE, Hoh E, Chatfield D, Hovell MF, Zakarian J, Matt GE. Do Voluntary Smoking Rules Affect Thirdhand Smoke Pollution in the Home? The dissertation author was the primary investigator and author of this paper. The research was supported by the California Tobacco-Related Disease Research Program of the University of California grant 13RT-0161H (GEM), National Cancer Institute, Comprehensive Partnerships to Reduce Cancer Health Disparities Program grants #1U54CA132384 and #1U54CA132379 (GEM), and California Tobacco-Related Disease Research Program, Office of the University of California, Cornelius Hopper Diversity Award Supplement (RAR).

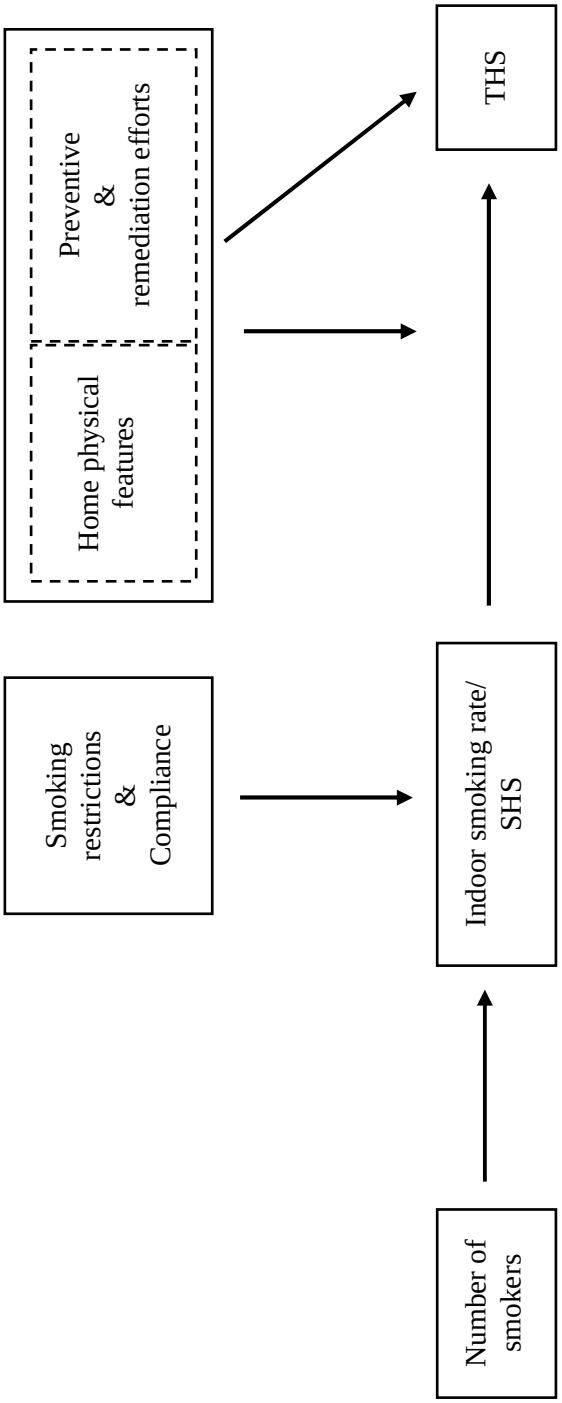

Figure 3.1. Logic model of the relationship between smoking restrictions and thirdhand smoke pollution

Table 3.1. Participant demographics and home characteristics

Characteristics	**n =100**
Sex	
Male	25%
Female	75%
Median Age (years)	37.5
Quartile: 25-75	28.3-46.1
Race/Ethnicity	
White	39%
African American/Black	30%
Hispanic	11%
Other	20%
Marital Status	
Single	59%
Married/Living with partner	23%
Divorced/Separated/Widow	18%
Education	
Less than high school	10%
High school graduate/GED	21%
Some college	60%
College & above	9%
Employment	
Not employed & not looking for employment	31%
Not employed & looking for employment	22%
Employed part-time	25%
Employed full-time	22%
Median Income	$25,000
Quartile: 25-75	$12,000-$35,000
Median Square footage of residence	586.9
Quartile: 25-75	438.3-804.0
Median Proportion of house carpeted	74.7
Quartile: 25-75	54.5-81.7
Noticed smoke drift inside from outside	
No	57%
Yes	43%
# of residents	
1	20%
2	32%
3	13%
4+	35%
# of children <11 years	
0	59%
1	19%
2	14%
3+	8%
# of smoker residents	
1	58%
2	35%
3+	7%

Table 3.2. Tobacco use, home smoking restrictions, and resident behaviors

Measures	**Percentages n=100**
Indoor smoking rate (#cigs/week)	48.4[a]
Minimum-Maximum	0-653
Quartile: 25-50-75	28.3-64.0-115.8
Outdoor smoking rate (#cigs/week)	31.2[a]
Minimum-Maximum	0-375
Quartile: 25-50-75	17.5-39.5-90.5
Household smoking restrictions	
Smoking allowed anytime	23%
Smoking allowed, with few restrictions	46%
Smoking not allowed, with few exceptions	26%
No one ever allowed to smoke	5%
Frequency of home restrictions broken (n=93)[b]	
Never broken	35%
Broken on a few occasions	49%
Broken on many occasions	15%
Preventive behaviors: Frequency of opening nearby window/door when smoking inside home (n=98)[b]	
Residents never open window/door	3%
Some residents sometimes open window/door	52%
All residents always open window/door	45%
Remediation behaviors: Frequency of ventilating home by opening windows	7%
All windows are only occasionally opened	14%
Opens some windows daily	79%
Opens most windows daily	
Frequency of ventilating home by using fans	
Fans not used	17%
Some fans used occasionally	16%
At least one fan in daily use	67%
Frequency in the past 30 days	
Vacuum entire house	
Quartile: 25-50-75	3-8-23
Dust entire house	
Quartile: 25-50-75	0-1-4.8

[a]Geometric mean

[b]Sum does not add to 100 due to missing data.

Table 3.3. Partial regression coefficients of factors associated with thirdhand smoke levels in dust and on surfaces

	Thirdhand Smoke Measures					
	Surface wipe Nicotine ($\mu g/m^2$)		Dust Nicotine ($\mu g/m^2$)		Dust Nicotine ($\mu g/g$)	
Factors	Bedroom	Living room	Bedroom	Living room	Bedroom	Living room
Pseudo R^2	0.088	0.073	0.173	0.158	0.222	0.207
p-value	0.018	0.050	0.005	<0.001	0.002	<0.001
Indoor smoking rate	0.80*	0.40*	0.51*	0.30*	0.36*	0.37*
Square footage of residence	--[a]	--[a]	-0.00062*	-0.00064*	-.00038	-0.00032*
Percentage of home carpeted	--[a]	--[a]	--[a]	0.0057*	-0.0054*	-0.0043*
Odor from smoke drifting inside	--[a]	-0.56*	--[a]	--[a]	--[a]	--[a]
Open windows/doors during active smoking	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]
Open windows						
Opens some windows daily	--[a]	--[a]	-0.72*	-0.93*	-0.57*	-0.36*
Opens most windows daily	--[a]	--[a]	-0.88*	-1.05*	-0.78*	-0.66*
Use fans	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]
Vacuum entire house	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]
Dust entire house	--[a]	--[a]	--[a]	--[a]	--[a]	--[a]

Note: Pseudo R^2 for Tobit regression models based on partial regression coefficients listed in the table.

*$p<0.05$

[a]Values were nonsignificant

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Chapter 4

Rental Car Smoking Policies: Implementation Challenges and Implications for Customers

Abstract

Background: The small, enclosed microenvironments of cars are excellent reservoirs for thirdhand smoke (THS) due to small volume, surface to volume ratio, and favorable materials for sorption and deposition. The high turn-over of rentals can lead to the long-term pollution of the vast majority of cars that may expose hundreds of nonsmokers to THS toxicants over the lease cycle of a rental car. The objective of this study was to explore smoking policies for national rental companies and their implementation and enforcement.

Method: The present study used data collected between 2007 and 2008 for the Rental Car project in San Diego, CA. Research assistants interviewed representatives from US national car rental companies operating in San Diego (Alamo/National, Dollar/Thrifty, Enterprise, Hertz, Avis, and Budget), both at the corporate headquarters (N=6) and local branch (N=125), to inquire about smoking policies and their implementation. Descriptive analyses were conducted to characterize rental car companies and the enforcement of smoking policies.

Results: Most (67%) national rental companies had a no-smoking policy in all of their cars, and two permitted smoking in designated smoker cars. With the exception of Enterprise, however, confederates were able to reserve and rent smoker cars from all companies, even those with an official no-smoking policy. Only

Alamo/National stated that employees were trained on their smoking policy, while others referred their employees to the procedures manual.

Discussion: Findings indicate that lack of employee training and poor communication with customers about smoking policies translated to poor implementation and enforcement of official smoking policies at the branch level. This explains why rental cars consequently become polluted with THS, potentially exposing future customers to toxic pollutants. Proper training and communication of smoking policies to employees could lead to consistent implementation, monitoring, and enforcement of smoking policies at the branch level.

Introduction

As the number of smoking prohibitions in public indoor settings increases and the social pressure from nonsmokers intensifies, smokers are becoming limited to smoke outdoors and in private indoor locations such as homes and cars. In 2010, 9.2% of United States (US) nonsmoking adults were exposed to SHS in a vehicle within the previous seven days, based on the National Adult Tobacco Survey.[1] With regard to youth, King and colleagues found that in 2009, 22.8% of nonsmoking youth and 75.3% of smoking youth were exposed to SHS in cars, based on the National Tobacco Youth Survey.[2] Since there is no risk-free level of exposure to SHS, even short exposures to SHS are hazardous to non-smokers' health.[3]

Thirdhand smoke (THS) contaminates indoor environments and can lead to the exposure of nonsmokers to toxic pollutants[4] long after cigarettes have been smoked[5]. Research on the chemical and physical properties of tobacco smoke and THS show that within minutes of emission, tobacco smoke adsorbs to carpets, walls, and fabrics,

deposits on surfaces, and accumulates in dust.[5] Although studies show that driver smoking behavior is the strongest predictor of THS contamination[6], the small, enclosed microenvironments of cars are excellent reservoirs for THS and thus aid in pollution. Car features such as small volume and high surface to volume ratio[5,7,8], and interior surfaces and upholstery[9] contribute to contamination of THS in cars. Other factors such as vehicle speed, window position, ventilation system, and air conditioning settings all influence air exchange rates that affect THS pollution in cars.[6,10,11]

Current evidence suggests that exposure to THS leads to health risks. Nicotine in THS reacts with components of ambient air (e.g., nitric acid, ozone) to produce carcinogenic byproducts, tobacco-specific nitrosamines (TSNA).[12] In vivo and in vitro experiments suggest that components of TSNA lead to pulmonary damage[13], oxidative stress[14], and affects multiple organ systems such as the lungs, liver, and skin[15].

According to data based on the National Adult Tobacco Survey, in 2010, 73.6% of US adults employed a voluntary complete smoking ban – smoking "never allowed in any vehicle" – in their cars.[1] Currently, there are six states and one US commonwealth that enacted laws to prevent smoking in private vehicles when children are present.[16] Studies show that the public supports such laws[17,18] and smoke-free car laws work in reducing SHS exposure among children.[19]

In 1936, Milwaukee, WI became the first United States city to institutionalize a ban on smoking on all public transportation.[20] This act became a precedent in protecting nonsmokers from SHS exposure while travelling in public transportation.

To date, there are 41 states with smoke-free air laws covering public transportation[21], in addition to the federal law prohibiting smoking on airplanes[20].

Research on the dangers of smoking and SHS exposure and grassroots efforts propelled governments to institutionalize smoke-free legislation. Unfortunately, these laws do not include privately owned rental car companies. Rental cars are important settings for better tobacco control policies and provide excellent opportunities for shaping smoking behavior. In 2013, there were over 1.9 million rental cars in service available for public use and over 1.8 million were owned and operated by national rental car companies.[22] Given the high turn-over rate of rental cars, and if one smoker rents the car every five to ten rentals, it is possible that the majority of cars in a rental fleet can turn into smoker cars in a short period of time.[23]

Although smoking restrictions reduce the level of THS contamination in cars, they do not completely protect cars from contamination[7] and nonsmoking passengers from exposure to THS. Findings from Matt and colleagues revealed that 44%-54% of nonsmoker national rental cars had nicotine in dust and surfaces.[23] Given the inherent property of THS to linger beyond active smoking, rental car customers are inadvertently exposed to toxic chemicals even if they did not smoke in the car. Investigators also reported that nonsmoker rental cars had lower levels of nicotine in dust and surfaces compared to smoker cars. Additionally, signage displaying restrictions in the branch office and rental cars are associated with lower nicotine pollution.[23]

In light of the chemical and physical properties of THS, potential health hazards of exposure to THS, and prevalence of THS contamination in rental cars, the

objectives of this study were to 1) investigate smoking policies for national car rental companies, 2) explore customer experience of renting smoker and nonsmoker cars, and 3) develop strategies to improve smoking policy implementation at the branch level.

Methods

Participants

The study was conducted in San Diego, CA between 2007 and 2008. Internet searches and online phone listings identified national rental car companies operating in the SD metropolitan area. National rental car companies were defined as companies that operated in multiple states, including California. Of all national car rental companies, the following operated in San Diego: Alamo/National, Avis, Budget, Dollar/Thrifty, Enterprise, and Hertz. Data reported came from interviews with representatives of the corporate headquarters of N=6 national car rental companies, N=329 interactions during telephone reservation calls with the rental companies, and N=125 rental agents of their San Diego branches. The Institutional Review Board at San Diego State University approved the research protocol.

A listing of rental car branches was created from which branches were randomly selected and rented from. The listing was updated periodically to include any new branches that opened up after the study began. A detailed explanation of car sampling is available in Matt 2012.[23] Reservations were made by phone using a sampling protocol. The research assistant (RA) requesting the reservation asked for a smoker car (n=25), nonsmoker car (n=50), or did not specify a smoking preference (n=50).

Measures

Data reported came from four distinct sources: 1) interview with corporate headquarters, 2) observations based on telephone reservations, 3) interview with rental agents at the branch office, and 4) content analysis of rental contract and website.

Interview with corporate headquarters

Representatives from national corporate headquarters were interviewed by telephone. RAs called the headquarters and asked to speak with someone from public relations (PR). In the case that a PR representative was not reached, a customer service representative was interviewed.

Corporate respondents were asked if the company had an official smoking policy. They were further asked to describe the policy and chose from three responses: (1) “Smoking is allowed in all cars,” (2) “Some cars are allowed to smoke in, and other cars are not allowed to smoke in,” and (3) “Smoking is not allowed in any cars.” RAs additionally asked if smoker cars were available for customers who request one. Lastly, respondents were asked who is responsible for establishing smoking rules, the corporate headquarters or each individual branches.

RAs asked open-ended questions about how smoking policy was communicated to rental agents. RAs asked if the branches charged a monetary fine if rules were violated and how much the fine cost the customer. In addition to customer smoking inside the rental cars, respondents were asked about smoking policies for employees. RAs inquired about the rules for smoking at the branch, location of smoking, and about employees smoking inside the rental cars.

Observations based on telephone reservations

RAs (confederates) called the reservation number for a particular rental company to request a rental car meeting the specifications of the sampling design (size and class). Upon reserving a car on the phone, confederates requested specifically for a car in which he/she can smoke, a nonsmoker car, or did not mention needing a smoker or nonsmoker car. Each call made was documented in a weekly call log that included information such as branch name, if a car was reserved from the branch, and reason for not being able to rent from the branch. Reasons for not renting a car from a particular branch were categorized into six categories: (1) the agency was out of business or closed at the time of the call, (1) the branch is a specialty rental car agency (i.e. only rents to military or dealership customers), (3) no car available (i.e. requested size not available, all cars sold out), (4) only nonsmoker cars available, (5) no smoker cars available, and (6) other.

Interview with rental agents at the branch office

At the time of car pick up, confederates recorded if the rental agents confirmed the car's smoking status based on the car reserved: (1) smoking is allowed in a smoker car, (2) no smoking is allowed in a nonsmoker car, or (3) if the rental agent did not mention any smoking policy for cars reserved without any preferred smoking status.

Confederates conducted semi-standardized exit interviews at each branch when the rental car was returned. Unlike the corporate interviews, which were more formal, confederates asked the rental agents interview questions during a casual conversation.[23] Questions asked included company official smoking policy, detection for tobacco use in the car, remediation if someone smoked inside the car, consequence of smoking policy violation, amount of fine, and employee smoking policy at branch.

Rental agents who checked in the returned cars were asked the following question: “What are your company’s rules about smoking in your cars?” Confederates asked rental agents to describe how employees checked if customers followed smoking rules. A follow up question was asked how they would determine if customers smoked cigarettes in the car and what branch employees did if smoking occurred in the car. Rental agents were asked if they charged customers a monetary fine if rules were violated, how much fine they charge, and how successful they were at collecting the fine.

Confederates inquired about company smoking policy and employee smoking behavior. Rental agents were asked if the company had a smoking policy, if employees smoke at the branch, and if they smoke inside the rental cars.

Content analysis of rental contract and website

Rental contract and the rental company websites were searched for references to smoking or nonsmoking policies, including potential penalties.

Statistical Analysis

Data were checked for data entry errors and missing data prior to statistical analysis. Some responses were aggregated due to small sample sizes and were recoded for data analysis. Descriptive analysis was conducted to characterize rental car companies using SPSS v21 software.[24]

Results

Interview with corporate headquarters

Table 4.1 displays results of interviews with national headquarter representatives. Four companies were grouped together as they were owned by the

same parent companies: Alamo/National and Dollar/Thrifty. With the exception of Avis and Enterprise, all national companies reported an official corporate policy about smoking in rental cars. The official corporate smoking policy for Alamo/National, Dollar/Thrifty, and Hertz was that all cars are nonsmoker; smoking is prohibited in all rental cars. However, both Alamo/National and Hertz had rental cars available to smoke in. Avis and Budget permitted smoking, but limited smoking to designated smoker rental cars. The representative for Enterprise stated that its policy varied by region, and for the San Diego region, all cars were nonsmoker. With the exception of Enterprise, the corporate headquarters were responsible for establishing a uniform official company smoking policy.

The interviews with corporate representatives revealed that local staff training and policy implementation varied by company. Only Alamo/National provided training for employees about the smoking policy. For the other companies, however, the policies were limited in written form for employees (i.e. company manual).

All companies except for Enterprise mentioned odor detection and/or physical inspection as methods to detect policy violation. Additionally, remediation efforts included detailing the rental cars and/or deodorizing to mask the odor. Although Hertz stated that all their cars were nonsmoker, the headquarter representative stated that once a car has been smoked in, it became a smoker unit. When customers violated nonsmoking policies, only Budget and Enterprise charged a fine, and the representative for Dollar/Thrifty did not know if a fine was charged. Only the representative for Dollar/Thrifty was able to confirm that they had established rules

for employee smoking in rental cars. It was not clear if rules for other companies existed as representatives interviewed reported that they did not know.

Observations based on telephone reservations

Table 4.2 displays the type of car requested at the time of reservation from each of the rental companies by car smoking status. Overall, reservations for nonsmoker cars and cars without a specified smoking status were successful in 52% and 53% of attempts, respectively; that is, it took on average about two attempts to reserve a nonsmoker and undesignated cars. On the contrary, it took on average five to six attempts to reserve a smoker car.

Reasons for why the confederates were not able to reserve a specified car varied by the car's smoking status. The top reason for why nonsmoker cars and cars with unspecified smoking status were not able to be reserved was that there were no cars available for the day requested. As for smoker cars, the number one reason why confederates were not able to reserve them was that all cars available at the branch for the day requested were nonsmoker cars.

With the exception of Enterprise, confederates were able to reserve smoker cars from all companies even if their corporate policies stated that all their cars are nonsmoker. On the other hand, despite offering smoker cars, rental agents at Avis and Budget rejected requests for a smoker car in 53% and 50% of attempts, respectively. Confederates succeeded in reserving nonsmoker cars from all companies. Similarly, cars without a specified smoking status were successfully reserved from all companies except for Alamo/National which had no cars available at the time the reservations were made.

Interview with rental agents at branch office

Table 4.3 shows findings regarding 125 cars rentals from the six companies. Reflecting the distribution of rental car branches in San Diego, most cars were rented from Enterprise (40%), Hertz (26%), and Avis (20%). This distribution reflects the sampling design and the proportional distribution of rental car branches in the San Diego Metropolitan area.

Upon car pick up at the branch, rental agents confirmed that confederates could smoke in the reserved smoker cars and that there was no smoking in the reserved nonsmoker cars. The former was true even if the corporate policy indicated that all rental cars are nonsmoker. With respect to unspecified cars, rental agents generally failed to inform the confederates of their smoking policy. However, in some Enterprise (29%) and Hertz (9%) branches, agents mentioned to the confederate that smoking is not allowed in cars, which is consistent with corporate policy.

Branch smoking policy

To learn more about smoking policies at local branch offices, confederates conducted unobtrusive semi-standardized interviews with rental agents at the time the confederate returned the car. To maintain the unobtrusive nature of the interview, no interviews were conducted at return visits to a branch.

Consistent with corporate nonsmoking policies, most agents at Alamo/National (100%) and Dollar/Thrifty (83%) branches stated that all cars are nonsmoker. Nevertheless, confederates were able to reserve and rent smoker cars from these companies.

According to their corporate policy, all Hertz cars are nonsmoker, while Avis and Budget offer smoker cars. However, rental agents at local branches provided responses inconsistent with corporate smoking policies. Roughly half of agents stated all cars are nonsmoker, while the other half indicated that smoking is permitted in some or all cars or that there was a no-smoking policy.

In contrast to all other national car rental companies sampled, Enterprise rental agents consistently stated the company's nonsmoking policy was that all rental cars are nonsmoker.

Detecting violations of smoking policies

Table 4.4 shows that, across all companies, rental car agents relied on tobacco smoke odor as the most common method to detect whether customers had smoked in the car (36%). This was followed by physical inspection (17%), such as looking for the presence of ashes, cigarette butts, and/or burn marks, and both odor and physical inspection (19%). Some agents did not specify a specific method of detecting tobacco use in the car (12%), some said they did nothing (13%), and a few did not know (3%). Confederates did not ask 11 rental agents due to repeat visits, as well as five agents since those employees said there were no rules.

Cleaning

Protocol of cleaning car after smoking policy violation varied by company and branch. A little less than a quarter of those questioned (24%) stated they did nothing if customers violated the smoking policy. Some agents simply said they cleaned/detailed the car (7%), turned the car into a smoker unit (5%), and 3% of agents did not know what to do if a customer violated the smoking policy. Some agents (33%) stated that

they charge a fine specifically to cover detailing fees. Confederates did not ask nine agents since they were questioned before and seven staff since those employees said there were no rules.

Penalties/Fines

A majority of branch staff (58%) reported charging a fine, while 10% said it depended on the extent of damage (i.e. odor and/or sign of tobacco use). The values of the fines charged were as follows: $50 - <$75, 28%; $75 - <$100, 2%; $100+, 35%. With regard to success in fine collection, a little over a quarter (29%) stated they always collected a fine from customers who violated smoking rules, 11% frequently collected fines, 34% occasionally collected fines, and 3% said they never collect fines. A few agents (23%) reported not knowing how often agents were successful in collecting fines. A few agents stated that after customers complained about the fines, their managers told them to reverse the charges (data not shown).

Branch employee smoking policy

Asked about employee smoking policies at rental car branches, 36% stated that employees smoked in designated smoking areas (including outside the building), 26% said that there was no smoking allowed, 11% said there were no rules about employee smoking, and 27% stated they did not know what the official rule was about employee smoking. The majority of those questioned (92%) agreed that employees were not allowed to smoke inside the rental car. Few agents stated that employees can smoke inside rental cars (4%) and did not know if employees smoked inside rental cars (4%).

Content analysis of rental contract and website

Confederates looked for any indication of smoking policy in the rental contract or company documents. Upon perusal of rental contract or company documents, some branches clearly stated the smoking policy. Over half of Enterprise branches (78%) had “No Smoking” stamped in red on the front of the rental contract. All other branches did not have any written policy for customer smoking in rental cars.

Discussion

Significance

This is the first study to look at smoking policies of rental car companies from corporate headquarter, local branch, and customer perspectives. This paper contributes to the growing literature of smoking regulations and rules for the hospitality industry by providing insight to how corporate policies are implemented at local branches and experienced by customers. Our findings indicate that even though national rental car companies had explicit smoking policies, these policies differ significantly between companies and are implemented with little guidance and training at the local branch level As a consequence, customers experience different smoking policies with different rental car companies, are exposed to residual signs of tobacco smoke (i.e. odor, ashes), are able to rent smoker cars from companies that presumably only offer nonsmoker cars, and there is no reliable approach to monitor if customers have smoked in nonsmoker cars. Overall, the existing policies and their implementation fail to protect cars from accumulating THS pollutants and customers from exposure to these pollutants even if they requested and a smoke-free car.

The corporate smoking policy did not seem to be consistently communicated and implemented at the local car rental branch. Findings from the study suggest that

mere provision of written policies in lieu of proper employee training (monitoring/compliance checks) was not sufficient, and resulted in poor implementation and enforcement of the smoking policy. With the exception of Enterprise, smoker cars could be reserved and rented from Alamo/National, Dollar/Thrifty, and Hertz. Customers should not be able to reserve and rent smoker cars from these companies since they have a no-smoking policy. On the contrary, agents at Avis and Budget rejected half of the reservation requests for smoker cars. According the rental agents, all their cars are nonsmokers. This was quite surprising since these two companies offer cars that customers can smoke in. In essence, knowledge of company policy fell short of effectuating it, and works both ways – offering smoker cars given a no-smoking policy and vice-versa. Agents at the reservation level and rental desk failed to implement corporate policies.

Aside from lack of training, there may be another reasons for the low implementation and enforcement of national corporate policies. Some branches were franchises. The data presented in this study did not discriminate between those branches that were franchises and those that were operated by corporate entities. Therefore, though it would seem that branches were not implementing corporate policy, it may be that some of the branches included in the study were franchises implementing their own policy, something that may not be the same as the corporate policy. Different local anti-tobacco laws could explain the incongruence for employee smoking policy between corporate and branch representatives. Since 1988, the California State Workplace Smoking Law banned indoor smoking in all public working places. This state law, as well as local ordinances, have been upheld in San

Diego County.[25] Therefore, branch employees (e.g., Avis and Budget), who were not aware of the official smoking policy, may be stating smoking policies based on local jurisdiction and not necessarily the official corporate policy.

Although several national car rental companies have voluntarily sanctioned a no-smoking policy in 100% of their fleet[26,27] since data for this study were collected, it is unknown to what extent the policy is implemented or enforced. Further investigation to ascertain follow-through of this policy would be beneficial to nonsmoking customers and passengers, and as an evaluation tool for internal review of company policy implementation.

In the study by Matt and colleagues, investigators found that rental cars are polluted with THS regardless of smoking status.[23] Findings from the current paper provide a possible explanation as to why rental cars are contaminated with THS. The apparent lack of employee training and poor communication with customers leads to gaps in knowledge about the smoking policy and lax implementation and enforcement.

Recommendations

Although smoke-free laws provide protection from SHS exposure in public transportation, these laws do not apply to private rental car companies. Instead, some rental car companies have voluntarily set policies in place for their customers. With one exception, this study showed that these voluntary policies are poorly implemented. This could result in a majority of rental cars being polluted with THS regardless of smoking policies.[23] There are several ways to increase compliance with the smoking policy. First and foremost is communication and reminders to customers and employees about the official smoking policy. All employees, from customer service to

rental agents, could be informed of the official smoking policy so that a consistent policy is given to all customers. The second method is proper employee training of rental agents at the reservation frontend, car pick-up, and return. If the smoking policy is strictly that all cars are nonsmoker, training could include methods of implementing and enforcing the smoking policy, as well as remediation for policy violation. Organizational psychologists specialize in developing employee training programs. There are several models for training programs[28] available which companies can avail of to enhance their employee training. Rental agents could be trained to remind customers of the policy and fine for violation at the time of car check-out. Lastly, compliance checks and reinforcement would aid in improved implementation. Employees could charge and collect fines for policy violation consistently. The consistent collection of fines may deter customers from smoking the next time they rent a car from the same company. Additionally, the fines collected can offset the cost of detailing the cars for maintenance due to THS pollution.

Visual cues may aid in communication and increased compliance. Companies could display no smoking signs on walls, key chains, and window decals to remind both employees and customers of policy. These may serve as visual cues of the company's official policy, as well as help drivers or passengers enforce the rules if smokers are riding with nonsmokers in the same car. Visual cues lead to customer compliance and lower THS contamination.[23] Rental contracts can also include the company's smoking policy. A well-placed no smoking stamp on the rental contract's front page and on a checklist of additional charges could ascertain that the policy has been communicated to the customers. The agent could have customers initial next to

notices of fines that will be charged for violating smoking policy along with insurance waivers. Companies could include smoking policy on the website through the Frequently Asked Questions section and as an option when requesting a reservation online. In addition to visible signs of tobacco use, collecting objective measures of THS contamination could aid in enforcing smoking policy and collecting fines. However, it may be years until the technology for a valid and reliable rapid test kit will become available for commercial use.

Another strategy would be to offer employees incentives to be diligent about detecting tobacco use in returned cars. Although incentives would encourage employees to implement and enforce the smoking policy, this could also work against nonsmoking customers who rented cars that were previously smoked in but not adequately cleaned.

Limitations

Though this is the first study to report about smoking policies of national car rental companies and their effects on customer experience, there are a few limitations. First is the interview of PR at corporate headquarter. Although respondents interviewed were generally knowledgeable about the smoking policy, it is possible that another company representative might not have been better suited to answer questions about policy and employee training. Additionally, in a few cases, the PR was not interviewed but a customer service representative whose knowledge about corporate policy may be limited.

Another potential limitation is social desirability and self-serving biases. It is possible that representatives interviewed from both headquarters and branches

provided more desirable answers as a public relation maneuver. On the other hand, confederates' notes on informal exit interviews (data not shown) suggested that agents appeared to be honest in their response. Additionally, as some of the answers provided by interviewees were not in support of official company policy, or they stated that they did not know the policy, it is unlikely that the responses provided were meant to shed a favorable light to the company.

Small sample size may limit the precision of estimates. Though the number of branches selected for each company were due to a random sampling protocol and represented the proportion of different companies operating local branches in San Diego, a larger sample size would provide more precise estimates for companies with fewer local branches.

Conclusion

Though most national rental car companies have official smoking policies, the lack of employee training and communication resulted in poor implementation, monitoring, and enforcement of the policy. Thus, a majority of rental cars, regardless of smoking designation, exhibited THS contamination[23] and potentially expose nonsmoking customers to toxic pollutants. A well-communicated, implemented and enforced no-smoking policy from these national companies would encourage nonsmoking customers to be diligent in requesting nonsmoker cars from other rental car companies (i.e. independent companies). In the same vein as the hotel industry, these independent companies may change their policy in order to compete for business, to adhere to local and state laws[29], or simply to concede to pressure from nonsmoking customers.

Chapter 4, in part, is currently being prepared for submission for publication of the material. Romero RA, Fortmann AB, Quintana PJE, Hovell, MF, Zakarian J, Matt GE. Rental Car Smoking Policies: Implementation Challenges and Implications for Customers. The dissertation author was the primary investigator and author of this paper. The research was supported by the California Tobacco-Related Disease Research Grants Program, Office of the University of California grant 15RT-0160 (GEM).

Table 4.1. Interview with national rental car corporate headquarters

	Rental Car Company					
Smoking Policy	**Alamo/ National**	**Dollar/ Thrifty**	**Enterprise**	**Hertz**	**Avis**	**Budget**
The company has an official smoking policy	Yes	Yes	No	Yes	No	Yes
Official smoking policy	All cars nonsmoker	All cars nonsmoker	All cars[a] nonsmoker	All cars nonsmoker	Smoking permitted in smoker cars	Smoking permitted in smoker cars
Smoker cars available	Yes	No	--[b]	Yes	Yes	Yes
Responsible party for making smoking policy	HQ	HQ	Individual regions	HQ	HQ	HQ
Employee smoking policy training	New hire training	No training, referral to manual	--[b]	No training, referral to manual		
Policy communication		Polices and procedures manual	--[b]	Policies and procedures manual	Don't know	Don't know
Written policy available for employees	Yes	Yes	Yes	Yes		Yes
Signs of policy violation	Odor; butts	Odor	--[b]	Odor; ashes; butts		Odor; ashes
Remediation if policy violated	Detail; deodorizer	Deodorizer	Varies by operation	Becomes a smoker unit; deodorizer		Detail
Fine penalty for violation	No	Don't know	Yes	No	No	Yes
Success in fine collection			Rarely			Always
Employees allowed to smoke onsite	Yes	Yes	Varies by region	Don't know	Don't know	Yes
Employees allowed to smoke in rental cars	Don't know	Yes	Varies by region	Don't know	Don't know	Don't know

[a]Only for San Diego region.
[b]Missing response. Enterprise completed a questionnaire instead of a phone interview.

Table 4.2. Confederate experience of reserving cars on the phone

	Rental Car Companies					
Reservation Experience	**Alamo/ National[a]**	**Dollar/ Thrifty[a]**	**Enterprise[a]**	**Hertz[a]**	**Avis[b]**	**Budget[b]**
Type of car requested						
Nonsmoker	2	4	50	20	14	6
Smoker	6	4	60	38	20	11
Nothing specified	2	1	50	21	16	4
Nonsmoker cars						
Reservation success						
Car not reserved	1	1	24	10	7	3
Car reserved	1	3	26	10	7	3
Reason for not renting car						
Agency out of business/Closed	0	0	5	2	1	1
Not a rental car agency	0	0	6	1	0	0
No car available	0	1	12	7	6	2
Other	1	0	1	0	0	0
Smoker						
Reservation success						
Car not reserved	4	2	60	27	15	6
Car reserved	2	2	0	11	5	5
Reason for not renting car						
Agency out of business/Closed	0	0	3	7	0	2
Not a rental car agency	0	0	2	3	0	0
No car available	0	2	2	6	4	1
All cars non smoking	4	0	53	8	8	3
Out of smoking cars	0	0	0	1	3	0
Other	0	0	0	2	0	0
No preference specified						
Reservation success						
Car not reserved	2	0	26	10	3	3
Car reserved	0	1	24	11	13	1
Reason for not renting car						
Agency out of business/Closed	1	--	4	3	0	1
Not a rental car agency	0	--	6	1	0	1
No car available	1	--	12	6	3	1
All NS	0	--	4	0	0	0

[a]Corporate official policy is that all cars are nonsmoker.
[b]Corporate official policy is that smoking is permitted in smoker cars.

Table 4.3. Confederate rental experience at the counter upon car pick-up

	Rental Car Companies					
Rental Experience	**Alamo/ National[a] N=3**	**Dollar/ Thrifty[a] N=6**	**Enterprise[a] N=50**	**Hertz[a] N=32**	**Avis[b] N=25**	**Budget[b] N=9**
Type of car rented						
Nonsmoker	1	3	26	10	7	3
Smoker	2	2	0	11	5	5
Unknown	0	1	24	11	13	1
Staff confirmed smoking designation of the requested car						
Smoking not allowed in nonsmoker cars	1	3	26	10	7	3
Smoking allowed in smoker cars	2	2	--	11	5	5
Smoking not allowed in cars, in general	--[c]	0	7	1	0	0
Staff did not mention any smoking policy	--[c]	1	17	9	13	1
Rental contract/documents state company policy about smoking						
Documents state smoking is not allowed in the car	0	0	39	0	1	0
Documents don't state anything about smoking policy	3	6	11	31	24	9

[a]Corporate official policy is that all cars are nonsmoker.
[b]Corporate official policy is that smoking is permitted in smoker cars.
[c]Not applicable.

Table 4.4 Informal exit interview upon return of rental car

Rental Experience	Rental Car Companies					
	Alamo/ National[a]	Dollar/ Thrifty[a]	Enterprise[a]	Hertz[a]	Avis[b]	Budget[b]
Company policy about smoking in rental cars						
Smoking allowed/No rules	0	0	1	1	5	1
All nonsmoker cars	3	5	45	16	10	5
Some smoker/some nonsmoker cars	0	1	0	14	6	2
Don't know	0	0	0	1	0	0
Didn't ask[c]	0	0	4	0	4	1
Method of detecting tobacco use in car						
Nothing	1	0	0	7	4	2
Physical inspection	1	1	8	4	2	3
Odor detection	0	3	19	8	7	2
Physical inspection & odor	1	0	12	6	1	1
Did not specify method	0	1	6	5	1	0
Don't know	0	1	0	2	0	0
Didn't ask[c]	0	0	5	0	5	1
Not applicable	0	0	0	0	5	0
Action taken if smoking policy violated						
Nothing	1	1	2	14	6	2
Clean/Detail	0	0	2	2	2	2
Car becomes smoker unit	0	1	0	5	0	0
Charge fine	2	2	17	5	2	2
Charge fine for detail	0	2	24	4	6	0
Don't know	0	0	1	1	0	1
Didn't ask[c]	0	0	4	0	4	1
Not applicable	0	0	0	1	5	1

[a]Corporate official policy is that all cars are nonsmoker.
[b]Corporate official policy is that smoking is permitted in smoker cars.
[c]Some branches were rented from more than once and an exit interview was not conducted since the representative recognized the confederate.

Table 4.4 Informal exit interview upon return of rental car (*Continued)*

	Rental Car Companies					
Rental Experience	**Alamo/ National[a]**	**Dollar/ Thrifty[a]**	**Enterprise[a]**	**Hertz[a]**	**Avis[b]**	**Budget[b]**
Fine charged for violating rules						
No	1	0	1	21	7	3
Yes	1	6	42	6	7	1
Depends	1	0	2	4	1	3
Don't know	0	0	1	1	0	0
Didn't ask[a]	0	0	4	0	4	1
Not applicable	0	0	0	0	6	1
Amount of fine						
$50 - <$75	1	0	13	3	1	3
$75 - <$100	0	0	10	1	3	1
$100+	1	2	19	1	3	0
Depends	0	0	1	2	1	0
Don't know	0	4	2	3	0	0
Didn't ask[a]	0	0	4	0	4	1
Not applicable	1	0	1	22	13	4
Frequency of success in collecting fine						
Never	0	0	1	0	1	0
Occasionally	0	1	15	4	2	2
Frequently	0	0	8	0	0	0
Always	1	1	15	0	3	0
Don't know	1	4	2	7	1	1
Didn't ask[a]	0	0	8	3	6	2

[a]Corporate official policy is that all cars are nonsmoker.

[b]Corporate official policy is that smoking is permitted in smoker cars.

[c]Some branches were rented from more than once and an exit interview was not conducted since the representative recognized the confederate.

Table 4.4 Informal exit interview upon return of rental car (*Continued)*

	Rental Car Companies					
Rental Experience	**Alamo/ National[a]**	**Dollar/ Thrifty[a]**	**Enterprise[a]**	**Hertz[a]**	**Avis[b]**	**Budget[b]**
Company policy about employee smoking						
No policy	1	0	5	3	2	1
Designated area	2	5	10	11	6	4
No smoking allowed	0	1	11	6	7	2
Don't know	0	0	16	9	3	0
Didn't ask[a]	0	0	8	3	7	2
Employee smoke inside rental car						
Yes	0	0	0	3	1	0
No	3	5	42	23	16	6
Don't know	0	1	0	2	1	0
Didn't ask[a]	0	0	8	4	7	2

[a]Corporate official policy is that all cars are nonsmoker.
[b]Corporate official policy is that smoking is permitted in smoker cars.
[c]Some branches were rented from more than once and an exit interview was not conducted since the representative recognized the confederate.

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CHAPTER 5

Conclusion

Smoking restrictions refer to a broad range of efforts by individual, families, communities, organizations, and businesses aimed at protecting nonsmokers from secondhand smoke exposure. Though increasing in popularity, their voluntary nature creates challenges in their establishment, implementation, and enforcement. The three papers presented in this dissertation examined the types of smoking restrictions that are in use in private homes and in rental car companies, with a focus on their implementation, and their impact on the pollution of private homes with THS toxicants.

Chapter 2 examined resident background and behaviors that affect agreement about the presence and agreement of a home smoking ban between pre-teens and their parents. Findings revealed 1) there is significant disagreement regarding smoking restrictions; 2) disagreements are partly a function of residents' smoking behavior and smoking-related practices; and 3) because of these disagreements, multiple reporters are needed to understand a family's smoking restrictions. Previous studies that used one reporter may be misreporting the true prevalence of home smoking bans due to misclassification of the household's smoker status, and therefore the protection of nonsmokers. Another important implication of this study is that it provided an insight as to why residents disagreed on the presence of a complete ban. Findings revealed that inconsistent smoking behaviors by residents lead to confusion among household members about smoking restrictions, and thus to discrepant reporting and enforcement.

Chapter 3 investigated the role of smoking restrictions on thirdhand smoke contamination in homes of smokers. Findings revealed that 1) smoking restrictions have a signifincant impact on SHS and THS regardless of the number of resident smokers; 2) smoking restrictions affect THS pollution through their indirect effect via SHS; and 3) remediation efforts affect THS in dust but not on surfaces. Surface nicotine deposits were persistent and not easily removed by remediation efforts nor prevented from adsorbing.

Chapter 4 examined smoking policies of rental car companies from the perspective of corporate headquarter, local branch, and customer. Findings revealed that though rental car companies had an official smoking policy, enforcement at the local branch level was inconsistent, failing to protect customers from THS. Despite having an official policy set by coporate management, some branches did not implement the policy while others did. This potentially exposes future customers to thirdhand smoke contamination. One of the reasons for this inconsistency is the lack of training and communication of the policy established by corporate to its employees. An important implication of this study is to inform the hospitality industry of potential targets for improvement in creating a smoke-free environment for their customers.

Challenges and potential barriers of voluntary smoking restrictions

Voluntary smoking restrictions are increasingly popular in settings where public smoking bans do not apply. While they are flexible, simple, and inexpensive to implement, this research has shown that these are also the reasons that limit their effectiveness. First and foremost, voluntary smoking restrictions often lack a clear definition of the restriction. Whether in the home or a business, there seems to be a

lack of details regarding what defines a smoking restriction. Another challenge is the lack of communication about the restriction. Residents and staff alike inconsistently communicated the restriction to guests and customers. Therefore, visitors and customers who smoke potentially violated restrictions they were unaware of. With regard to rental car companies, eagerness to make a profit now comes at the expense of later repercussions. Rental agents reverse fines to appease customers who complain about getting charged a fee for violating the smoking policy. This makes it difficult for employees to be reinforced for enforcing the restrictions. Furthermore, residents may believe that preventive and remediation efforts are adequate at minimizing SHS exposure and THS contamination, and therefore inconsistently implement smoking restrictions.

Future research direction

Effective voluntary smoking restrictions are important tools to reduce smoking and SHS and THS exposure because they may be the only tools to restrict smoking in private settings. Investigators interested in minimizing SHS and THS exposure in the home should focus on the household as a unit instead of select residents to ensure that all residents are aware and agree on the restrictions, and how to implement, monitor, and enforce them. Trained research staff can provide assistance in developing operational definitions of a smoke-free home or complete home ban that all residents understand and agree upon. Staff can focus on key targets such as communication of the restrictions to visitors, establishment of specific smoking locations, appropriate consequences for violation, reinforcement to smoke in smoking locations, preventive and remediation efforts, and measurement tools. Use of technology such as text

messaging can afford instant communications between participants and research staff of air quality, presence of toxicants, and allergens. Feedback on exposure and pollution with use of air monitors and biomarkers can accompany the study to provide objective measures.

As technological advances have made possible adaptive real time and telemetry systems, future studies may benefit from implementing such feedback contingencies in interventions.[1,2] It would be of interest to determine if feedback about secondhand smoke pollution and reinforcing contingencies would deter smokers from smoking inside the home and/or car, or adhere to a complete ban. The use of this technology, along with a clear definition of a complete ban, may encourage establishment of a truly smoke-free environment.

Researchers interested in examining the effectiveness of rental car companies' smoking policies can focus on companies such as Enterprise. A closer investigation of this company might inform other rental companies how to effecticely train employees and implement their policy. Although the use of confederates diminishes social desirability, a collaboration with the rental company may provide access to individuals who created the policy and documents such as training manuals. Also, approval from corporate headquarters may open doors at the local branch where all branch staff can answer surveys about the policy.

Final thoughts

Private homes and businesses are challenging settings for public tobacco control efforts due to the public's increasing concern over privacy and government interference. While public tobacco control efforts have been shown to affect smoking

behavior and smoking restrictions in private settings, the establishment and effective implementation of voluntary smoking restrictions is paramount in reducing non-smokers' exposure to SHS and THS in these settings. To this end, new means of initiating, implementing, monitoring, and enforcing restrictions is crucial. Of importance is that residents and companies make explicit the smoking restrictions, whether partial or complete, and develop a shared understanding of their implications. Additionally, consistent adherence to restrictions is pivotal in their success. Even though smoking restrictions in private settings are voluntary, this does not mean that they have to be accidental and haphazard. To be successful, they have to be part of a coordinated and planed effort in which individuals, families, and businesses recognize their independent role and critically important contribution to protect themselves from the exposure to tobacco smoke pollutants in settings where public polices do not apply.

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