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Pages 1–8

Third-hand smoke as a potential intervention message for promoting smoke-free homes in low-income communities

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Abstract

Third-hand smoke (THS) is the residual tobacco smoke contaminant that remains after a cigarette is extinguished. It can react with the indoor air pollutant nitrous acid to produce a carcinogen. Understanding perceptions of THS is critical, as it may inform the development of messages for promoting smoke-free homes. Six focus groups, of smokers and non-smokers, with 39 participants were conducted. Participants were asked whether they knew about THS and its harmful effects and whether it would motivate people to make their homes smoke free. They also answered questions about THS beliefs. Participants were mostly African-American, female and high-school graduate or General Educational Development (GED) recipients. Most of the participants had not heard about it and did not know what THS was. When asked about the dangers of THS, some participants made references to children indicating that they can easily inhale or ingest the residue leading to harmful effects. Almost all of the participants stated that they thought being educated about THS would motivate people to make their homes smoke free. There is a need for more scientific understanding of the potential dangers of THS and subsequent education about its exposure and harm to children and possibly adults.

Introduction

The term 'third-hand' smoke (THS) has been coined to describe the residual tobacco smoke contamination that remains after a cigarette is extinguished. Previous research has demonstrated that smoking in the home is linked to persistently high levels of tobacco toxins, long after active smoking has occurred there [1–3]. In fact, just a single day of smoking in an indoor setting exposes people to tobacco toxins within that setting in the future, potentially for days and even months. Specifically, these toxins exist in various forms, including particulate matter deposited in a layer onto surfaces indoors or as dust or other particles in the air [4, 5]. It also reacts with nitrous acid to form tobacco-specific nitrosamines, dangerous carcinogens [6, 7].

Extensive research has focused on detrimental health effects of cigarette smoking and second-hand smoke (SHS) exposure [1]. In addition, vast research has examined awareness of the negative health effects of smoking [8] and SHS exposure [9]. Smoke-free homes have been shown to reduce exposure to SHS for both non-smokers and children [1, 10]. Current population survey data showed that the national prevalence of US households with smoke-free home rules was 83.8% in 2006–07 [11]. Approximately 88 million non-smokers, aged 3 and older, were exposed to SHS from 2007 to 2008, with higher levels of exposure in children

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and youth [12]. Other disparities exist in exposure to SHS with higher prevalence in the home for persons with lower incomes and among non-Hispanic blacks [13]; this may be because they are less likely to have a total home smoking ban [11, 14].

Given the development of THS as a concern, far less research has focused on the perceived harm of THS exposure. Understanding perceptions of THS is critical, as it may be an effective intervention target for promoting smoke-free homes. One previous study using a nationally representative sample of adults examined perceptions of THS exposure in relation to smoking status and having smoke-free policies in the home [15]. They found that 65.2% of non-smokers versus 43.3% of smokers indicated a belief that THS harms children. Even controlling for other variables, belief that THS harms the health of children remained independently associated with rules prohibiting smoking in the home, whereas the belief that SHS harms the health of children was not independently associated with rules prohibiting smoking in the home and car. This finding suggests the powerful impact that knowledge regarding THS exposure may have in promoting smoke-free policies.

Given the potential importance of perceptions of THS in encouraging smoke-free policies, this study sought to examine knowledge and opinions of THS among a low-income population.

Methods

Design

We recruited participants from two county health department clinics in metro Atlanta and a county health department in rural southwest Georgia. Participants were recruited through fliers advertising the opportunity to discuss making homes smoke free, which were posted at health departments and in-person recruitment at participating clinics. Interested participants either called the research office and were screened for eligibility or were screened in-person. Each participant had to be 18 years or older, African-American or white, speak English, be a smoker living with at least one other person in the household or a non-smoker who lives with a smoker and not have a total smoking ban in the home. A total of 132 potential participants were screened for eligibility (41 were ineligible). Ninety-one were invited to participate. Six focus groups (3 with smokers and 3 with non-smokers) with 39 participants were conducted. Focus groups averaged 6 participants (range: 2–10).

Trained moderators facilitated the focus groups. Informed consent was obtained at the beginning of each group, and participants were asked to complete a short survey. All focus group discussions were audio-recorded, and a note taker recorded major themes. Focus groups lasted on average 79 min (SD = 14.87), and participants were compensated with a $35 gift card for their participation. The study protocol was approved by the Emory University Institutional Review Board.

Measures

The focus group guide was developed to solicit reactions to smoke-free home intervention materials and the concept of THS. THS was first defined as tobacco residue that stays after the cigarette has been put out and that the toxins linger in carpets, sofas, clothes and other materials hours or even days after a cigarette is put out. Open-ended questions regarding THS included what they have heard about it and beliefs that breathing air in a room today where people smoked yesterday could harm children. In addition, we asked whether a message about THS would motivate people to make their home smoke free. Participants also completed a short survey with items on general demographics, smoking in the home and attitudes about THS prior to the focus group discussion.

Beliefs about the harm of THS were also assessed by asking two close-ended items: ‘breathing in air in a room today where people smoked yesterday can harm the health of infants and children’ and ‘tobacco residue in dust and surfaces can harm children and adults in the home’. These items were measured on a four-point scale ranging from 0 (strongly disagree) to 4 (strongly agree) and were adapted from the study by Winickoff *et al.* [15].

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Analysis

All focus groups were recorded, transcribed verbatim and analyzed using standard qualitative data analysis procedures. The research team used an iterative process to develop a master coding structure [16, 17]. The codebook contained 11 primary upper level codes that included THS knowledge, perceived harm and motivation to make a home smoke free. Content analysis was conducted by two independent coders to identify themes, and matrices were constructed to help identify patterns by smoking status. Each coder reviewed transcripts independently, and coders resolved any discrepancies through discussions. Nvivo 8 was used for data storage, retrieval and analysis. Nvivo retrieved all passages associated with each upper level code stratified by group, and authors summarized these themes and found representative quotes. For the quantitative items, SPSS version 19.0 was used for data entry and descriptive analyses and significance tests.

Results

Overall, the participants were mostly African-American (89.7%), female (60.5%), married (35.9%) or single (33.3%) and high-school graduate or General Educational Development (GED) recipients (61.5%). The majority made <$35 000 and had 0 to 2 children in the home (91.9%). Within the three focus groups with smokers, the participants generally smoked everyday (51.3%) and lived with smokers (64.1%). In terms of smoking bans, 52.9% allowed smoking anywhere or in some places or times, 14.7% had a rule but had enforcement issues and 32.4% had no rules (Table I). In terms of beliefs about SHS, there was ~80% agreement or greater that breathing SHS was related to lung illness in children and lung cancer in adults (Table II). Only 56% of participants believed that SHS causes heart disease in adults.

Participants were also asked about their knowledge and attitudes about THS in the focus groups. Major themes are presented below.

Knowledge about third-hand smoke

When participants were asked whether they had heard of THS, most of the participants had not heard about it and did not know what THS was.

> I haven't heard anything about it (urban female non-smoker).
>
> It's my first time hearing about it (urban female smoker).

Although, most of the participants had not heard of THS, some of the participants thought that the concept was obvious once the term was defined. They indicated that they experienced the persistent effects of tobacco residue such as dust and the lingering smell of smoke in clothing and within their homes.

> Or, yeah, or just be more dusty. I didn't know that it would still let off toxins (Rural female smoker).
>
> I was just thinking, so you were saying that third-hand smoke, the residue would be there for days on whatever, and kids and grandkids come over, they touch the surface you mean to tell me it gets on them? (Urban female smoker)

When asked about THS in the survey, smokers were more likely to strongly agree that tobacco residue in dust and surfaces can harm children and adults in the home (3.39 versus 2.81) and that breathing air in a room today where people smoked yesterday can harm the health of infants and children than non-smokers (3.26 versus 2.69) (Table II).

Perceived harm of residue

Participants were asked whether they thought the residue in dust and on surfaces could harm adults and children in the home; most participants agreed. Some participants made references to children and the potential impact tobacco residue could have on their health. Some indicated that children can easily inhale or ingest the residue and that because of their developing systems may be more at risk as seen in Table III.

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Table I. *Focus group participants characteristics (n = 39)*

	Non-smoker (*N* = 16)	Smoker (*N* = 23)	Total (*N* = 39)	Significance (*P*)
Ethnicity				
White	0	4 (17.4%)	4 (10.3%)	0.078
African-American	16 (100%)	19 (82.6%)	35 (89.7%)	
Gender				
Male	7 (43.8%)	8 (36.4%)	15 (39.5%)	0.646
Female	9 (56.3%)	14 (63.6%)	23 (60.5%)	
Age, mean (SD)	48.2 (11.9)	46.1 (10.6)	46.9 (11.0)	0.575
Education attainment				
High-school graduate/General Educational Development or less	7 (43.8%)	17 (73.9%)	24 (61.5%)	0.058
Vocational/technical school/some college	7 (43.8%)	5 (21.7%)	12 (30.8%)	
College graduate or higher	2 (12.5%)	1 (4.3%)	3 (7.7%)	
Number of children in household				
Mean (SD)	1.07 (1.4)	0.55 (1.0)	0.76 (1.2)	0.194
0 children	7 (46.7%)	16 (72.7%)	23 (62.2%)	
1 child or more	8 (53.3%)	6 (27.3%)	14 (37.8%)[a]	
Annual household income				
<$15 000	6 (46.2%)	10 (52.6%)	16 (50%)	0.790
$15 001–25 000	3 (23.1%)	2 (10.5%)	5 (15.6%)	
$25 001–35 000	1 (7.7%)	1 (5.3%)	2 (6.3%)	
$35 001–74 999	3 (23.1%)	5 (26.3%)	8 (25.0%)	
$75 000 or more	0	1 (5.3%)	1 (3.1%)	
Smoking frequency				
Not at all	16 (100%)	0	16 (41.0%)	<0.001
Some days	0	3 (13.0%)	3 (7.7%)	
Every day	0	20 (87.0%)	20 (51.3%)	
Cigarettes smoked per day				
Average number (SD)	—	11.52 (9.03)	11.52 (9.03)	
Other smokers in household				
Yes	16 (100%)	9 (39.1%)	25 (64.1%)	<0.001
Number of other smokers in household				
Average number (SD)	1.44 (0.6)	1.13 (1.6)	1.29 (1.2)	0.489
Household smoking rules				
No rules	3 (21.4%)	8 (40.0%)	11 (32.4%)	0.198
Allowed anywhere or some places or sometimes	8 (57.2%)	10 (50.0%)	18 (52.9%)	
Not allowed anywhere	3 (21.4%)	2 (10.0%)	5 (14.7%)	

[a]Individuals reported having a total ban but had problems with enforcing the ban.

Most of the participants had experienced the effects of tobacco residue in places such as their clothing, furniture, walls, floors, carpet, curtains and hard surfaces. One participant commented:

> Do you know if you smoke in the house and you go to another place and you see how clean it is, you don't see the residue on the curtains or the blinds (urban male smoker)

Perceived harm of the air

Participants stated that they thought that breathing air in a room today where people smoked yesterday could harm the health of children and adults because the smell lingers. Participants agreed that the air could still be harmful and have remaining toxins from the day before. They stated that even after cleaning, chemicals from SHS may stay in the home (Table III).

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Table II. *Attitudes about second-hand smoke and third-hand smoke*

	Non-smoker ($N = 16$)	Smoker ($N = 23$)	Total ($N = 39$)	Significance (P)
Breathing smoke from other people's cigarettes causes heart disease, *n* (%)	11 (73.3)	9 (42.9)	20 (55.6)	0.07
Breathing smoke from other people's cigarettes causes lung illness in children, *n* (%)	12 (80.0)	16 (80.0)	28 (80.0)	1.00
Does breathing smoke from other people's cigarettes causes lung cancer in adults, *n* (%)	14 (87.5)	18 (85.7)	32 (86.5)	0.88
Tobacco residue in dust and surfaces can harm children and adults in the home, mean (SD)[a]	2.81 (1.3)	3.39 (0.9)	3.03 (0.98)	0.13
Somewhat/strongly agree	10 (62.5%)	21 (91.3%)	31 (79.5%)	
Somewhat/strongly disagree	6 (37.5%)	2 (8.7%)	8 (20.5%)	
Breathing air in a room today where people smoked yesterday can harm the health of infants and children, mean (SD)[a]	2.69 (1.1)	3.26 (.9)	3.15 (1.1)	0.074
Somewhat/strongly agree	10 (62.5%)	19 (83.6%)	29 (74.4%)	
Somewhat/strongly disagree	6 (37.5%)	4 (17.4%)	10 (25.6%)	

[a]A higher mean indicates great agreement.

Table III. *Themes related to third-hand smoke*

Theme/question	Sample quote
Do you think this type of residue in dust and on surfaces could harm adults and children in the home?	'Well it is depending on the air circulation and the fiber contents of the room you know those things are retaining the smoke odor, and you know I know children have, their immune systems are not as fully developed as an adult and their sensitivities can be stronger, I mean are more sensitive than adults can be' (urban female nonsmoker).
	'Here comes the children, they can rub their hands across whatever and put their hands in their mouth' (urban female nonsmoker)
	'So I think it, it takes effect, one way or another . . . Because if it's, she's in the house and it's lingering on everything, she's still breathing in'. (urban female smoker)
	'. . . environmental effects and all of that that's going on with that in terms of infants and children's performance in school, all that. I'm sure. And we'll see, smoking, breathing in second hand smoke or third hand smoke will have an adverse effect on your developmental period in life or infants and children' (urban female nonsmoker)
Do you think breathing in air in a room today where people smoked yesterday can harm the health of infants and children?	'Because it still holds the, the toxins and you're still breathing it'(urban female nonsmoker)
	'. . . I think it stays, you know what I'm saying? Even if you clean up I still think some still stays in the house, because I have asthma and stuff' (urban female nonsmoker)
	'I think so because cigarettes have fiberglass and stuff in it, so when you smoke you know I think all that goes up in the air and it's going to stay in the air until you clean it out, you know, or get it to air out' (urban female nonsmoker)
Do you think this message would motivate people to make their home smoke-free? Why or why not?	'Yeah, Just the care of the children really. I mean, if they got or especially if they're around, if somebody comes in their house that they don't think is sensitive to it or something, it would still affect them' (rural female smoker)
	'I think it might be an additional motivator, there is a lot of information out there about not smoking and the effects of smoking, and if this is yet another thing that happens, another negative associated with smoking and more people hear about how negative it is then it could have an effect . . .'(urban female nonsmoker)
	'Because we'll be affecting other people lives' (urban female smoker)
	'Not only yours, but especially a small child' (urban female smoker)

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Motivation

Almost all of the participants stated that they thought the message of THS would motivate people to make their homes smoke free. They stated that people would be persuaded because of the effects of cigarette smoke on children and other people they may live with (Table III).

Only a few stated that the messages would not make a difference and would not motivate everyone to make their homes smoke free. They indicated that people who do not care about the health of others are not likely to be motivated by the messages. Some participants also stated that because smoking is addictive, the messages would not have an impact, especially among people who have a long history of smoking. However, one person mentioned if someone was unconvinced about the dangers of smoking, then it could help change his mind.

> I think it has minimum impact, some people, you know what we've learned about the addictive nature of smoking is significant for some people and you know it just amazes me how it really has such a grip on folks. And I think most people would prefer not to be smokers but breaking that habit can be a tremendous obstacle (urban female nonsmoker)

> . . . I can't think that it would have a significant effect on someone who already knows about the impact of first hand smoking, and second hand smoking, you know if somebody's on the fence it might make a difference (urban female nonsmoker)

Discussion

This is the first focus group study to explore opinions about THS. Overall, many participants in our study had not heard about THS and did not know what the term meant. Once the definition was given to them, many agreed that residue in dust and on surfaces could harm adults and children in the home. Ratings on agreement of the harms of THS in the survey were also validated by qualitative data from the focus groups. Some participants made references to children specifically and the potential impact on their health. Almost all of the participants stated that they thought the message of THS would encourage people to make their homes smoke free. Interestingly, knowledge about the effects of SHS on heart disease was also moderately low.

Responses about SHS and THS knowledge and beliefs from these focus groups have important implications for tobacco control. Emphasis can also be given on educating about the relationship between SHS and heart disease to communities in addition to messages on its effects about lung cancer and asthma. There needs to be greater education about THS and how it can impact the health of others in the home, especially as evidence about its harmfulness begins to accumulate. Particularly, emphasizing the effect on the health of children is a salient message that may resonate with parents and grandparents. Second, smokers may be receptive to messages about THS and could be encouraged to smoke outside. The difference between smokers and non-smokers in this study, although not statistically significant, did trend toward smokers having higher level of agreement that THS is harmful. This finding in our population differs from the findings of Winickoff *et al.* [15] that a greater proportion of non-smokers compared with smokers indicated a belief that THS harms children, and therefore, potential differences in attitudes among different populations may require further study. Compared with non-smokers who live with smokers, smokers themselves may be more receptive because they more often observed and complained about the stains and residue on surfaces in their homes. Third, THS may be another strong message to promote smoke-free homes in addition to the health consequences of smoking and SHS. Messages that reinforce that THS remains for months, and even after cleaning the home or replacing carpet or paint, could be an important deterrent to smoking in the home [4]. The inclusion of THS in educational initiatives for communities creates stronger justification for increasing the prevalence of smoke-free

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homes. Kegler *et al.* [18] have incorporated messages about THS in their educational materials to promote a home smoking ban in a pilot study and found that 33% of participants ($n = 40$) reported making their homes smoke free.

This study has several limitations. The focus groups were conducted in one urban city and one rural county and may not be generalizable to other places. There may have been a tendency to offer socially desirable answers in a focus group; however, we did see the full range of responses, strongly disagree to strongly agree, to items about THS.

There is a need for more research, awareness and education about THS exposure and its harm to children and possibly adults. Research is warranted to understand the levels of THS carcinogens on household surfaces, pathways for their entry into humans and health effects. Educational and policy interventions may benefit by highlighting the exposure and health risks of THS as another critical reason for promoting smoke-free environments. Studies could also explore the cost of remediation, or clean up, of THS as a motivator to having a smoke-free home. In addition, further study is needed to understand the environmental effects of THS in cars and beliefs about THS in cars through survey research or focus group discussions. Currently, there are policies about SHS in cars when children are present; however, these policies do not address THS exposure. Furthermore, quantitative surveys designed to assess perceptions regarding THS are needed to understand this phenomenon and to evaluate educational efforts for increasing its awareness.

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Conflict of interest statement

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