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Thirdhand Smoke Beliefs and Behaviors among Healthcare Professionals

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Abstract

Thirdhand smoke (THS) refers to tobacco smoke contaminants and by-products that remain in the environment after a cigarette is extinguished. The purpose of this study was to assess beliefs and behaviors regarding THS among healthcare professionals, and to examine associations among smoking attitudes/beliefs, provider demographics, and THS beliefs and behaviors. Healthcare professionals (N = 204) at a comprehensive cancer center and affiliated general hospital in a northeastern urban area completed online questionnaires. About one third of the respondents had heard of THS before completing the survey, and more than two thirds of the sample believed that THS issues do not receive enough attention. Being female, likelihood of discussing THS with others, endorsing the belief that smoking affects the quality of parenting, and support for government action towards smoking bans were significantly associated with providers' belief that THS is harmful. Endorsing the belief that smoking affects the quality of parenting and belief that THS is harmful were significantly associated with the likelihood of discussing THS with others. Findings shed light on THS beliefs and behaviors of healthcare providers (a group of individuals that could be trained to educate and advise patients about THS) and inform recommendations for new tobacco policies and clinical guidelines for best practices in tobacco control and prevention.

Keywords

tobacco; smoke exposure; carcinogen; environmental health; attitudes

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The effects of cigarette smoke on the health of smokers and those around them are well-known (CDC, 2012). However, “thirdhand smoke” has recently been gaining attention as having potentially harmful health effects to those exposed. Thirdhand smoke (THS) is

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defined as the tobacco smoke contaminants and by-products that remain in materials such as clothing after extinguishing a tobacco product (Matt et al., 2011; Sleiman et al., 2014). Residual nicotine from tobacco smoke gets absorbed onto surfaces and reacts with ambient nitrous oxide to form carcinogenic tobacco-specific nitrosamines (Sleiman et al., 2010). This aerosol mass can then be easily ingested, inhaled, or absorbed through the skin and may be more harmful to children and infants than adults (Becquemin et al., 2010). Nonsmokers living in homes previously inhabited by smokers may be exposed to THS through carcinogenic dust and/or contaminated surfaces (Matt et al., 2011; Ramirez et al., 2014; Thomas et al., 2014). THS can remain on fabrics for more than 1.5 years (Bahl, Jacob, Havel, Schick, & Talbot, 2014).

The effects of THS on human health have not been thoroughly examined, but evidence indicates that THS may negatively impact health. A study by Hang and colleagues (2013) demonstrated that THS exposure causes significant DNA damage to human cells. In vivo studies also confirmed that THS is highly toxic to fibroblast and neurocytes, and zebrafish development was delayed with many embryos dying following exposure to textiles contaminated with cigarette smoke (Hammer, Fischer, Mueller, & Hoefer, 2011). Mice exposed to THS exhibited changes in liver metabolism, excess collagen production and higher levels of inflammatory cytokines in the lungs, poor healing of skin wounds, and hyperactive behavior (Martins-Green et al., 2014).

Only a few studies to date have examined beliefs regarding THS, and these studies have focused primarily on adults from the general population. Winickoff and colleagues (2009) found that 65% of nonsmokers and 43% of smokers from a national sample believed that THS was harmful to children. Secondary data analyses from an RCT designed to address parental tobacco use via pediatrician offices showed that 91% of parents believed THS was harmful to children and infants, though fathers and heavy smokers were less likely to endorse this belief (Drehmer et al., 2012). In addition, parents who reported receiving advice during their pediatrician visit regarding quitting smoking or maintaining a smoke-free home or car were more likely to endorse the belief that THS is harmful to children and infants. Believing that THS is harmful was also associated with making at least one quit attempt (Drehmer et al., 2014).

Little is known about healthcare professionals' beliefs about THS and related communication practices. An assessment of these beliefs in healthcare professionals would be valuable, as this population tends to be highly respected by the community regarding health matters, and healthcare consumers may heed the advice of healthcare professionals (Drehmer et al., 2012; Moseley, Freed, & Goold, 2011; Oberg & Frank, 2009). For example, interventions for health behavior change utilizing advice from health professionals tend to be impactful (Rice & Stead, 2008; Stead et al., 2013). Therefore, understanding providers' knowledge and beliefs about THS, as well as their attitudes about educating patients and the public about its dangers, are important steps toward improving best practice guidelines prompting providers' tobacco control practices. The purpose of the current study was to assess knowledge, beliefs, attitudes, and health education practices regarding THS among hospital-based healthcare professionals. Specifically, we examined associations between the belief that THS is harmful and likelihood of discussing THS with others, with smoking

attitudes and beliefs, and demographic variables such as providers' gender (Drehmer et al., 2012; Moseley et al., 2011; Oberg & Frank, 2009). We hypothesized that endorsing the belief that THS is harmful, as well as the self-reported likelihood of discussing THS with others, would be associated with being a non-smoker, being female, and negative attitudes regarding smoking, such as support for public smoking bans and government action towards banning smoking.

Methods

Participants and procedures

Healthcare professionals ($N = 204$) recruited via electronic announcements and emails sent to all employees of a comprehensive cancer center and affiliated general hospital in Philadelphia completed a brief anonymous online questionnaire. In case participants had not heard of thirdhand smoke (THS) prior to completing the survey, all surveys began with the statement "Thirdhand smoke refers to residual tobacco smoke pollutants that linger on surfaces, fabrics, and in dust after cigarette smoking."

Measures

Thirdhand smoking attitudes—Respondents were asked if they had ever heard of THS, with response options being yes, no, and not sure. Based on an item adapted from the Secondhand Smoke Survey for Central and Western Minnesota (Schwarzwalter, Danielson, Rathge, & North Dakota State Data Center, 2005), respondents were then asked if they thought issues regarding THS are receiving too much, not enough, or just the right amount of attention.

Respondents were also asked to indicate their likelihood of discussing THS with others (hospital patients and families, as well as their own family and friends). Response options ranged from 1 to 5 (1 = "not likely at all", 5 = "very likely"). Respondents were asked to indicate how informed the following groups are regarding THS issues: people in the area where they currently live, people in their workplace, and people in general (adapted from items by Schwarzwalter and colleagues) (2005). Response options were: not at all informed, somewhat informed, very informed, and not sure.

A seven-item scale was developed to assess the belief that THS is harmful. Three items were adapted from Schwarzwalter and colleagues (2005) (e.g., "People should be protected from thirdhand smoke."). The remaining four items presented smoking-related scenarios, adapted from a scenario used in a measure by Winickoff and colleagues (2009) (e.g., "Moving into an apartment where a smoker lived for the past year may be harmful to the health of an infant or child."). All seven items were scored on a five-point Likert scale of agreement, and internal consistency across the seven items was very good ($\alpha = 0.94$).

Smoking behaviors and attitudes—Respondents were asked to indicate how many cigarettes they smoke per day. Responses were categorized into never smoked, used to smoke but quit, and smokes more than one cigarette per month. Participants were also asked to indicate if anyone else in their household smokes.

An item was adapted from Winickoff and colleagues (2009) to assess rules for smoking at home and in one's car. We also assessed accuracy of knowledge of the workplace smoking policy by asking respondents to indicate their workplace's current smoking policy (workplace smoking policy is a complete smoking ban, including outdoor property). Respondents also indicated their preference regarding smoking policy (i.e., complete smoking ban, smoking allowed a certain distance from buildings, no smoking restrictions, or not sure/other) (Schwarzwalter et al., 2005). Using items from Schwarzwalter and colleagues (2005), respondents were asked to indicate how much they agreed with statements that banning smoking in public places discriminates against smokers, and that it is the responsibility of the government to enforce policies and regulations to protect citizens against cigarette smoke. These two items were scored on a five-point Likert scale.

Perceived smoking norms were assessed by having respondents indicate the percentage of people in the Philadelphia metropolitan area that they believed to be smokers. Four items, adapted from items by Wagener and colleagues (2010), were created to assess beliefs regarding conflict between parental smoking status and parental roles (e.g., "Smoking can interfere with one's role as a parent."). Items were scored on a five-point Likert scale, and internal consistency for our sample was good ($\alpha = 0.81$).

Demographics—Respondents were asked to indicate their race/ethnicity, education, sex, marital status, age, occupation (physician, nurse, or other), and whether they live in an owned or rented household.

Data analysis plan

There were two main variables of interest: belief that THS is harmful and likelihood of discussing THS with others. Univariate analyses were conducted to examine the relationship between these variables of interest and the other study variables, using Pearson's correlations, one-way analysis of variance (ANOVA), and independent samples *t*-tests. Finally, a multivariable linear regression model was constructed and carried out based on significant univariate results (i.e., any univariate results with $p < .05$).

Results

Descriptive statistics of study variables are reported in Table 1, with variables categorized as demographics, attitudes regarding thirdhand smoke (THS), and smoking behaviors and attitudes. About 35% of the sample had heard of THS before completing the survey, and about 69% believed that THS issues do not receive enough attention.

Univariate analyses

An ANOVA showed that smoking status (never, former, or current) was associated with the belief that THS is harmful, $F(2, 195) = 4.90, p = .008$. A Scheffé post hoc test indicated that current smokers ($M = 3.5, SD = 0.6$) were less likely to endorse the belief that THS is harmful, relative to never ($M = 4.2, SD = 0.7$) and former smokers ($M = 4.1, SD = 0.8$).

Pearson's correlations showed that endorsing the belief that THS is harmful was significantly positively correlated with the likelihood of discussing THS with others ($r =$

0.51, $p < .001$). Both endorsing the belief that THS is harmful and the likelihood of discussing THS with others were positively correlated with greater perceived local smoking norms ($r = 0.15$, $p = .04$, and $r = .23$, $p = .001$, respectively), the belief that smoking affects quality of parenting ($r = 0.47$, $p < .001$, and $r = 0.25$, $p < .001$, respectively), and the belief that smoking bans do not discriminate against smokers ($r = -0.36$, $p < .001$, and $r = -0.16$, $p = .03$, respectively). Endorsing the belief that THS is harmful was significantly positively correlated with the belief that it is the responsibility of the government to protect citizens from cigarette smoke ($r = 0.27$, $p < .001$).

Independent samples t -tests showed that those who prefer a more lenient workplace smoking policy were less likely to endorse the belief that THS is harmful, $t(36) = -3.87$, $p < .001$, and reported a lower likelihood of discussing THS with others, $t(200) = -2.36$, $p = .02$, relative to those who prefer a complete no-smoking ban at work. Those who said they were not aware of the current smoking policy at their workplace reported a lower likelihood of discussing THS with others, $t(200) = -2.88$, $p = .004$, and were marginally less likely to endorse the belief that THS is harmful, $t(196) = -1.95$, $p = .05$, relative to those who said they were aware of their workplace smoking policy. Men were also less likely to endorse the belief that THS is harmful ($M = 3.7$, $SD = 0.6$), relative to women ($M = 4.2$, $SD = 0.7$), $t(190) = 2.70$, $p = .008$.

Multivariable models

Two multivariable linear regression models were run to examine predictors of beliefs about THS being harmful and the likelihood of discussing THS with others (see Table 2). Models included the following variables: sex, smoking status (current vs. former or never), perceived smoking norms, the belief that smoking affects quality of parenting, the belief that smoking bans discriminate against smokers, the belief that it is the responsibility of the government to protect citizens from cigarette smoke, awareness of workplace smoking policy (correct vs. incorrect), and preference regarding smoking policy in the workplace (preference for a complete no smoking policy vs. preferring a more lenient policy). Beliefs about THS being harmful was included in the model examining predictors of the likelihood of discussing THS, and vice versa.

Regarding beliefs about THS, the overall model was significant, $F(9, 174) = 18.27$, $p < .001$, accounting for almost 50% of the variance in belief that THS is harmful ($R^2 = 0.49$). When controlling for other variables, men continued to be less likely to endorse the belief that THS is harmful, $t(174) = 2.38$, $p = .02$. Likelihood of discussing THS with others, $t(174) = 6.37$, $p < .001$, and endorsing the belief that smoking affects quality of parenting, $t(174) = 3.56$, $p < .001$, were also associated with the belief that THS is harmful. Endorsing the belief that smoking bans discriminate against smokers was negatively associated with endorsing the belief that THS is harmful, $t(174) = -2.14$, $p = .03$, whereas endorsing the belief that it is the responsibility of the government to protect citizens from cigarette smoke was positively associated, $t(174) = 3.53$, $p = .001$.

Regarding the likelihood of discussing THS with others, the overall model was significant, $F(9, 174) = 9.06$, $p < .001$, accounting for 32% of the variance. When controlling for other variables, endorsing the belief that THS is harmful, $t(174) = 6.37$, $p < .001$, and perceiving

smoking as being more common in the metropolitan area, $t(174) = 2.01, p = .05$, were associated with a greater likelihood of discussing THS with others.

Discussion

The purpose of this study was to assess beliefs, attitudes, and health education practices regarding THS among healthcare professionals employed at a cancer center and affiliated general hospital, and to explore associations with smoking attitudes and beliefs. A little more than one third of the sample had heard of THS before completing the survey, and more than two thirds of the sample believed that THS issues do not receive enough attention. Though respondents overall reported believing that THS is harmful, results were mixed regarding likelihood of discussing THS with others. Given that secondhand smoke is a known carcinogen, we expected healthcare providers affiliated with a cancer center to be more alert to the emerging evidence around THS, and that they would report being more likely to discuss the potential harm with patients.

Being female, likelihood of discussing THS with others, support for government action towards banning smoking, and believing that smoking affects quality of parenting were associated with the belief that THS is harmful, while perceiving smoking as being a common behavior and belief that THS is harmful were significantly related to the likelihood of discussing THS with others. Results suggest that believing that THS is harmful is associated with negative attitudes about smoking in general, such as support for public smoking bans and government action towards banning smoking. That smoking status was not statistically significant in the multivariable model illustrates the potentially crucial role of attitudes about smoking when examining beliefs about the harmfulness of THS. This result should be viewed with caution, however, given the small number of smokers in our sample.

Results showed that understanding or believing that THS is harmful was associated with a greater likelihood of providers discussing THS with others. Improving provider education about THS could increase the likelihood that more smokers and patients exposed to THS receive information from providers, who are a credible source of health education that can improve motivation to quit or reduce smoke exposure. This may be especially beneficial for parents who smoke, as believing that quitting will benefit one's own children is associated with successful quit attempts (Mahabee-Gittens et al., 2014). Since our results did not suggest that attitudes about smoking relate to likelihood of discussing THS, these results further point to the importance of educating providers about the dangers of THS. Doing so may shape perceptions of smoking restrictions and improve harm reduction advice practices.

We replicated previous findings showing that men are less likely to believe that THS is harmful, relative to women (Drehmer et al., 2012). Men are more likely to be cigarette smokers than women (CDC, 2013) and report fewer intentions to quit smoking (Sorensen et al., 2013). Men also tend to report lower perceived risk of lung cancer (Costello, Logel, Fong, Zanna, & McDonald, 2012) and are less receptive to smoke-free policies (Berg et al., 2011). Smoke exposure education campaigns should consider that men may be less receptive

and should make efforts to ensure that campaign messages and materials are appropriate and targeted for men.

The study had some limitations. Specifically, THS as a research topic is still so new that the health effects are not completely known. However, previous research provides evidence for potentially dangerous toxicity of THS (Hammer et al., 2011; Hang et al., 2013; Matt et al., 2011). In addition, some of the assessment tools used for this study were not validated for its current use, as many of these items were adapted from measures assessing beliefs regarding secondhand smoke (Schwarzwalter et al., 2005). Finally, we used a convenience sample of healthcare providers at a comprehensive cancer center and affiliated general hospital.

The study had several strengths, however. First, we added to findings in a relatively new area of research. We examined THS-related beliefs in healthcare professionals, who are often regarded as an authority on health behaviors and risk (Moseley et al., 2011; Oberg & Frank, 2009). A previous study in this area showed that parents being given information by a pediatrician about maintaining a smoke-free environment increased the likelihood of these parents believing that THS is harmful to children (Drehmer et al., 2012). Second, we examined beliefs about and likelihood of discussing THS in association with smoking status and more general attitudes towards smoking and smoke-free policies, which helps elucidate potential messages and groups to target in smoke exposure educational campaigns. Therefore, the study findings have implications for public health.

In summary, the current study identified associations between beliefs about THS being harmful and likelihood of discussing THS with general attitudes about smoking, as well as gender. This study provides information about factors that could influence provider practices regarding exposure to passive tobacco smoke, which is an important step towards improving tobacco control efforts. As future research reveals the health effects of THS, educational campaigns should be developed, especially for healthcare professionals, who in turn may educate families, particularly those with small children. In addition, researchers and healthcare professionals should recognize exposure to THS as a potential carcinogen and public health challenge.

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Table 1Descriptive Statistics (N = 204) ^a

Demographics	n (%)
<i>Ethnicity</i>	
Hispanic or Latino	6 (3.0)
<i>Race</i>	
White	186 (93.0)
Asian-American	5 (2.5)
Black	5 (2.5)
Other/Mixed	4 (2.0)
<i>Education</i>	
High school/GED	2 (1.0)
Partial college, Associate degree, or vocational	48 (24.0)
Standard college or university graduate	66 (33.0)
Graduate degree or professional training	84 (42.0)
<i>Sex</i>	
Female	176 (89.3)
Male	21 (10.7)
<i>Relationship status</i>	
Single or casually dating	18 (8.9)
In a committed relationship or engaged	28 (13.8)
Married	137 (67.5)
Separated or divorced	11 (5.4)
Widowed	9 (4.4)
<i>Work position</i>	
Physician	16 (7.8)
Nurse	113 (55.7)
Other ^a	74 (36.5)
<i>Household type</i>	
Own	175 (87.9)
Rent	24 (12.1)
	<i>M (SD)</i>
Age	48.0 (11.9)
Thirdhand smoke variables	n (%)
<i>Have you heard of thirdhand smoke before now?</i>	
Yes	71 (35.0)
No	114 (56.2)
Not sure	18 (8.9)
<i>How much attention do you think thirdhand smoke is receiving?</i>	
Not enough attention	140 (68.6)
Just the right amount of attention	23 (11.3)

Demographics	<i>n</i> (%)
Too much attention	8 (3.9)
Not sure	33 (16.2)
<i>How informed are the following groups regarding thirdhand smoke?</i>	
<i>People where you live</i>	
Not at all informed	108 (53.7)
Somewhat informed	53 (26.4)
Very informed	6 (3.0)
Not sure	34 (16.9)
<i>People in your workplace</i>	
Not at all informed	68 (34.0)
Somewhat informed	79 (39.5)
Very informed	34 (17.0)
Not sure	19 (9.5)
<i>People in general</i>	
Not at all informed	123 (60.9)
Somewhat informed	45 (22.3)
Very informed	3 (1.5)
Not sure	31 (15.3)
	<i>M (SD)</i>
Beliefs that thirdhand smoke is harmful	4.1 (0.7)
Likelihood of discussing thirdhand smoke with others	3.4 (1.0)
Other smoking variables	
<i>n</i> (%)	
<i>Accurate knowledge of workplace smoking policy</i>	
Correct	185 (90.7)
Incorrect or not sure	19 (9.3)
<i>Prefers a no-smoking policy at workplace</i>	
Prefers a campus-wide no-smoking policy	170 (83.3)
Prefers a more lenient smoking policy	34 (16.7)
<i>Household smoking rules</i>	
Smoking is allowed in some parts of the home	15 (7.4)
Smoking is not allowed indoors but is allowed on the property outdoors	135 (66.2)
Smoking is not allowed, even on the property outdoors	54 (26.5)
<i>Smoking status</i>	
Never smoker	166 (81.4)
Former smoker	27 (13.2)
Current smoker	11 (5.4)
<i>Smoker in household (excluding respondent)</i>	
Other smoker lives in household	41 (20.6)
	<i>M (SD)</i>
Perceived smoking norms	43.9 (17.8)
Belief that smoking affects quality of parenting	4.4 (0.7)

Demographics	<i>n</i> (%)
Belief that smoking bans discriminate against smokers	2.2 (1.2)
Belief that it is the government's responsibility to protect people from cigarette smoke	3.5 (1.3)

Note:

^aMost frequent "other" positions are: allied health professional (e.g., pharmacist, physical therapist, *n* = 28), technician (e.g., x-ray technician, surgical technician, *n* = 12), assistant (e.g., medical assistant, surgical assistant, *n* = 9)

Linear Regression Models Examining Predictors of Beliefs about Thirdhand Smoke (THS) Being Harmful and Likelihood of Discussing THS (n = 184)

Table 2

Variables	Beliefs about THS being harmful ^a			Likelihood of discussing THS ^b		
	B	SE	sr ²	B	SE	sr ²
Male	0.32	0.13	0.02 ^c	-0.27	0.22	0.01
Beliefs about THS being harmful	-	-	-	0.72	0.11	0.16 ^e
Likelihood of discussing THS with others	0.26	0.04	0.12 ^e	-	-	-
Current smoker	-0.07	0.19	<0.01	-0.11	0.31	<0.01
Perceived smoking norms	0.00	0.00	0.01	0.01	0.00	0.02 ^c
Belief that smoking affects quality of parenting	0.23	0.06	0.04 ^e	0.09	0.11	<0.01
Belief that smoking bans discriminate against smokers	-0.08	0.04	0.01 ^c	0.01	0.06	<0.01
Belief that it is the government's responsibility to protect people from cigarette smoke	0.11	0.03	0.04 ^d	-0.08	0.05	0.01
Correct knowledge of workplace smoking policy	0.07	0.14	<0.01	0.40	0.23	0.01
Prefers a no-smoking policy at workplace	0.17	0.13	0.01	0.06	0.21	<0.01

^a $R^2 = 0.49$, $F(9,174) = 18.27$, $p < .001$;^b $R^2 = 0.32$, $F(9,174) = 9.06$, $p < .001$;^c $p < .05$;^d $p < .01$;^e $p < .001$