

Thirdhand Smoke Beliefs of Parents



WHAT'S KNOWN ON THIS SUBJECT: Little is known about how thirdhand smoke beliefs are related to smoking and quitting behaviors, and how parental smokers' thirdhand smoke beliefs influence behaviors to protect children. A previous study suggests thirdhand smoke beliefs are associated with home smoking bans.



WHAT THIS STUDY ADDS: This is the first study to show that parents' beliefs about thirdhand smoke are associated with multiple smoking-related attitudes and behaviors that affect the health of children.

abstract



OBJECTIVE: To determine if the belief that thirdhand smoke is harmful to children is associated with smoking parents' attitudes, home or car smoking policies, and quitting behaviors.

METHODS: Data from a national randomized controlled trial, Clinical Effort Against Secondhand Smoke Exposure, assessed thirdhand smoke beliefs of 1947 smoking parents in an exit survey after a pediatric office visit in 10 intervention and 10 control practices. Twelve-month follow-up data were collected from 1355 parents. Multivariable logistic regression determined whether belief that thirdhand smoke harms the health of children is independently associated with parental behaviors and attitudes 12 months later. A χ^2 test assessed whether parents who disagreed that thirdhand smoke is harmful were more likely to make a quit attempt if they later believed that thirdhand smoke is harmful.

RESULTS: Belief at the exit survey that thirdhand smoke is harmful was independently associated with having a strictly enforced smoke-free home policy (adjusted odds ratio: 2.05; 95% CI: 1.37–3.05) and car policy (adjusted odds ratio: 1.69; 95% CI: 1.04–2.74) at the 12-month follow-up. A significantly higher percentage (71% vs 50%) of parents who did not hold the thirdhand smoke harm belief at baseline made at least 1 quit attempt if they agreed that thirdhand smoke is harmful at the 12-month follow-up ($P = .02$).

CONCLUSIONS: Thirdhand smoke harm belief was associated with a strictly enforced smoke-free home and car and attempts to quit smoking. Sensitizing parents to thirdhand smoke risk could facilitate beneficial tobacco control outcomes. *Pediatrics* 2014;133:e850–e856

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KEY WORDS

smoking, tobacco, thirdhand smoke, pediatrics, family practice, parent, smoking cessation, secondhand smoke, environmental tobacco smoke, tobacco control

ABBREVIATIONS

AAP—American Academy of Pediatrics

CI—confidence interval

Mr Dreher conceptualized and designed the analysis, drafted and revised the manuscript, conducted the data analyses, and takes full responsibility for the final submission; Dr Winickoff conceived of and conducted the larger trial as principal investigator, made substantial intellectual contributions to the conception and design of the study, and critically reviewed the manuscript; Dr OSSIP, Dr Nabi-Burza, Dr Rigotti, Ms Hipple, Dr Woo, and Dr Chang made substantial intellectual contributions to the conception and design, analysis and interpretation of data, and editing of the manuscript; and all authors approved the final manuscript as submitted.

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Thirdhand smoke is a toxic residue that settles on indoor surfaces and remains long after tobacco smoking has taken place. Thirdhand smoke can persist on surfaces for weeks to months.^{1,2} It undergoes chemical transformations as it ages with ozone³⁻⁵ and nitrous acid⁶ gases that are commonly present in homes⁷ and cars⁶ to produce secondary highly carcinogenic pollutants such as formaldehyde⁵ and the tobacco-specific nitrosamines 4-(methylnitrosamino)-4-(3-pyridyl)butanal (NNA) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK).^{6,8} People can be exposed to thirdhand smoke through inhalation, ingestion, or dermal uptake.² Infants and young children are likely exposed to more thirdhand smoke than adults because they breathe faster, have thinner skin, and spend more time in the home and on the floor where dust collects, is disturbed, and is resuspended into the air.⁹ A recent study examining the genotoxicity of thirdhand smoke revealed that human cells exposed to acute or chronic levels of thirdhand smoke had significant increases in DNA strand breaks,¹⁰ and findings from another new study showed that the potent lung carcinogen NNK is present on the surfaces of most smokers' homes.¹¹ As scientific evidence regarding potential serious health risks from exposure to thirdhand smoke increases, it is important to know if informing parents about the risks associated with thirdhand smoke can facilitate beneficial tobacco control outcomes.

Little is known about how thirdhand smoke beliefs emerge and evolve,² how they are related to smoking and quitting behaviors, and how parental smokers' beliefs influence their behaviors to protect their children from thirdhand smoke. Research has revealed that perceived vulnerability to smoking-related diseases¹² as well as perceived benefits of quitting smok-

ing¹³ are associated with successful smoking cessation. The Health Belief Model suggests that people can be motivated to make proactive behavior changes in an effort to avoid a negative health consequence.^{14,15} Although previous studies have shown that home smoking bans are associated with the awareness that secondhand smoke is harmful in both nonsmoking and smoking households,^{16,17} almost all adults (95%) now agree that parental secondhand smoke is harmful to children.¹⁸ Despite this fact, differences persist in the likelihood of believing that secondhand smoke is harmful according to factors such as level of education, gender, age, and race.¹⁹ Even though secondhand smoke messages have achieved widespread dissemination throughout US society over the past quarter century, 18% of children aged 3 to 11 years and 17% of children aged 12 to 19 years still live in a home where someone smokes inside.²⁰ New health messages may be needed to encourage tobacco control behaviors that protect children from exposure to the toxicants in tobacco smoke. Thirdhand smoke messages might influence parents differently from secondhand smoke messages because thirdhand smoke messages imply that passive exposure to tobacco smoke can occur long after secondhand smoke dissipates. A study in a representative sample of US adults revealed that the belief that thirdhand smoke harms the health of children is associated with household rules strictly prohibiting smoking in the home.²¹

In a previous study we found that smoking parents who were encouraged by pediatricians to quit or to adopt smoke-free home or car policies were more likely to believe that thirdhand smoke harms children.²² Unlike our previous study that analyzed exclusively baseline data, in the current study we collected follow-up data from

the parents seen in the pediatric setting 12 months later. To our knowledge, no previous studies have assessed prospectively whether thirdhand smoke beliefs are associated with parental tobacco control behaviors. We hypothesized that among smoking parents seen in the pediatric setting, belief that thirdhand smoke is harmful to the health of children at baseline is associated with attitudes about smoking, strictly enforced smoke-free home and car policies, and quitting behaviors at 12 months.

METHODS

A secondary data analysis was performed by using data from the Clinical Effort Against Secondhand Smoke Exposure (CEASE), a cluster randomized controlled trial that tested the effectiveness of an intervention designed for use in pediatric offices to address parental tobacco use. The study was conducted in partnership with Pediatric Research in Office Settings (PROS), the practice-based research network of the American Academy of Pediatrics (AAP). Institutional review board approval was obtained from Massachusetts General Hospital, Boston, MA, the AAP, and local practice institutional review boards, when required. Data were collected from 2009 to 2012.

Twenty pediatric practices were randomized to an intervention or usual-care control condition. The 10 intervention practices were located in 8 states (Illinois, Massachusetts, Maryland, Ohio, Oklahoma, Oregon, South Dakota, and West Virginia), and the 10 control practices were located in 8 states (Alaska, Connecticut, Missouri, New Mexico, Pennsylvania, South Carolina, Tennessee, and Virginia). Participating practices were not housed within a medical school or parent university, had at least 3 practitioners on staff, and had reported at least 50 patient visits and 10 parental smokers per

day before randomization. The trial tested an intervention to address parental tobacco use in the pediatric primary care office setting. The intervention provided training to pediatric health care providers to conduct routine screening for parental tobacco use, to deliver motivational messages to parents about having smoke-free homes and cars, to encourage the use of nicotine replacement therapy with a nicotine patch or gum, and to refer parents to their state's tobacco quitline.²³

Parents were eligible to be enrolled in the study if they accompanied their child to the pediatric office visit, were the legal guardian of the child seen, spoke English, were at least 18 years old, and reported during the baseline screener survey that he or she smoked at least a puff of a cigarette in the past 7 days.²⁴ Study-trained exit interviewers were stationed at the exits of the practices and administered the baseline screener survey to parents at the conclusion of their child's visit. The exit interviewer then obtained informed consent and administered an enrollment survey to each eligible and willing parent. Each parent who completed the enrollment survey received \$5 in cash. Screening continued until ~100 parents who smoked were enrolled at each practice. All enrolled parents were contacted using a standardized protocol consisting of telephone calls and text messages 12 months after the office visit asking them to complete a computer-aided telephone interview.

Thirdhand smoke beliefs were assessed at the postvisit enrollment survey and 12 months after the office visit. Parents were asked whether they strongly agreed, agreed, disagreed, or strongly disagreed with the following statement: "Breathing air in a room today where people smoked yesterday can harm the health of babies and children."²⁵ Parents who strongly agreed or agreed were categorized

as holding the belief that thirdhand smoke harms the health of children, and parents who disagreed or strongly disagreed were categorized as not holding the belief that thirdhand smoke harms the health of children.

Data collected at 12 months included various 10-level Likert items that measured parents' attitudes about the benefits of quitting, perception of harm from smoking, and opinions about how smoking affects overall well-being. Responses were coded from 1 (not at all) to 10 (extremely). Parents were asked to rate how likely it is that they will benefit from quitting smoking and how likely it is that their children will benefit from their quitting smoking. Parents rated the level of harm that continuing to smoke would have on themselves and their children. Additionally, parents assessed how important quitting smoking would be to their overall well-being as well as that of their children. Parents were also asked "How acceptable do you feel it is for your child's doctor, nurse, or other health care provider to talk to you about your smoking?" and were provided the following answer choices: not at all, a little, somewhat, or very acceptable. Responses were coded from 1 (not at all) to 4 (very). Two-sample *t* tests were conducted to determine if parents' attitudes about the benefits of quitting, perception of harm from smoking, opinions about how smoking affects overall well-being, and acceptability to talk about their smoking with their child's doctor differed on the basis of their baseline thirdhand smoke beliefs.

Logistic regression models were constructed to determine if the belief that thirdhand smoke harms the health of children was independently associated with parental behaviors and attitudes 12 months later. The dependent variables measured at 12 months included parent self-report of making at least 1

quit attempt since being enrolled, using a form of cessation assistance such as nicotine replacement therapy, using a quitline or an online cessation program to quit smoking, and having a strictly enforced smoke-free home or car policy defined as having both a rule prohibiting smoking as well as reporting that no one had smoked in the home or car in the past 3 months. A model was also constructed to determine if thirdhand smoke belief was independently associated with parents' perceptions about the degree to which being a smoker gets in the way of being a parent. Parents who strongly agreed or agreed that being a smoker got in the way of being a parent were categorized as holding the perception and parents who disagreed or strongly disagreed were categorized as not holding the perception. Unadjusted odds ratios and odds ratios adjusted for parent gender, parent age, parent education, parent race and ethnicity, number of cigarettes smoked per day at enrollment, and study arm assignment were calculated for each dependent variable.

Pearson's χ^2 was calculated to learn whether parents who disagreed at the exit survey that thirdhand smoke is harmful were more likely to make a quit attempt during the subsequent year if they later agreed that thirdhand smoke is harmful at the 12-month survey. All results were evaluated by using a type I error rate of $\alpha = 0.05$. Systat version 13.1 (Systat Software, Inc., Chicago, IL) was used for the statistical analysis.

RESULTS

A total of 3228 of the parents screened at the exit survey were eligible smokers. Of the 1980 parents who enrolled in the study, 1947 answered the thirdhand smoke question and 91% (1770) agreed that it is harmful at baseline and 9% (177) did not agree.²² Of the

1355 parents who were reached to complete the 12-month follow-up survey, 1306 parents answered the same question; 88% (1147) reported that they believed that thirdhand smoke is harmful and 12% (159) did not agree. Parent characteristics collected at baseline are presented in Table 1.

Parents who believed thirdhand smoke is harmful at baseline reported higher perceptions of harm to themselves ($P = .01$) and their children ($P \leq .001$) if they continued to smoke, felt that successfully quitting would be more important for their overall well-being ($P = .001$) and more important for the overall well-being of their children ($P = .001$), and perceived greater benefit in quitting smoking for themselves ($P = .02$) and their children ($P = .001$) at 12 months compared with parents who did not believe that thirdhand smoke is harmful. Additionally, parents who believed that thirdhand smoke is harmful found it to be more acceptable for their child's doctor to talk to them about

their smoking ($P = .001$). Results are presented in Table 2.

Adjusted odds ratios displayed in Table 3 show that parents who believed thirdhand smoke is harmful were 2.05 (95% confidence interval [CI]: 1.37–3.05) times more likely to have a strictly enforced smoke-free home policy, 1.69 (95% CI: 1.04–2.74) times more likely to have a strictly enforced smoke-free car policy, 2.27 (95% CI: 1.40–3.70) times more likely to believe that being a smoker gets in the way of being a parent, and 1.70 (95% CI: 1.08–2.67) times more likely to have reported using cessation assistance such as nicotine replacement therapy, calling a quitline, or enrolling in an online program compared with parents who did not hold the thirdhand smoke harm belief, after controlling for the other variables in the model. The interactions between baseline thirdhand smoke beliefs and parent gender, parent age, parent education, parent race and ethnicity, the number of cigarettes smoked per day, and study arm assignment (control versus intervention) were also tested, and each was found to be not significant. Therefore, the interaction variables were not included in the final logistic regression models.

Table 4 shows that among parents who initially disagreed ($n = 177$) at the exit survey that thirdhand smoke is harmful, a significantly higher percentage (71% vs 50%) made at least 1 quit attempt during the study period if they later agreed at the 12-month survey that thirdhand smoke is harmful, compared with parents who continued to disagree ($\chi^2[1] = 5.07, P = .02$). Parents whose thirdhand smoke beliefs were not assessed at 12 months due to loss to follow-up ($n = 70$) were not included in the analysis.

associated with parents' attitudes about their smoking, adopting strictly enforced home and car smoking bans, and behaviors associated with quitting. These novel findings are important because they provide an evidence base from which to design new tobacco counseling messages to smoking parents about thirdhand smoke and to incorporate thirdhand smoke topics into tobacco control interventions. Informing parents about thirdhand smoke risks could facilitate beneficial tobacco control outcomes.

Although directionality cannot be established, this study did show that parents who change from believing that thirdhand smoke is not harmful to later believing at 12 months that thirdhand smoke is harmful are more likely to make at least 1 quit attempt within that time period. Interventions that identify parents who do not believe that thirdhand smoke is a health concern for their children and that aim to influence those beliefs may have beneficial corollaries to achieving other tobacco control outcomes. Future research should aim to identify what factors influence parents who do not think that thirdhand smoke is harmful to change their beliefs toward thinking that thirdhand smoke is harmful.

Limitations of the current study include the use of volunteer parents, which may have led to self-selection bias for completing the exit surveys and the 12-month telephone surveys. The reliance on parent self-report could have led to recall and response biases as well. Social desirability bias may have influenced parents' responses to the survey questions, although parents were notified as part of the informed-consent process that their responses were confidential and would not be shared with their child's health care providers. PROS practices may not be representative of the general population, and the use of cross-sectional

TABLE 1 Baseline Characteristics of Parents

Variable	n (%)
Age, y	
18–24	521 (26.8)
25–44	1303 (67.0)
≥45	122 (6.3)
Gender	
Male	420 (21.6)
Female	1525 (78.4)
Race/ethnicity	
Hispanic	215 (11.0)
Non-Hispanic, white	1288 (66.2)
Non-Hispanic, black or African American	314 (16.1)
Other	130 (6.7)
Education	
Less than high school	304 (15.7)
High school graduate	898 (46.3)
Some college/trade school	547 (28.2)
College graduate	191 (9.8)
Number of cigarettes smoked per day ^a	
≤10	1288 (66.7)
>10	643 (33.3)

$N = 1947$ (the denominator varies slightly for individual analyses because of missing data). Demographic data were only collected at baseline. Data were from reference 22.

^a Parents who reported smoking at least 1 puff of a cigarette in the past 7 days at baseline.

DISCUSSION

This study shows that beliefs about the harms of thirdhand smoke are

TABLE 2 Differences Between Means of Dependent Variables Measured at the 12-Month Interview for Baseline Thirdhand Smoke Beliefs

Dependent Variable Measured at 12-Month Interview	Agree That Thirdhand Smoke Can Harm Health of Infants and Children (<i>n</i> = 1770)			Disagree That Thirdhand Smoke Can Harm Health of Infants and Children (<i>n</i> = 177)			<i>t</i> (<i>df</i>) ^a	<i>P</i>
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>		
You will benefit from quitting	8.99	2.18	1194	8.40	2.59	113	−2.34 (127.55)	.02
Your children will benefit from your quitting	9.26	1.95	1194	8.38	2.60	112	−3.51 (122.96)	.001
Continuing to smoke will harm you	9.57	1.49	1196	9.03	2.18	112	−2.59 (120.88)	.01
Continuing to smoke will harm your children	8.67	2.51	1193	7.39	3.14	109	−4.16 (120.95)	<.001
How important for your overall well-being that you successfully quit	9.47	1.44	1194	8.75	2.29	112	−3.28 (119.34)	.001
How important for your child's overall well-being that you successfully quit	9.41	1.68	1197	8.57	2.55	111	−3.42 (119.01)	.001
How acceptable for child's doctor to talk to you about your smoking	3.55	0.70	1199	3.25	0.87	115	−3.56 (128.50)	.001

Data are presented for parents who reported smoking at least 1 puff of a cigarette in the past 7 days at baseline; *N* = 1947. Parents with missing data were not included in the analysis. *df*, degrees of freedom.

^a All variances were found to be unequal by using the *F*-test; separate variance *t*-statistics and *df* were reported.

data precludes inference of causality. The ability to speak English was an inclusion criterion for enrollment into the study because the exit surveys and 12-month telephone surveys were conducted by English-speaking interviewers. This study could not determine if non-English-speaking parents differed in thirdhand smoke beliefs compared with parents who did speak English. Despite these limitations, the sample size was large and included parental data collected from pediatric

practices across 16 US states nationally. Additionally, the parental belief that thirdhand smoke can harm the health of infants and children did not differ on the basis of parent age, race and ethnicity, level of education, or study arm assignment (control versus intervention), which allows us greater confidence that these characteristics did not have a large influence on thirdhand smoke beliefs. The effects of thirdhand smoke harm beliefs were also consistent in the logistic re-

gression models across parent gender, parent age, parent education, parent race and ethnicity, the number of cigarettes smoked per day, and study arm assignment.

As shown in a previous study, the pediatric primary care setting is an opportunity for health care professionals to influence parents' beliefs about the health effects of thirdhand smoke on children in routine clinical practice.²² Thirdhand smoke messages could be used to promote favorable tobacco

TABLE 3 Unadjusted and Adjusted Odds Ratios for Parent Belief That Thirdhand Smoke Can Harm the Health of Infants and Children

Dependent Variable	Unadjusted OR (95% CI) for Belief That Thirdhand Smoke Can Harm Health of Infants and Children	Number of Parents Included in Analysis for Unadjusted ORs	Adjusted OR (95% CI) for Belief That Thirdhand Smoke Can Harm Health of Infants and Children ^a	Number of Parents Included in Analysis for Adjusted ORs
Quit attempt since enrolled	1.18 (0.80–1.75)	1331	1.10 (0.74–1.64)	1314
Used assistance (NRT, called quitline or Web site/online program)	1.56 (1.00–2.43)*	1328	1.70 (1.08–2.67)*	1313
Have a strictly enforced smoke-free home policy	2.14 (1.46–3.14)*	1330	2.05 (1.37–3.05)*	1315
Have a strictly enforced smoke-free car policy	1.88 (1.17–3.03)*	1172	1.69 (1.04–2.74)*	1161
Being a smoker gets in the way of being a parent	2.19 (1.36–3.55)*	1301	2.27 (1.40–3.70)*	1286

Data are presented for parents who reported smoking at least 1 puff of a cigarette in the past 7 days at baseline; *N* = 1947. Parents with missing data were not included in the analysis. NRT, nicotine replacement therapy; OR, odds ratio.

^a ORs adjusted for parent gender, parent age, parent education, parent race and ethnicity, number of cigarettes smoked per day, and study arm assignment (control versus intervention).

* *P* < .05.

TABLE 4 Likelihood of Making a Quit Attempt Among Parents Who Disagreed at Both Baseline and 12 Months That Thirdhand Smoke Is Harmful Versus Parents Who Initially Disagreed That Thirdhand Smoke Is Harmful at Baseline and Agreed That Thirdhand Smoke Is Harmful at 12 Months

	Disagreed at Both Baseline and 12-Month Follow-up That Thirdhand Smoke Is Harmful	Disagreed at Baseline and Agreed at 12-Month Follow-up That Thirdhand Smoke Is Harmful
Did not make a quit attempt	29 (50)	14 (29)
Made at least 1 quit attempt	29 (50)	35 (71)
Total	58 (100)	49 (100)

Data are presented as *n* (%). *N* = 107 (parents with missing data were not included in the analysis).

control outcomes by influencing peoples' behaviors to keep houses and cars smoke-free as well as to enhance motivation to quit smoking. It is unclear whether thirdhand smoke beliefs of parents affect protective smoking-related behavior such as smoke-free homes and cars differentially according to whether they have children with medically vulnerable respiratory conditions such as asthma or cystic fibrosis. Designing effective thirdhand smoke messages that educate people about the current state of knowledge regarding the potential acute and chronic health risks associated with thirdhand smoke exposure would be an important first step in studying thirdhand smoke counseling interventions. Exploring to what extent thirdhand smoke educational messages have particular benefit for certain tobacco control outcomes such as adopting smoke-free homes and cars versus smoking cessation will help focus counseling interventions on higher yield outcomes. For example, educa-

tional messages about the potential adverse health consequences from the irritants found in thirdhand smoke that are known to cause asthma attacks,² messages about the potent carcinogenic tobacco-specific nitrosamines that are formed through chemical reactions with common household gases,^{2,6} and messages about the discovery that thirdhand smoke is genotoxic in human cells¹⁰ could each be tested for efficacy within counseling interventions.

CONCLUSIONS

Thirdhand smoke harm belief was associated with having a strictly enforced smoke-free home and car policy. In addition, parents who held the thirdhand smoke harm belief perceived greater benefit to quitting, were more likely to feel that being a smoker gets in the way of being a parent, and were more likely to use evidence-based cessation assistance to quit smoking. Parents who changed their thirdhand smoke beliefs in favor of believing that thirdhand smoke is harmful had an

increased likelihood of making at least 1 quit attempt. Parents' beliefs that thirdhand smoke is harmful to infants and children were associated with beneficial tobacco control outcomes.

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