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Original investigation

Family Beliefs and Behaviors About Smoking and Young Children's Secondhand Smoke Exposure

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Abstract

Introduction: Home smoking bans (HSBs) reduce children's secondhand smoke exposure (SHSe), a contributor to health disparities. General psychosocial characteristics and SHSe beliefs and behaviors within the family may relate to HSB existence. This study's aim was to identify general psychosocial characteristics and SHSe beliefs associated with HSB presence and lower SHSe among children living with a smoker.

Methods: Caregivers ($n = 269$) of Head Start preschool students (age 1–6 years) living with a smoker reported on HSBs, caregiver depressive symptoms and stress, family routines, SHSe beliefs, and household smoking characteristics. SHSe biomarkers included air nicotine in 2 areas of the home and child salivary cotinine.

Results: One-quarter of families reported complete HSBs, and HSBs were more common among nonsmoking (37%) versus smoking caregivers (21%; $p < .01$). Perceived importance of HSBs differed between nonsmoking (9.7 ± 1.0) versus smoking caregivers (9.1 ± 2.0; $p < .01$). Smoking caregivers, more smokers in the home, and lower self-efficacy and intent to implement an HSB were consistently associated with lower likelihood of HSB existence and children's higher SHSe. Caregiver SHSe beliefs were more consistently associated with HSBs and SHSe than were general psychosocial factors.

Conclusions: Despite greater HSB likelihood and higher perceived importance of HSBs among nonsmoking versus smoking primary caregivers, SHSe reduction self-efficacy and intent are protective for Head Start students at high-risk for exposure. Pediatric healthcare providers and early education professionals may be able to support SHSe reduction efforts (e.g., smoking cessation, HSB implementation) and reduce children's SHSe with counseling strategies to address caregivers' HSB self-efficacy, intent, and related behaviors.

Introduction

Health problems associated with secondhand smoke exposure (SHSe) in childhood are well-documented[1,2] and have costly economic consequences.[2,3] Disproportionately high SHSe rates among low-income, urban, primarily Black children[4–7] contribute to serious and worsening disparities in children's health. Young children's SHSe primarily occurs in the home,[4] and family demographic factors (e.g., unemployment, unmarried status, lower income and educational achievement) are associated with higher exposure and poorer respiratory health.[4,7–9] One-half of U.S. children in poverty live with a smoker,[5] a key household contributor to SHSe.[4] "Home smoking bans" (HSBs) reduce SHSe[10–13] yet are less common among Black families and those with lower socio-economic status,[8,13–15] further escalating health risks among low-income minority children.

Efficacious interventions to reduce children's residential SHSe target HSB implementation and/or smoking cessation.[16–22] Because these strategies require major behavioral changes, their success likely pivots on caregivers' confidence and motivation to reduce or eliminate sources of SHSe.[23] Yet, little is known about psychosocial and cognitive factors that influence HSB implementation or SHSe. General family psychosocial factors that affect children's well-being in other domains (e.g., academic, social) may also impact SHSe. For example, routines (e.g., eating together, consistent discipline) and caregiver stress and depression are associated with parenting behaviors that impact their children's health (e.g., car seat use, administering vitamins/medications, healthy feeding/sleep practices)[24–29] and may influence children's SHSe.[9,28,30] Stress and depression are also associated with more smoking in adults,[31,32] further raising the risk for SHSe. Health beliefs, such as perceived importance of and confidence to engage in health behaviors, are associated with smoking cessation,[33,34] and the few studies that have examined caregivers' perspectives about SHSe suggest likely links with HSB existence and children's SHSe.[13,14,23,35,36] Despite evidence linking general psychosocial factors and health beliefs with engagement in health behaviors and with children's health outcomes, their potential roles in reducing SHSe among at-risk children have not been examined.

Among families with comparably high risk for SHSe, some implement protective processes such as HSBs and some do not. This study aimed to identify which family factors (i.e., demographics, psychosocial characteristics, SHSe beliefs) were associated with HSB existence and SHSe among low-income, primarily Black Head Start students. These children's high risk for SHSe and associated health problems are partially due to immutable demographic and socioeconomic factors that cannot be changed by the healthcare system. Thus, identifying potentially modifiable contributors to SHSe is critical to intervene to promote children's health and decrease disparities. We hypothesized that primary caregivers who currently smoke would report lower HSB implementation and more negative general psychosocial factors (e.g., greater caregiver depressive and stress symptoms, fewer family routines) and SHSe beliefs (e.g., lower self-efficacy, importance, and intent to implement an HSB; more negative outcome expectancies of SHSe) than nonsmoking primary caregivers. Guided by the Behavioral Ecological Model,[37] we hypothesized that demographic and smoking characteristics (e.g., lower caregiver education, primary caregiver smokes, more smokers in the home), general psychosocial factors, and SHSe beliefs would be associated with lower likelihood of the existence of an HSB and higher SHSe in children. Caregiver SHSe beliefs were expected to demonstrate stronger associations with these outcomes than general psychosocial factors because they represent cognitions specifically related to household smoking.

Methods

Participants

This study is a secondary data analysis of baseline data from a randomized controlled effectiveness trial of motivational interviewing to reduce children's SHSe.[38] Participants included caregivers of Baltimore City Head Start students (age 1–6 years) who reported a smoker living in the home (not necessarily the primary caregiver). Baltimore City Head Start serves over 3,000 children between the ages of 1–6 years who are defined as low income. Head Start is a federal program designed to promote school readiness by enhancing educational, social, and physical development through preschool program, family service coordinators, and partnerships with health care providers. Exclusion criteria included individuals not fluent in reading/speaking English or currently participating in another respiratory disease study. Each year for four years teachers in 16 Baltimore City Head Start programs invited caregivers of all students to complete screening forms assessing the smoking status of all adults in the home and household smoking restrictions. Caregivers who agreed to be contacted about research were telephoned by study staff to confirm eligibility and obtain verbal informed consent. Of 10,394 students screened over four school years, 1,289 (12.4%) were eligible for further screening and were approached by telephone for study participation. Of these, 676 (52.4%) confirmed eligibility and 350 (51.7%) consented to participate. The primary reasons for ineligibility following phone screening efforts were inability to contact (71%), no smokers in the home (11%), or sibling enrolled in the study (5%). Seven families were not fluent in English (1%). Baseline data were collected from 336 families (96%). Sixty-seven families (20%) were excluded from the current analysis due to incomplete data, resulting in a final sample of 269 families. Compared to those participants whose data were excluded, this sample did not significantly differ by child gender, age, or race/ethnicity; caregiver education or number of cigarettes smoked per day; number of smokers in the home; presence of an HSB; or SHSe biomarkers (air nicotine, salivary cotinine).

Procedure

Baseline assessments consisted of two home visits conducted 1 week apart to obtain written consent, collect baseline survey data, collect two saliva samples from the child, and install and collect home air nicotine monitoring equipment (described below). Incentives ($50) were provided for home data collection and interviews. The Johns Hopkins University institutional review board approved this study.

Measures

Demographic and Smoking Characteristics

Caregivers reported on demographic (e.g., caregiver education, race/ethnicity), child health (e.g., diagnosis of asthma or reactive airway disease [RAD]), and household smoking characteristics (e.g., whether the primary caregiver smokes, number of smokers living in or visiting the home over the previous week).

General Psychosocial Factors

Caregivers self-reported about depressive symptoms using the 20-item Center for Epidemiologic Studies—Depression Scale (CES-D)[39] and about perceived stress, using the 4-item Perceived Stress Scale (PSS-4).[40] Caregivers also completed the 28-item Family Routines Inventory (FRI),[41] which measures caregivers' perceived frequency and importance of family routines (e.g., spending time together, dining and reading together, bedtime and discipline routines). Higher scores indicate greater depressive symptoms (CES-D) and caregiver stress (PSS-4), and higher frequency and greater perceived importance of family routines (FRI, frequency and importance scales, respectively). In our sample, internal consistency for these scales was good (CES-D: $\alpha = 0.91$; PSS-4: $\alpha = 0.80$; FRI-frequency: $\alpha = 0.85$; FRI-importance: $\alpha = 0.93$). Because the focus of the research question was to evaluate how any degree of depressive symptoms (rather than only elevations warranting a clinical diagnosis of depression) were related to SHSe outcomes, the CES-D scores were used as a continuous variable and no cut-off score was used.[42,43]

SHSe Beliefs

Caregivers rated three items about their self-efficacy (i.e., confidence) to, perceived importance of, and intention to ban smoking by themselves, family members, and other visitors in the home. For example, the three self-efficacy items are: "I am sure that I can… …1) not smoke in my home with no exceptions; …2) make sure family members never smoke in my home; …3) make sure other people never smoke in my home." Each belief was rated on a 10-point scale. For each construct the three items are summed together to get an overall score, with higher scores reflecting higher confidence to, perceived importance of, and intention to reduce SHSe in the home via an HSB. Internal consistency for each scale was acceptable to good (self-efficacy: α = 0.77; intention: α = 0.86; motivation: α = 0.81).

Caregivers also completed a 26-item measure of SHSe-related outcome expectancies regarding their expectations for positive or negative consequences of HSB implementation and SHSe on a 5-point scale. Items were adapted from the measure of negative attitudes and beliefs about children's SHSe developed by Yousey[13], which reported associations between more negative beliefs and less frequent HSBs. Example items include: "People would think I was a good parent if I banned smoking in my home and car" and "I am not convinced smoke exposure is bad for people's health." Responses were recoded such that higher scores indicate more positive SHSe outcome expectancies. Internal consistency was good (α = 0.83).

The primary outcomes in this study were HSB presence and SHSe biomarkers (air nicotine and salivary cotinine). Caregivers indicated whether smoking is always, sometimes, or never (with no exceptions) allowed in their homes. Responses were dichotomized: the third option was classified as a complete HSB, other options were classified as partial/absent HSBs. Air nicotine was measured using passive home air monitoring with sampling badges[44] and analyzed using gas chromatography. Research assistants placed an air monitor in each of two different parts of the home—where the family indicated the child slept ("bedroom") and in the "major activity room" (i.e., near the television). These two placements were selected to ensure that data were captured from at least two different rooms in which the children in the study spend time and thus two distinct areas of potential SHSe. The bedroom monitor was intended to capture SHSe during the overnight hours; it may be difficult for families to change where the child sleeps, making this a more challenging source of SHSe to modify. In contrast, the activity room monitor was intended to capture SHSe in a space that many people may be exposed and for which children's SHSe may be more modifiable. Duplicate air monitors were placed in 10% of homes to verify monitor accuracy and field blanks were placed in a different 10% of homes as a negative control. After seven days, air monitors were collected and analyzed. Two values are reported: (a) from the child's bedroom, and (b) from the major activity room. Air monitors' detection limit is 0.01 µg and coefficient of variability is 0.11. All field blank values were zero.

Salivary cotinine assessed children's direct exposure to tobacco smoke over the previous several days. At each of the two baseline visits, two salivary fluid samples were collected using a Sorbette® oral fluid specimen collection device for 1 min, totaling four samples. Cotinine analyses were performed with Enzyme Immunoassay techniques. The test used 20 ml of sample (10 µl saliva diluted in 90 µl of assay diluent), had a lower limit of sensitivity of .05 ng/mL, range of sensitivity from .05 to 200 ng/mL, and average intra-and inter-assay coefficients of variation of less than 10% and 15%, respectively. The mean of the four samples is reported.

Data Analytic Plan

Statistical analyses were conducted with SAS software (Version 9, SAS Institute Inc., 2002–2010). Due to non-normal distributions, natural log transformations were conducted for the nicotine and cotinine variables. The FRI importance scale was also non-normally distributed and was transformed; because results did not differ and to facilitate interpretation, results using the untransformed FRI scores are reported.

First, descriptive analyses were conducted to characterize the sample. In order to evaluate the role of primary caregiver smoking status on SHSe beliefs and behaviors, a chi-square analysis was conducted comparing HSB rates between smoking and nonsmoking caregivers, and *t* tests were conducted comparing general psychosocial factors and caregiver SHSe beliefs.

Next, a series of hierarchical linear regressions were conducted with each of the three SHSe biomarkers (i.e., salivary cotinine, air nicotine in the major activity room and bedroom) as the dependent variable, and multivariate hierarchical logistic regressions were conducted with HSB presence as the dependent variable. For each outcome, independent variables were entered in three blocks. Model A included a block of four demographic and smoking characteristics: child asthma/RAD diagnosis, caregiver high school education, caregiver smoking status, number of smokers in the home over the previous week. Model B included the first block plus a block including the four General Psychosocial Factors (see Measures section). Model C included the first block (demographic and smoking characteristics) plus a block including the four SHSe Beliefs (see Measures section). To compare the effects of general psychosocial factors versus SHSe beliefs on HSB existence and SHSe beyond demographic and smoking characteristics, the general psychosocial block was not included in Model C and the SHSe beliefs block was not included in Model B. Unstandardized coefficients (b) and 95% confidence intervals (CI) are reported for each independent variable. To determine the additional variance beyond demographic and smoking characteristics explained by each block of independent variables, the R^2 (linear regressions) or ROC (logistic regressions) values of each model were compared. Multicollinearity was evaluated in all regression analyses through examination of the variance inflation factor (VIF) statistic, with none found.

Results

Participant Characteristics

Participating primary caregivers were 90% Black, 82% female, and mean age was 32.4 ± 9.1 years. Approximately two-thirds (68%) had earned a high school degree (or equivalent) or beyond. Mean child age was 3.7 ± 0.8 years and 30% had a caregiver-reported asthma or RAD diagnosis. Having at least one smoker in the home was an eligibility requirement, and the mean number of smokers in the home was 1.8 ± 1.0 (range = 1–7). Table 1 summarizes the mean scores for general psychosocial factors and caregiver SHSe beliefs variables.

Two-thirds (67%) of primary caregivers reported smoking themselves. Overall 26% of caregivers endorsed complete HSBs. Children's median salivary cotinine level was 3.4 (IQR = 5.5) and all had average salivary cotinine values exceeding detection limits. The median air nicotine levels were: bedroom = 0.6 (IQR = 1.9), major activity room = 0.7 (IQR = 2.0); 92.9% of the families had average

Table 1. General Psychosocial Factors and Caregiver SHSe Beliefs, Means (M) and Standard Deviations (SD), and *t* Tests Comparing Smoking (n = 180) vs. Nonsmoking (n = 89) Caregivers

	Score range	Whole sample	Smokers	Nonsmokers	*p*
General psychosocial					
Caregiver depressive symptoms	0–60	14.1 ± 11.4	14.8 ± 12.0	12.5 ± 10.1	.12
Caregiver stress	0–12	4.2 ± 3.1	4.4 ± 3.3	3.8 ± 2.8	.16
Family routines (frequency)	0–84	12.3 ± 5.0	12.2 ± 4.9	12.6 ± 5.1	.55
Family routines (importance)	0–84	18.8 ± 5.5	18.7 ± 5.5	18.8 ± 5.5	.91
SHSe beliefs					
Self-efficacy	0–30	8.6 ± 2.1	8.4 ± 2.2	8.9 ± 1.7	.06
Importance	0–30	9.3 ± 1.8	9.1 ± 2.0	9.7 ± 1.0	<.01
Intent	0–30	9.1 ± 1.8	9.0 ± 1.9	9.2 ± 1.5	.39
Outcome expectancies	0–104	68.9 ± 13.4	68.0 ± 13.7	70.6 ± 12.7	.14

Note. SHSe = secondhand smoke exposure.

air nicotine values exceeding detection limits in the bedroom and 92.5% in the major activity room. Air nicotine in the rooms was significantly different (Wilcoxon signed rank test $W = -7{,}417$, $p < .01$). All SHSe outcomes were significantly correlated with one another (range = 0.47–0.85, $p < .0001$).

Comparisons by Primary Caregiver Smoking Status

Nonsmoking versus smoking primary caregivers were significantly more likely to have an HSB, $\chi^2 = 8.45$, $p < .01$(37% vs. 21% reported complete HSBs). Nonsmoking caregivers rated HSB importance significantly higher overall (9.7 ± 1.0) than smoking caregivers (9.1 ± 2.0), $t = 3.38$, $p < .01$ (Table 1). This pattern held for each individual item that measured caregivers' perceived importance of banning smoking by themselves, by family members, and by other people (data not shown). Self-efficacy and intent to ban one's own smoking were each significantly lower for smoking (self-efficacy: 7.6 ± 1.8, intent: 8.8 ± 2.2, respectively) versus nonsmoking primary caregivers (both: 9.7 ± 1.3), $t = 8.36$ and 4.14, $p < .01$. Self-efficacy and intent scores did not significantly differ between smoking and nonsmoking caregivers overall or in relation to banning smoking by family members or other people (data not shown).

Hierarchical Regressions

HSB Presence (Table 2): In Model A, the only significant demographic or smoking characteristic associated with HSB presence was having a primary caregiver who smokes. Smoking primary caregivers were one-half as likely to report an HSB. In Model B, having a smoking primary caregiver remained the only variable with a significant association with HSB presence, and the ROC of 0.67 was not a significant improvement over Model A (ROC of 0.64). In Model C, having a smoking primary caregiver retained significance and higher ratings on two SHSe beliefs—self-efficacy and intent to implement an HSB—were also significantly associated with greater likelihood of HSB existence. The Model C ROC of 0.84 was a significant improvement over Model A ($X^2 = 31.1$, $p < .01$).

Salivary cotinine (Table 3): Smoking primary caregivers and more smokers in the home were significantly associated with salivary cotinine in Model A, and these variables accounted for 9% of the cotinine variance. In addition to these two variables, in Model B, higher caregiver depressive symptoms accounted for 11% of the variance in cotinine. However, this was not a significant improvement over Model A ($\Delta R^2 = 0.03$, nonsignificant [*ns*]). In Model C, having a smoking caregiver, more smokers in the home, and lower self-efficacy and intent to implement an HSB were associated with higher salivary cotinine. Model C accounted for 14% of the variance in salivary cotinine, representing a significant improvement over Model A ($\Delta R^2 = 0.05$, $p < .01$).

Air nicotine—major activity room (Table 3): In Model A, no demographic or smoking variables were associated with air nicotine in the major activity room. In Model B, only the number of smokers was significantly associated with air nicotine, and the 6% of the variance accounted for was not a significant improvement over Model A ($\Delta R^2 = 0.01$, *ns*). In Model C, lower self-efficacy and intent to implement an HSB were significantly associated with higher air nicotine. These variables accounted for 14% of the variance in the major activity room, representing a significant improvement over Model A ($\Delta R^2 = 0.09$).

Air nicotine—bedroom (Table 3): In Model A, lower caregiver education, having a smoking primary caregiver, and more smokers in the home were significantly associated with higher air nicotine in the bedroom, and these variables accounted for 9% of the variance. In Model B, the only significant independent variables were having a smoking caregiver and number of smokers in the home, and this did not improve over Model A ($\Delta R^2 = 0.01$, *ns*). In Model C, having a smoking caregiver, more smokers in the home, and lower self-efficacy to implement an HSB were associated with higher air nicotine in the bedroom. Model C accounted for 17% of the variance in the bedroom, a significant improvement over Model A ($\Delta R^2 = 0.08$, $p < .01$).

Discussion

Despite the shared risks of living with one or more smokers and low-income, the children in this study had various levels of SHSe. Primary caregivers who smoke and having more smokers at home were less likely to have a complete HSB and their children had greater SHSe. Smoking primary caregivers believed HSBs were less important, and had lower intentions and confidence in their ability to limit their own smoking in the home. Compounding these risks, caregivers' self-efficacy and intent to have an HSB in place were associated with all SHSe outcomes. In other words, children whose primary caregivers indicated being more ready to take action to reduce SHSe were more likely to live in a home with a complete HSB and had lower SHSe.

This study emphasized the identification and comparison of potentially modifiable cognitive and behavioral factors that would be amenable to intervention to ultimately decrease SHSe in an at-risk population. These findings build upon previous research

Table 2. Associations with Home Smoking Ban Presence, Odds Ratios and 95% Confidence Intervals

Independent variables	Model A	Model B	Model C
Demographic and smoking			
Asthma/RAD	1.38 (0.76, 2.49)	1.40 (0.77, 2.56)	1.08 (0.55, 2.13)
Caregiver education	1.05 (0.57, 1.96)	1.09 (0.57, 2.10)	0.83 (0.40, 1.74)
Smoking caregiver	0.50 (0.28, 0.90)*	0.52 (0.29, 0.95)*	0.42 (0.22, 0.83)*
Number of smokers in home	0.73 (0.52, 1.02)	0.73 (0.52, 1.03)	0.80 (0.55, 1.18)
General psychosocial			
Caregiver depressive symptoms		0.86 (0.45, 1.67)	
Caregiver stress		0.98 (0.87, 1.10)	
Family routines (frequency)		1.04 (0.97, 1.12)	
Family routines (importance)		1.02 (0.95, 1.09)	
SHSe beliefs			
Self-efficacy			1.28 (1.13, 1.46)**
Importance			1.01 (0.84, 1.20)
Intent			1.51 (1.12, 2.05)**
Outcome expectancies			1.00 (0.97, 1.03)
ROC	0. 64	0.67	0.84
ROC contrast		$X^2 = 1.84, p = .18$	$X^2 = 31.10, p < .0001$

Note. RAD = reactive airway disease; ROC = receiver operating curve; SHSe = secondhand smoke exposure. Model A: demographic and smoking block; Model B: demographic and smoking block + general psychosocial block; Model C: demographic and smoking block + SHSe beliefs block.
$^*p < .05$; $^{**}p < .01$.

related to general psychosocial factors, SHSe beliefs, household smoking, HSBs, and children's SHSe[9,14,23,28,30,35,36] by demonstrating consistent associations of SHSe-related self-efficacy and intent with key SHSe outcomes in an understudied, high risk population. Compared to other potentially relevant family factors, SHSe-specific self-efficacy and intent demonstrated stronger associations with greater likelihood of HSB existence and children's lower SHSe, which has important implications for SHSe prevention. By evaluating associations of general psychosocial factors and multiple SHSe beliefs in the analyses, this finding is consistent with and extends beyond Okah and colleagues[23] and Hennessy and colleagues[35], both which also reported that self-efficacy emerged as a significant predictor of HSBs even when accounting for other beliefs about SHSe.

While demographic factors and the smoking status of people in the home may be difficult or impossible to impact, self-efficacy and intent are two potentially modifiable and protective beliefs that may enhance the likelihood of successful SHSe reduction. That these beliefs were associated with HSBs and SHSe suggests they play an important role in adopting and enforcing SHSe reduction strategies such as HSBs. In contrast, outcome expectancies and motivation were not associated with SHSe outcomes. This is different than the findings of Winickoff and colleagues[36], likely due to the comprehensive assessment of multiple SHSe beliefs in the current study compared with the singular focus on harm expectancies in Winickoff et al.[36] When considered together with other SHSe beliefs, self-efficacy and intent may be more strongly associated with outcomes than beliefs about harm. That is, knowing the consequences of smoking and believing HSBs are important may not be as directly relevant to taking specific actions to reduce children's SHSe as are other beliefs. Specifically, having the skills to ban smoking and planning to take action appear to be more proximally related to the ultimate existence of an HSB and reducing SHSe. Thus, SHSe reduction interventions designed to build confidence in one's ability to take the necessary steps to implement an HSB may increase both self-efficacy and intent. Such interventions may be better positioned to impact behavior change and SHSe than would be interventions that emphasize education about the importance of HSBs and health consequences of SHSe.

As hypothesized, general psychosocial factors demonstrated less consistent associations with outcomes than SHSe beliefs. In fact, most general psychosocial factors were not associated with HSB or SHSe at all, highlighting the relative importance of targeting individuals' SHSe beliefs and behaviors over targeting general psychosocial factors in SHSe reduction interventions.[16,23,35] One exception is the association between depressive symptoms and salivary cotinine reported by Butz and colleauges[9] was replicated in this study, but was not extended to other SHSe outcomes of air nicotine or HSB existence. Similarly, Butz et al's[9] finding relating stress with cotinine was not replicated here. Because few other studies have evaluated general psychosocial functioning with the SHSe outcomes evaluated in this study, the current findings contribute to our knowledge about the potential importance of modifiable factors and determining which factors should be targeted for intervention.

Although we did not find a significant association between depressive symptoms and SHSe measures, prior research supports intervening to reducing caregiver depressive symptoms given the associations between depression and smoking status among low-income, at-risk parents.[30] However, our research suggests that solely addressing general psychosocial difficulties may not be sufficient to impact children's SHSe. Future research on the role of clinical depression in smoking status and children's SHSe, and treatments that could reduce depression and SHSe, is warranted.

Primary caregiver smoking status was consistently associated with lower likelihood of HSB existence and with more negative beliefs about HSBs and SHSe, strengthening existing messages that efforts to reduce SHSe must include some components of smoking cessation support.[37] Pediatricians routinely address caregiver smoking status,[45] making pediatric primary care a prime setting in which health care professionals could deliver interventions to reduce children's SHSe. Empirically supported approaches for pediatricians include routinely screening for parental smoking, encouraging HSB adoption, and facilitating parents' use of nicotine replacement therapy.[16–22,46] Less is known about the delivery of such interventions by

Table 3. Associations With Child Salivary Cotinine Concentration (Natural Log-Transformed, Mean of Four Samples Collected Within 1 Week) and Air Nicotine Concentrations (Natural Log-Transformed, in the Major Activity Room and Child's Bedroom), Unstandardized Coefficients (b) and 95% Confidence Intervals

Salivary cotinine			
Independent variables	Model A	Model B	Model C
Demographic and smoking			
Asthma/RAD	−0.20 (−0.47, 0.08)	−0.23 (−0.50, 0.05)	−0.16 (−0.43, 0.11)
Caregiver education	−0.26 (−0.53, 0.02)	−0.25 (−0.53, 0.04)	−0.18 (−0.46, 0.09)
Smoking caregiver	0.36 (0.09, 0.64)*	0.35 (0.08, 0.63)*	0.36 (0.09, 0.63)*
Number of smokers in home	0.16 (0.03, 0.30)*	0.17 (0.04, 0.31)*	0.14 (0.00, 0.27)*
General psychosocial			
Caregiver depressive symptoms		0.32 (0.03, 0.60)*	
Caregiver stress		−0.05 (−0.10, 0.00)	
Family routines (frequency)		0.01 (−0.02, 0.04)	
Family routines (importance)		−0.02 (−0.05, 0.01)	
SHSe beliefs			
Self-efficacy			−0.02 (−0.04, −0.00)*
Importance			0.02 (−0.01, 0.05)
Intent			−0.03 (−0.06, −0.01)*
Outcome expectancies			−0.01 (−0.02, 0.00)
R^2	0.09	0.11	0.14
Extra sums of squares test		$\Delta R^2 = 0.03$; $F(4) = 2.02$, $p = .09$	$\Delta R^2 = 0.05$; $F(4) = 4.14$, $p < .01$
Air nicotine—activity room	Model A	Model B	Model C
Demographic and smoking			
Asthma/RAD	−0.30 (−0.87, 0.27)	−0.33 (−0.92, 0.24)	−0.17 (−0.73, 0.38)
Caregiver education	−0.42 (−0.99, 0.16)	−0.34 (−0.94, 0.25)	−0.23 (−0.79, 0.34)
Smoking caregiver	0.52 (−0.06, 1.09)	0.48 (−0.10, 1.06)	0.46 (−0.10, 1.02)
Number of smokers in home	0.29 (0.01, 0.57)	0.28 (0.00, 0.56)*	0.21 (−0.06, 0.48)
General psychosocial			
Caregiver depressive symptoms		0.47 (−0.13, 1.06)	
Caregiver stress		−0.01 (−0.12, 0.10)	
Family routines (frequency)		0.01 (−0.06, 0.08)	
Family routines (importance)		0.01 (−0.05, 0.07)	
SHSe beliefs			
Self-efficacy			−0.07 (−0.11, −0.02)**
Importance			0.02 (−0.04, 0.08)
Intent			−0.08 (−0.14, −0.02)**
Outcome expectancies			−0.02 (−0.03, 0.01)
R^2	0.05	0.06	0.14
Extra sums of squares test		$\Delta R^2 = 0.01$; $F(4) = 0.94$, $p = .44$	$\Delta R^2 = 0.09$; $F(4) = 7.04$, $p < .0001$
Air nicotine—bedroom	Model A	Model B	Model C
Demographic and smoking			
Asthma/RAD	−0.28 (−0.83, 0.27)	−0.31 (−0.87, 0.24)	−0.20 (−0.73, 0.34)
Caregiver education	−0.57 (−1.11, −0.02)*	−0.57 (−1.14, 0.00)	−0.44 (−0.99, 0.10)
Smoking caregiver	0.66 (0.11, 1.21)*	0.62 (0.06, 1.18)*	0.60 (0.06, 1.14)*
Number of smokers in home	0.42 (0.16, 0.69)**	0.42 (0.16, 0.69)**	0.37 (0.11, 0.63)**
General psychosocial			
Caregiver depressive symptoms		0.39 (−0.18, 0.96)	
Caregiver stress		−0.02 (−0.12, 0.09)	
Family routines (frequency)		−0.02 (−0.08, 0.04)	
Family routines (importance)		0.02 (−0.03, 0.08)	
SHSe beliefs			
Self-efficacy			−0.07 (−0.12, −0.03)**
Importance			0.02 (−0.04, 0.07)
Intent			−0.06 (−0.11, 0.00)
Outcome expectancies			−0.00 (−0.02, 0.02)
R^2	0.09	0.10	0.17
Extra sums of squares test		$\Delta R^2 = 0.01$; $F(4) = 0.66$, $p = .62$	$\Delta R^2 = 0.08$; $F(4) = 5.92$, $p < .0001$

Note. RAD = reactive airway disease; SHSe = secondhand smoke exposure. Salivary cotinine outcome represents mean of two samples obtained at time of baseline questionnaire completion. Model A: demographic and smoking block; Model B: demographic and smoking block + general psychosocial block; Model C: demographic and smoking block + SHSe beliefs block.

*$p < .05$; **$p < .01$.

other pediatric healthcare providers or by preschool teachers or staff, yet professionals in these settings may also be well-situated to deliver such interventions. The results of this study highlight two potentially modifiable beliefs—self-efficacy and intent—that may be addressed to amplify the impact of SHSe reduction efforts, both for caregivers who smoke themselves and nonsmokers who live with smokers. For example, the 5-As and motivational interviewing[22] are counseling techniques that emphasize open dialogue about making a behavioral change. Individual beliefs (e.g., self-efficacy, intent) are integral to these approaches. Pediatric healthcare providers and early education professionals might pose questions about parents' confidence or plans to limit or eliminate smoking in the home as prompts to begin a conversation with caregivers about beliefs about the various components of complete HSB implementation. Given the differences in perceived importance of HSBs between smoking and nonsmoking caregivers, it may be helpful to first inquire about perceived importance in order to gauge caregivers' openness to discussing the topic of SHSe reduction strategies. Increasing awareness of caregivers' previous experiences with and beliefs about HSB adoption and smoking cessation can help professionals guide families in developing realistic behavioral plans to reduce SHSe and ultimately improve children's health.

Cross-sectional data limits interpretations about causal relations among SHSe beliefs, HSB existence, and SHSe. One possible alternative explanation is caregivers who attempt to limit SHSe without success may feel discouraged (and thus report lower self-efficacy or intent) or increase smoking,[47] making subsequent attempts at HSB implementation even more difficult. In contrast, those who have successfully implemented an HSB previously may reflect on their previous successes and thus feel more confident in their ability to reduce SHSe and may have stronger intentions to continue enforcing HSBs. A similar pattern is evident among people who quit smoking: self-efficacy related to smoking cessation has been shown to increase after a successful attempt to quit,[48] indicating that the construct of self-efficacy reflects not only future behaviors but also completed behaviors. Because regression analyses with cross-sectional data cannot conclusively demonstrate such causal links, future research should evaluate directionality and potential mediators (e.g., HSBs) of the links demonstrated here (between SHSe beliefs and biomarkers) in a longitudinal design. Additionally, despite assessing demographic and smoking characteristics, general psychosocial factors, and SHSe beliefs as possible correlates of SHSe, our models were under-identified and accounted for <20% of the variance, highlighting the complicated, multifactorial nature of complex health behaviors like smoking and SHSe reduction. This study emphasized the identification of potentially modifiable variables, although some nonmodifiable variables or variables less amenable to intervention (e.g., addiction contingencies, family smoking patterns, social reinforcers in home/community, genetic makeup) may demonstrate stronger relationships with biomarker outcomes. Similarly, broad ecological issues that can impact smoking behavior, such as socio-economic influences, policy, and other systems influencing health were not included in the measurement or design of this study. Even with these limitations, prediction of HSB existence was relatively high (e.g., ROC = 0.85), indicating good measurement of issues related to a critical behavior to reduce SHSe.

The strengths of this study design are notable. The focus on young, low income, primarily Black children living with at least one smoker extends previous studies, which often survey large samples of the population via telephone,[30,35,36] by targeting a specific population highly vulnerable for SHSe-related health disparities through local Head Start preschool programs. To understand a broad range of potentially modifiable contributors to children's health disparities and to identify possible protective factors among the most vulnerable families, we purposively recruited a large, community-based sample of caregivers from underserved populations at high risk for SHSe and health disparities. Our school-based recruitment and screening approach broadened the range of families enrolled in research and the requirement of living with a smoker ensured that our sample comprised children at the most concerning levels of health risk. All eligible families were invited to participate but most families were difficult to contact, uninterested in participating, or did not respond to phone calls, which may bias the sample selection. It is unknown whether this sample differs in any meaningful way from the broader sampling frame. This sample was almost entirely Black; although this may limit generalizability to samples with different racial/ethnic makeup, this is a high-risk group deserving of target study. Focusing on this young, at-risk population was consistent with and extended previous findings with other, broader samples of youth with potential SHSe.[35] Evaluation of modifiable psychosocial and cognitive factors related to SHSe among children at high risk for health disparities and identifying potential intervention targets represents an important contribution to the literature and children's healthcare.[37]

The use of individual and environmental SHSe biomarkers provides wide coverage of smoking-related outcomes and decreases concerns about reporter bias. These objective biomarker indicators of SHSe also represent an expansion on other research linking social and behavioral factors with HSB existence.[35] Although alternative sources of SHSe (e.g., nonresidential exposure,[49] "thirdhand smoke"[50]) were not assessed, high correlations between air nicotine and salivary cotinine are consistently documented[51] and were evident in this sample, demonstrating that children's residential SHSe is strongly associated with overall exposure. It is possible that placing monitors in the home may have impacted air nicotine outcomes. For example, family members who smoke may have altered their smoking behavior (e.g., reduced smoking, smoked in other rooms or outside of the home), which could impact air nicotine values. The collection and averaging of multiple monitor readings over the span of 1 week was designed to reduce the potential impact of possible initial reactivity to being monitored. Knowing monitors were placed in the home may also have reduced the risk of social desirability bias in reporting HSBs. With these potential monitoring biases in mind, the high levels of exposure detected in this sample is of extra concern, as SHSe may likely be even higher.

Conclusions

Despite common, often unchangeable risks including demographics and living with a smoker, caregiver beliefs about HSBs are associated with both the existence of an HSB and children's SHSe, and have potential for intervention. Pediatricians who assess and address caregivers' smoking-related beliefs and behaviors may be better positioned to promote families' implementation of complete HSBs and decrease children's SHSe.

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Declaration of Interests

None declared.

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