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Exploring the barriers and incentive architecture for modifying smoke exposures among asthmatics

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Abstract

Background: The socio-structural barriers for reducing secondhand smoke exposure (SHSe) among children with asthma may be insurmountable for low-income caregivers. Health promoting financial incentives (HPFIs) are increasingly being used in the adult population to motivate and sustain tobacco-reduction behaviors. We assessed barriers to SHSe reduction and means to overcome them through the design of an HPFI-based, caregiver-targeted SHSe reduction study.

Methods: Using a mixed-methods design, we conducted semi-structured in-depth interviews among low-income primary caregivers of children with asthma residing in Baltimore City. Quantitative data using an online survey were used to augment interview findings.

Results: Home smoking restrictions were a frequently referenced strategy for decreasing SHSe, but interviewees (n=22) described the complex social pressures that undermine reduction efforts. Caregivers redirected conversations from broadly implemented smoking bans towards targeted reduction strategies among mothers and members of their social network who are active smokers. Participants converged on the notion that sustainable SHSe reduction strategies are realizable only for mothers who are active smokers, possess high self-efficacy and social structures that promote cessation. Survey data (n=56) clarified the multiple contexts that underlie pediatric SHSe and preferred HPFI architecture that included fixed, recurrent payments contingent on reduced nicotine biomarkers and completion of basic asthma education classes.

Conclusions: Based on the combined analyses, we envision testing a HPFI-based study design whose optimal target population included low-income caregivers and members of their social network where incentives are tied to pediatric biomarkers and asthma education – an integrated approach that has not yet been used in pediatric tobacco studies.

Keywords

Smoking; pediatrics; public health; smoking cessation; smoking ban; financial incentive

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INTRODUCTION

Indoor cigarette smoke exposures are a major contributor to sustained high levels of asthma prevalence among children of lower socioeconomic status (1,2). Pediatricians and policymakers have long advocated for the implementation of an indoor smoking ban to minimize these concerns (3,4). This strategy does not account for complex psychosocial dynamics resulting in secondhand smoke exposures (SHSe) in settings where the caregiver may not be self-empowered to modify smoking behaviors of others or where the caregivers themselves are active smokers (5). The individuals in a caregiver's social network might influence a child's smoking exposures through their own smoking behaviors or by altering the caregiver's norms about the acceptability of smoking by, for example, vocalizing preferences for an indoor smoking ban (6). Maternal caregivers, who often bear the responsibility of childcare in urban environments, are also less able to modify smoke exposures due to numerous sex- and gender-based factors (e.g., unequal social influence between men and women, differential earning power to afford economic and housing freedoms) (7).

Health promoting financial incentives (HPFIs) may be a formidable strategy to address these complex psychosocial dynamics to encourage the uptake of health behaviors (8). HPFIs provide compliant participants an immediate material reward for the adoption of health-promoting behaviors. Because the clinical implications of these behaviors are often delayed, HPFIs make these behaviors more instantly attractive to individuals (9). Randomized-control trials (RCTs) of smoking cessation in predominantly adult populations are particularly notable in that they show the critical relationship between the specific design features of HPFIs and the success of smoking behavior modification. Among adult smokers at an urban safety-net hospital, escalating incentives totaling \$750 delivered at 6 and 12 months significantly increased cessation (9.6% increase in cessation rates at 12 months in those being incentivized) – as verified by salivary cotinine (10). Employing more frequent incrementally increasing HPFIs among lower income adults (maximum of \$1,650 over 6 time points in 6 months) showed short- and long-term improvements in cessation among those being incentivized (11). Employed adult smokers offered \$100 for completion of a smoking-cessation program (CSP), \$250 for cessation within 6 months and \$400 for abstinence for an additional 6 months yielded significantly increased CSP participation and sustained cessation at 15 – 18 months after enrollment (12). Trials of individual versus group-based HPFIs valued up to \$800 showed no significant increase in biochemically-verified cessation; incentives using a deposit schema in this same adult population, whereby the deposited money is returned along with additional HPFIs based on cessation, resulted in higher rates of cessation among those willing to recruited into the cohort (13). Despite the impact of HPFIs on adult smoking behaviors, they have yet to be employed as a means to modify smoking behaviors among adult caregivers of children with asthma (14,15). Caregivers are an ideal target for an HPFI incentive since parental smoking is the most common source for SHSe; they also are the individuals most likely to be invested in minimizing clinically-impactful smoke exposures (16–18). Moreover, because the expense of cigarette purchases seems particularly contrary to the self-interest of low-income

individuals, HPFIs could serve as a further nudge to caregivers to change behaviors leading to their childrens' SHSe (12,13).

The ongoing debate regarding the value of HPFIs has yet to address their potential utility for caregivers seeking to improve clinical outcomes of their children. Our goal was to understand the psychosocial barriers low-income urban caregivers face in limiting their childrens' SHSe, their opinions about a future proposed HPFI intervention to encourage indoor smoking bans in their own homes, and to determine acceptable levels of incentives in such an intervention. We hypothesized that lower income caregivers of asthmatic children would describe more insurmountable barriers to SHSe prevention, but would be receptive to high-value HPFIs for motivating a response to reduce indoor SHSe derived from either themselves or from other individuals. This paper contributes to the literature by assessing the potential role of caregiver-directed incentives in reducing SHSe among children in lower income urban settings.

METHODS

This study utilized a mixed-methods design to explore barriers and caregiver-based incentives for the reduction of home smoke exposures among children with persistent asthma, as defined by greater than 2 exacerbations requiring systemic steroids over a 12-month interval. Qualitative and quantitative data were analyzed separately and partially mixed during analysis (19). Using complementary data allowed us to better define the target population and develop a more nuanced incentive program.

Study participants and recruitment

The study population was purposively sampled from rosters of former participants in an ongoing Johns Hopkins Medical Institutional Review Board-approved randomized clinical trial. This trial is testing the effectiveness of an emergency department (ED) and home-based intervention on children with persistent asthma (NCT01981564 – which will be referred hereafter as the Asthma ED study) (20). A purposive sampling method was used to identify caregivers of children aged 3–8 years who were native English-speakers and had completed the Asthma ED intervention. A total of 127 participants were identified and contacted by both telephone and mail for inclusion in our study. Of the participants who could be contacted by telephone, 6 refused to take part with no detailed explanations provided. We consented 22 participants (17.3%) for qualitative interviews. All 127 prospective participants were also sent online survey links electronically and, 56 (44.1%) accessed and completed the survey; 16 (28.6%) of survey takers had also completed qualitative interviews.

Qualitative data collection

An open ended, semi-structured interview guide with key questions and probes was developed in consultation with researchers in behavioral economics, pediatric asthma, and tobacco control (Table 1). Pilot interviews were conducted with 3 individuals to refine the questions and the flow of the conversation. The guide was then revised to address emergent themes from the initial 11 interviews and a second iteration was used in subsequent interviews. Interviews covered three key domains: 1) perception of SHSe as a trigger for

asthma, 2) sources of SHSe and perceived ability to modify smoking in indoor and outdoor settings, 3) opinions regarding the utility and target recipients of financial incentives contingent on the reduction of a pediatric nicotine biomarker. The interviews were conducted by both the principal investigator (MJ) and trained qualitative research staff (AM) between March–July, 2016. All participants were verbally consented and each interview lasted approximately 30 minutes. Research staff communicated with each other at the conclusion of each discussion to review interview processes and initial impressions. All interviews were digitally recorded and transcribed verbatim. Thematic saturation was met after 22 interviews after which point no further interviews were conducted.

Quantitative data collection

The research team sent survey participants an email detailing the objective of the study, requesting participation and linking to the survey in June 2016. A text message with link to the survey and a brief description was also sent to the last available mobile phone number listed in the Asthma ED study. Three follow-up requests were sent to non-respondents. Participants were allowed to choose either guaranteed or lottery-style compensation.

The survey was created on a web-based survey platform (Qualtrics Labs, Provo, UT) and covered four general domains used in the development of the qualitative interview guide (Table 1): smoking behaviors; incentive structure; risk behaviors on decision-making; and sociodemographics. The survey questions were designed to be distinct from and complement interview questions to provide additional insights for triangulation during analysis.

Data analysis

Participant interviews were transcribed and coded after all data collection was complete. Interview transcripts were reviewed through an iterative coding process using principles of qualitative description (21). Two members of the research team (CT and MJ) reviewed the interview transcripts and iteratively analyzed them using the descriptive analysis methods, to formulate both topical and thematic codes to reflect ideas present in the text. The final codebook used codes, definitions and example quotes to elucidate emerging central themes. Preliminary coding primarily used deductive codes based on topics from the interview guide and themes in the literature review, while inductive codes reflected themes emerging from participant statements. Interviewees were not involved in transcript review due to concerns that edited versions could potentially remove valuable candid verbal exchanges captured during the interviews. Data were analyzed to determine if any smoking and risk behaviors patterns matched participant demographics. Nvivo 10 (QSR International Pty Ltd, Australia) was utilized for data management and coding. Standard descriptive statistics outlined survey participant characteristics stratified by smoking status. The Consolidated Criteria for Reporting Qualitative Research (COREQ) guideline statement was used to assist in the reporting of the study (see supplementary data file for COREQ checklist) (22).

Ethical review

Ethical approval was granted by The Johns Hopkins School of Medicine Institutional Review Board for Human Subjects (IRB0007568).

RESULTS

Qualitative - interviews

Sociodemographic characteristics: The majority of primary caregivers (81%) participating in interviews were less than 35 years of age and identified as being single (Table 2). All participants were African-American women, reflecting the population dynamics of Baltimore City (23). Two-thirds of smokers were unemployed, while non-smokers had a greater variety of statuses of employment. Despite the slightly higher level of employment in non-smokers, their annual incomes were on average less than \$30000; 78% of smokers earned less than \$20000 annually.

Context and behavioral responses to SHSe: When asked to describe strategies they used to reduce their child's SHSe, participants most frequently mentioned indoor smoking bans. Although most preferred this strategy, caregivers wrestled with complex social pressures that often undermined indoor bans (Figure 1). Avoiding SHSe in the homes of other family members or close acquaintances is perceived as a far greater challenge than implementing home smoking restrictions in the child's primary home. Some caregivers relied on family members to provide daycare, others felt obligated to interact socially with friends and family members who smoked or to allow their children to interact with their biological fathers in spite of their child's potential for SHSe. In such situations, the influence of primary caregivers tends to be low, leading them to rationalize the child's SHSe.

Caregivers linked the lack of effectiveness of home smoking bans to their inability to change the behaviors of others who come into contact with their child, which they repeatedly portrayed as showing "respect" for their child (Figure 1). Their emphasis on respect reflects their dependence on the empathy of friends, family, and even strangers to protect the child from SHSe. Some caregivers suggested they were more willing to advocate for changes in smoking behaviors around their child when they were socially empowered by their own perceived social standing and resources. For example, one caregiver mentioned that she felt empowered to ask her neighbors to cease smoking near her home after she relocated to a "nice" neighborhood, where neighbors are willing to modify their behavior to limit unintentional harm to others (Figure 1). However, not all caregivers have the means or status to expect such voluntary behavior modification, even from their own family.

Opinions and preferred incentive architecture: Caregivers in the study were not familiar with the concept of financial incentives as a means to modify smoking behaviors. Once the concept was explained in the context of motivating behavior change, participant responses fell into three non-exclusive categories: 1) they may serve as a mechanism for motivation, 2) they may be ineffective or counterproductive in yielding behavior change, 3) they may unethically incentivize cessation of a perceived immoral or irresponsible behavior. Interviewers explained that incentives would solely encourage home smoking restrictions, but some caregivers still tended to conflate the smoking ban with smoking cessation.

Those who believed that incentives would be of benefit focused on the notion that lower income individuals would be more likely to modify their behaviors due to financial need. Some connected the prospect of incentives directly to the perception that smoking

temporarily alleviates financial stress. One respondent saw the incentive money as a substitute for cigarettes that are used in part to alleviate the daily stresses of poverty. Some participants suggested that the primary attraction of incentives would be to further encourage their child's asthma control. A current smoker commented:

Money is the best incentive for me. But I'm saying money because a lot of people like money, but I wouldn't just do it for the money. I'm doing it for the health of my child. -003-R1

Some current or former smokers felt that incentives would not be successful in modifying smoking behaviors. Current smokers seemed the most reticent to accept incentives but all had conflated the study's focus on home smoking restrictions with smoking cessation. The following active smoker demonstrated this unprompted focus on smoking cessation:

Because it's like... for me, giving a person money to stop smoking... they might do it at that time, but they not going to stop smoking unless they ready to stop smoking. -015-R2

The few non-smoking caregivers were skeptical based on an understanding that behavioral decisions are based on complex motivations:

You know, money doesn't solve everything... They'll take the money and make it all about the reason they got their money. Once it's in their hands, okay come on, let's go up to that house and you know... forget all about oh I ain't supposed to take him up there because I was in program and they paid me not to take him up there. -004-R1

Several interviewees argued against incentives not based on their efficacy, but on the morality of paying people to change their own addictive or negative behaviors. These individuals generally conceptualize addiction not as a disease, but as a personal moral failure:

it shouldn't take money for them to stop smoking around that child if they know that it affects their asthma. -011-R1

Some participants viewed the payment of incentives as unintended encouragement of smoking behaviors:

Well, I think it would be a waste of money to give it to the smoker because all they going to use it for is to probably go buy them another carton of cigarettes. -009-R1

Despite the negative perception of incentives in a minority of respondents, the majority of interviewees appeared to be receptive to incentives if their delivery was contingent on measurement of low biomarkers of nicotine intake by the smoker. However, their willingness to accept the usage of incentives contingent on nicotine values was balanced against their concern that smoking behaviors would be immediately reestablished after incentive were ceased.

Quantitative - surveys

Sociodemographic characteristics: Of the 56 survey participants, 20% identified as active smokers, closely approximating the rate reported in city-wide surveys in Baltimore City (24). Much like the interview sample, the majority of the survey cohort was African-American women aged less than 35 years. Greater than half (64%) of all smokers were high school graduates, while 93% of non-smokers had achieved taking some college-level coursework. Most (73%) of smokers also earned less than \$10,000 annually.

Context and behavioral responses to SHSe: In the 56 person survey sample, all but 3 of the 11 smokers reported no sites of SHSe for their child; 42% of non-smokers reported similar lack of exposures (Table 3). Notably, no individual who was an active smoker reported the primary home as a site of SHSe. The most frequent SHSe locations for both smokers and non-smokers were outdoor public spaces and the homes of family members. Smokers reported more observed SHSe in the homes of friends of caregivers, suggesting that there are more smokers in their social networks.

Opinions and preferred incentive architecture: Survey data showed that using incentives to substitute or counteract the addictive power of nicotine is complicated by the numerous motivations for continued cigarette consumption (Table 3). Smokers identified stress reduction and relaxation as the two primary reasons for cigarette use, just above the addictive nature of the product. All smokers were at least contemplating smoking cessation. Greater than 60% appeared to be strongly in favor of quitting and potential candidates for the preparation phase of cessation. Despite their desire to quit, most patients have been unsuccessful in past smoking cessation efforts. The most common was unavailability of an effective way to quit; other explanations included low-self-control and poor family support.

The framing of an incentive program was explored using several risk scenarios presented to smokers, who proved to be overwhelmingly risk averse (Table 3). Though their smoking carries high health risks, these individuals appeared to prefer lesser-valued outcomes that are obtained with certainty, relative to higher-valued outcomes that are merely probable. Non-smokers were more likely to accept risk, but the majority of lower-income earners preferred a guaranteed but lower payment. To further triangulate risk decision making using real-word scenarios, we offered all participants completing the survey the choice of a small guaranteed compensation or the probability of a larger compensation. The vast majority of both groups preferred to be reimbursed a guaranteed amount of \$10, as opposed to a 1/25 or 1/50 chance of earning \$50 or \$100, respectively. The choice scenarios suggest that the lower-income target population would prefer guaranteed incentives rather than a lottery.

When asked what monetary amount would be necessary for smokers to enforce a home ban, all but one smoker reported that <\$40 would be sufficient to enforce a 1-month smoking restriction; approximately 30% of non-smoking participants believed that the equivalent would be required for that smoker to put in place a ban (Supplemental Figure 2). Over 20% of non-smokers believed that >\$200 would be needed for a smoker to restrict SHSe within the home for 1-month. A similar pattern emerged when asking about 3- and 6-month home restrictions. All smokers required a total of <\$140 and <\$260 for 3-month and 6-months

bans, respectively. In contrast, 30% of non-smoking participants believed an aggregate of > \$300 and >\$500 for smokers to enforce a 3- and 6-month home smoking restrictions, respectively.

DISCUSSION

The purpose of this mixed method analysis was to explore the feasibility and preferred characteristics of HPFIs targeting the reduction of indoor SHSe among low-income urban caregivers of children with asthma. Our research shows that complex psychosocial interactions present significant barriers to the effective implementation of home smoking restrictions. Consistent with past research in low-income settings, these factors appear to be compounded and more challenging to alter among individuals classified as being of lower socioeconomic status (25,26). Notably, several caregivers within the study believed that addressing psychosocial obstacles to change is difficult if not impossible given the poverty and social pressures that they faced. Interviewees were generally unaware of the HPFI strategies, but when informed of this approach, the majority were receptive to rewards based on objective outcomes (e.g., nicotine biomarker). The survey results suggest furthermore that active smokers prefer lower-value, non-probabilistic incentives. In contrast, non-smoking caregivers were more likely to prefer lottery-based methods to earn high-value monetary rewards in such an HPFI program. They also overestimated by 5x the HPFI value that an active smoker would need to enforce a 1-month home smoking ban compared to the amount suggested by the participating smokers.

Our work supports previous tobacco incentive studies that have shown varied support for the notion of HPFIs for modification of smoking behaviors, but whose acceptance may be enhanced if the strategy is proven effective (e.g., reduction in nicotine biomarkers) (27,28). Previous studies have used high levels of incentives (e.g., >\$750) to alter smoking behaviors, but our population of lower income smokers appeared to require a fraction of this value to change smoking patterns over similar study time periods (14,15). Moreover, most of the HPFI literature has focused on adult patient-oriented behavioral outcomes (8,17,29), but our work distinguishes itself by focusing HPFIs on caregivers' smoking behaviors affecting pediatric outcomes. The one previous pediatric study that did utilize incentives in modifying smoke exposures promoted avoidance measures among preteens, an approach that diverges from ours, which proposes targeting caregivers (30).

Consistent with past literature, our study also emphasizes the importance of addressing key elements within lower socioeconomic settings (e.g., housing independence) in which one's social standing directly impairs the ability to reduce environmental exposures (25,26). For individuals facing such significant social impediments, concepts focusing on individual behavior change such as Bandura's self-efficacy (a key element in his social cognitive theory [SCT]) lack explanatory power (31,32). However, Bandura's SCT model recognizes that in such situations individuals must feel confidence in their ability to influence behavior change in others - they must have what Bandura calls "proxy efficacy." Non-smoking caregivers who rely on others to modify their own smoking patterns perceive insurmountable impediments to reducing SHSe in their dependents given their perceived lower social status and reliance on social networks with varying smoking health beliefs and home smoking

patterns (33). HPFIs could be a means to address issues of self-efficacy by targeting mothers who are active smokers, who have an understanding of pediatric SHSe health risks, and who have positive outcome expectations – those with high self-efficacy. The proxy efficacy of caregivers could also be increased by incorporating key members of their social networks as recipients of HPFI schemas, thereby increasing the ability of caregivers to encourage them to limit tobacco use around the affected child.

A consistent concern among participants was that broadly implemented indoor home smoking restrictions would not be as effective as a program that is focused on reducing indoor smoke exposures among caregivers who smoke in direct proximity to their child. As this theme emerged during data collection, it became increasingly clear that participants did not think that the implementation of an indoor home smoking ban would protect their children from SHSe; instead, a program of HPFIs should aim to encourage a complete smoking cessation within a smoker's network of family and close friends. It was in this context that HPFIs were explored in-depth and their utility in a community-based study was further explored. Based on the synthesis of findings from the interviews and targeted surveys, we formulated a potential strategy based on five key factors: stage of smoking cessation contemplation; HPFI value; timing; social support; and skills obtainment. This combination of elements has not been used together in pediatric tobacco outcome studies (17,34).

The use of HPFIs using this combination of five factors for the reduction of pediatric SHSe appears most promising among maternal caregivers who are at a minimum contemplating smoking cessation because few participants believed that HPFIs could alter the behaviors of those who enjoy or actively crave cigarettes. Based on participant feedback, guaranteed incentives would be preferable to a non-probabilistic (e.g., lottery-based) incentive. The absolute monetary value of a monthly incentive to enact a change in smoking behaviors is relatively small when viewed from the perspective of an active smoker. Regardless of the characteristic of the incentive, most preferred the delivery of HPFIs contingent on an objective pediatric biomarker (e.g., decreased pediatric cotinine values) to enhance the social acceptability of the strategy. Participants also did not view HPFIs as a solely individual strategy, but saw a need to include members of the caregivers' social network to either serve as peer support during the implementation of smoking reduction or to be incentivized if they are active smokers. Lastly, it was suggested that incentives be tied to a formal, state-sponsored smoking cessation program offering nicotine replacement therapy, smoking cessation counseling, and education on the pediatric and adult harms of smoking activities.

Our study's participant-informed HPFI strategy would be novel within currently implemented, government-sponsored programs targeting pediatric outcomes. The *Oportunidades* government-sponsored cash transfer program in Mexico provides low income families with monetary reimbursement in exchange for compliance with preventative health care services (35,36). Canada offers up to \$1000 of tax credits per child enrolled in a prescribed program of physical activity or other health-promoting behaviors (37). The US codified the implementation of HPFIs in the Affordable Care Act by authorizing incentives for Medicaid beneficiaries to adopt healthier behaviors, though its impact on pediatric-based outcomes is yet to be determined (38,39).

Despite the important implications of this work for tobacco and behavioral economic researchers, there are limitations in the study design. The key constraint of this research was the limited sample size and the subsequent findings derived from this restricted cohort. Our participants were used to grasp both psychosocial barriers that hinder an indoor smoking ban and HPFI-based strategy to overcome those obstacles. Low-income caregivers of asthmatic children are a heterogeneous population and we cannot state with certainty that the elucidated barriers or derived HPFI strategy can be applicable to caregivers in urban locales with diverse socioeconomic environments (8,9,26). The translation of the study would be enhanced with a more varied, larger sample size. Moreover, less than 30% of respondents completed the interview and survey – both of which complement each other and provide a more complete picture of the preferred HPFI architecture. This “incomplete” data, along with the limited sample size, could have confounded our derived HPFI strategy and ultimately limit future implementation of the intervention among a broad populace of urban low-income caregivers.

Further limitations attributed to our study population include our reliance on a convenience sample of participants that limited the generalizability of the findings. We used mixed methods to explain specific behaviors in a well-defined population of low-income urban African-American caregivers, not to measure the amplitude of those behaviors or to assert generalizability. Convenience sampling assured that the study population comprised mothers of pediatric urban asthmatics and accurately reflected the characteristics of study populations used in prior pediatric asthma outcome research in Baltimore City (40–42). However, our results may have been potentially biased by our subjects’ participation in the Asthma ED study, in which potential education and subsequent awareness about SHSe-influenced asthma symptoms may have occurred (20). Moreover, the Asthma ED study population often had unstable contact information (e.g., non-working phone numbers or unreliable home addresses) which resulted in a low response rate and limited the strength of our conclusions. Because our participants were unfamiliar with HPFIs, they offered unbiased opinions on incentives, but a greater period of reflection may have altered their opinions. Several caregivers initially viewed incentives as equivalent to bribery or promoting negative behaviors; however, the majority eventually held cautiously positive opinions of HPFIs when considering their ethics and potential benefit on a more targeted, individual level. We also repeatedly emphasized in our interviews that the HPFIs were intended for the implementation of indoor home smoking restrictions, but caregivers sometimes described their challenges in the context of smoking cessation. We suspect that because current tobacco control health programming often emphasizes cessation, our participants may have unwittingly conflated tobacco reduction with smoking cessation since as members of the community they have seen firsthand pediatric SHSe among children of mothers who are active smokers – a fact that is well-documented in previous studies among similar populations (43,44). Furthermore, we described HPFIs as cash payments to gauge the appropriate incentive level in this population. Participant opinions of HPFIs may have differed if we discussed gift cards or vouchers for specific purchases (e.g., HPFIs to purchase child-centered gifts), which could not be spent on perceived negative behaviors. Lastly, we focused our HPFI questions solely on incentives a reward for positive health outcomes, given that past studies have extensively documented the benefit of positive

incentives among low income populations (17,45). Exploration of payment or loss of money for the continuation of negative health behaviors may be a potent tool to explore in future research.

CONCLUSIONS

Our results show that important psychosocial pressures limit the ability of low-income urban caregivers to limit their asthmatic childrens' SHSe in significant ways. Caregivers of children with asthma often feel disempowered and as such are unable to voice their desire to reduce SHSe in order to sway the smoking behaviors of visitors in indoor settings. Most caregivers were unaware of HPFI strategies as a means to modify tobacco behaviors and were initially doubtful of their effectiveness and concerned about their potential to reinforce negative behaviors. When presented with a suggested program of indoor smoking cessation through HPFI delivery contingent on reduction of objective nicotine biomarkers, most participants were receptive to its usage. Smokers appeared to prefer relatively low financial incentives to implement a home smoking ban, and favored HPFIs delivered in a non-probabilistic (e.g., non-lottery based) fashion. In aggregate, our results could be used to generate hypotheses for a HPFI-based SHSe reduction intervention among an analogous population. A four-pronged HPFI strategy could potentially build efficacy and lead to positive outcomes by: including caregivers with existing motivation to alter smoking behaviors; choosing appropriate incentive characteristics; providing social support; and offering asthma education. The results of this study will help improve not only the design of future studies, but also may help to explain the lack of effectiveness of previous behavioral and environmental SHSe research in reducing pediatric nicotine biomarkers. The finding of this work may also provide a model for enhancing future asthma outcome research by using methodologies that take into account the complex social environments that impact the individual health actions of low-income caregivers residing in urban settings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

The intersection of potential behavioral control strategies and the contextual and response elements that influence their implementation.

Table 1.

Key domains from both instruments and sample question topics

Semi-structured phone interviews	Web-based survey platform
Asthma control and SHSe modification <ul style="list-style-type: none"> • Opinions regarding SHSe and its linkage to asthma exacerbations • Sites of indoor and outdoor SHSe • Who cared for the child in a typical month and their smoking behaviors (e.g., personal smoking patterns and usage of indoor smoking ban) • Primary caregivers ability to modify smoking behaviors of other individuals in and outside the home • Experience with previous SHSe reduction strategies Incentive role <ul style="list-style-type: none"> • Opinions on financial incentives in modifying home SHSe if payment was contingent on pediatric nicotine biomarkers • Ideal features of adult caregiver and pediatric populations who would most benefit from incentives • Effectiveness of incentives in reducing SHSe in all potential asthma trigger environments 	Smoking behaviors of active smokers <ul style="list-style-type: none"> • Frequency, cost, location and preferred times of cigarette usage • Addictive or psychological reasons (e.g., stress relief) for usage of cigarettes smoking • Intergenerational smoking behaviors • Frequency and reasons for failure of past quit attempts Smoking behaviors of non-smokers <ul style="list-style-type: none"> • Past usage of cigarettes and strategy employed for smoking cessation • Employment of a home smoking ban • Location of indoor and outdoor smoke exposures of the child Preferred incentives <ul style="list-style-type: none"> • Amount of money (\$US) required to institute a complete indoor smoking ban for 1-,3- and 6-months among non-smokers. • Amount of money (\$US) that non-smokers believed that smokers would require to institute a complete indoor smoking ban for 1-,3- and 6-months Incentive architecture <ul style="list-style-type: none"> • Frequency, type and preferred means of gaining incentives using probabilistic risk scenarios Respondent characteristics <ul style="list-style-type: none"> • Economic, sociodemographic and housing characteristics

Table 2.

Characteristics of interview participants based on smoking status.

Characteristics	Smokers (N=9)	Non-smokers (N=13)
Caregiver age		
18–24	1	1
25–34	7	9
35–44	1	2
>45	-	1
Gender		
Male	-	-
Female	9	13
Marital status		
Single, never married	7	11
Single, divorced	1	1
Married	-	2
Living with a partner	1	-
Race		
White/Caucasian	-	-
African American	9	13
Other		
Highest level of education		
Less than high school	1	2
Some or completed high school	5	7
Some or completed college	2	3
Prefer not to answer	-	1
Current employment status		
Part-time	-	2
Full-time	1	4
Homemaker	1	1
Unemployed	6	5
Retired	-	1
Prefer not to answer	1	-
Annual income range (\$)		
<10000	4	6
10000–19,999	3	-
20,000–29,999	-	2
30,000–39,999	-	2
>40000–49999	1	1
Prefer not to answer	1	2

Table 3.

Sociodemographic, clinical and incentive characteristics among smokers (n=11) and non-smokers (n=45) among online survey participants.

Characteristics	Smokers N (%)	Non-smokers (N %)
Gender		
Male	-	2 (5)
Female	11 (100)	43 (95)
Age		
18–24	1 (9)	6 (13)
25–34	8 (73)	25 (56)
35–44	2 (18)	13 (29)
>45–54	-	1 (2)
Marital status		
Single, never married	8 (73)	31 (69)
Married	1 (9)	14 (31)
Living with a partner	2 (18)	-
Race		
White/Caucasian	-	2 (5)
African American	10 (91)	39 (87)
Other	1 (9)	4 (9)
Highest level of education		
Less than high school	1 (9)	0
Some or completed high school	6 (54)	19 (42)
Some or completed college	4 (37)	23 (51)
Prefer not to answer	-	3 (7)
Current employment status		
Part-time	1 (9)	4 (9)
Full-time	2 (18)	20 (44)
Homemaker	2 (18)	7 (16)
Student	-	1 (2)
Unemployed	6 (55)	10 (22)
Prefer not to answer	-	3 (7)
Annual income range (\$)		
<10000	8 (73)	13 (29)
10000–19,999	-	6 (13)
20,000–29,999	1 (9)	6 (13)
30,000–39,999	1 (9)	6 (13)
>40000–49999	-	8 (18)
Prefer not to answer	1(9)	6 (13)

Characteristics	Smokers N (%)	Non-smokers (N %)
Locations of pediatric SHSe (multiple responses allowed)		
Home	-	2
Another parent's home	-	5
Outdoor public space	7	16
Relative's house	7	15
Friend's house	3	1
Other's house	4	4
No SHSe reported	3	19
Number of cigarettes smoked		
10 cigarettes	9 (81)	-
11–20 cigarettes	2 (18)	-
20 cigarettes	0	-
Monthly cost of cigarettes (\$)		
1–20	3 (27)	-
21–50	4 (36)	-
51–100	2 (18)	-
>100	2 (18)	-
Reasons for smoking (multiple responses allowed)		
Reduces stress	7	-
Enhances relaxation	7	-
Addicted/crave cigarettes	6	-
Reduces weight	2	-
Assists with focus/concentration	2	-
Enhances feelings of happiness	2	-
Stage of smoking cessation		
I don't want to quit	0	-
I want to try to quit	4 (36)	-
I think it's really important to quit	7 (64)	-
Quit attempts over past year		
Yes	8 (73)	-
No	3 (27)	-
Reason for re-starting smoking (multiple responses allowed)		
Low-self control	3	-
Didn't have a good way to quit	6	-
Poor family support	2	-
Other	2	-
Past usage of cigarettes		

Characteristics	Smokers N (%)	Non-smokers (N %)
Yes	-	9 (20)
No		36 (80)
Risk attitude towards gain of cash		
Risk averse (high probability)		
80% chance of winning \$1000	1 (9)	31 (69)
Winning \$700 for sure	10 (91)	14 (31)
Risk seeking (low probability)		
1% chance of winning \$1000	0	19 (42)
Winning \$20 for sure	11 (100)	26 (58)
Chosen survey reimbursement		
\$10, guaranteed	9 (82)	32 (71)
1/25 chance to win \$50		4 (9)
1/50 chance to win \$100	2 (18)	9 (20)