Vol.2, No.11, 1264-1271 (2010)
doi:10.4236/health.2010.211188

Residential smoking restrictions are not associated with reduced child SHS exposure in a baseline sample of low-income, urban African Americans

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Received 3 September 2010; revised 15 September 2010; accepted 26 September 2010.

ABSTRACT

Second hand smoke exposure (SHSe) relates to many chronic and acute illnesses. Low income African American (AA) maternal smokers and their children have disproportionately higher tobacco-use and child SHSe-related morbidity and mortality than other populations. While public health officials promote residential smoking restrictions to reduce SHSe and promote smoking cessation, little is known about the impact of restrictions in changing smoking behavior and SHSe in this population. Thus, the purpose of this study was to examine associations between residential smoking restrictions, maternal smoking, and young children's SHSe in the context of other factors known to influence low income AA mothers' smoking behavior. For this study, we used cross-sectional, baseline data from 307 AA maternal smokers' pre-treatment interviews completed as part of a subsequent behavioral counseling trial to reduce their young (< 4 years old) children's SHSe. Residential smoking restriction was dichotomized as 0 = no restrictions and 1 = some restrictions. Child urine cotinine provided a biomarker of SHSe. Mothers reported cigarettes/day smoked, cigarettes/day exposed to child, and intention to quit. Multivariate regressions modeled effects of restriction as the primary predictor of smoking and exposure outcomes. Maternal smoking patterns such as cigarettes per day (β = 0.52, p < 0.001) and years smoked (β = −0.11; p = 0.03) along with presence of additional smokers in the home (β = 0.10; p = 0.04), but not residential restriction (β = −0.09, p = 0.10), predicted reported SHSe. Restriction did not relate to baby cotinine or maternal intention to quit. Thus, residential smoking restrictions may contribute to efforts to reduce children's SHSe and promote maternal smoking change; but alone, may not constitute a sufficient intervention to protect children. Multi-level intervention approaches that include SHSe-reduction residential smoking policies plus support and cessation assistance for smokers may be a necessary approach to smoke-free home adoption and adherence.

Keywords: Home Smoking Policy; Second Hand Smoke; Underserved Populations

1. PURPOSE

The World Health Organization and U.S. public health agencies have concluded that secondhand smoke exposure (SHSe) contributes to morbidity and mortality and that there is no safe level of exposure [1,2]. SHSe is associated with a variety of acute and chronic health consequences, with infants and toddlers across all racial and socioeconomic groups bearing greater susceptibility to acute consequences than other age groups [1,3-14]. Estimated medical expenditures for SHSe-attributable respiratory illness and pediatric emergency department admissions alone exceeds $115 per child exposed annually, or over $2.5 billion annually if extrapolated to U.S. children of 3-11 years old [15-17].

While children's SHSe remains a pressing public health concern in general, addressing SHSe in low-in-come, minority populations is a more urgent need. Given evidence that low income African Americans (AAs), suffer greater SHSe-related morbidity and mortality compared to other groups [18-29], many public health agencies, such as the National Cancer Institute and Centers of Disease

Control, cite the reduction of SHSe in such underserved populations as a public health priority.

Reducing SHSe can lead to short-term and sustained health benefits [30,31]. This evidence has accelerated the trend to implement policies to reduce nonsmokers' exposure to SHS in public places and to protect young children from SHSe in public housing and cars [32]. However, more research is needed to understand the degree to which voluntary efforts to create residential smoking restrictions influence children's SHSe. The rationale behind efforts to reduce child SHSe in family residences is based on evidence that tobacco smoked at home, particularly mothers' smoke, is the predominant source of children's SHSe [1,26,33-35].

Health officials have established practice guidelines [36] to promote SHSe reduction, and some communities have promoted smoke-free home adoption to protect children [37]. Restricting residential smoking may benefit children's health and promote reduction in smokers' daily smoking consumption [38]. Restrictions could produce even greater benefits among low income families who are more likely to live in multiunit residences with smaller square footage and experience higher rates of overcrowding [39]. However, such communities experience greater barriers to smoking behavior change [40-46]. Thus, the impact of residential smoking restrictions on child SHSe and smokers' daily consumption requires further examination in low income communities.

Mechanisms by which workplace and public smoking restrictions are successful will not easily translate to residential environments. One must consider unique psychosocial and socio-cultural factors that influence smoking in the home versus other settings. Moreover, children of smokers may continue to be exposed to SHSe via contaminated clothes, furniture, and other surfaces even if parents enforce residential smoking restrictions [47]. Thus, an assumption that residential smoking restrictions alone are sufficient to reduce child SHSe may lead to public health programs that are overly simplistic and fail to address other factors that influence child SHSe. This shortcoming could be magnified in low-income and underserved minority communities who face additional, poverty-related barriers to smoking behavior change compared to other populations. Therefore, research examining the associations between restrictions, maternal smoking, and child SHSe in the context of other smoking-related factors within underserved, low-income populations is warranted.

The purpose of this study was to examine associations among residential smoking restrictions, maternal smoking behavior, and child SHSe in the context of other smoking-related factors in a population of low income, AA maternal smokers. We hypothesized that residential restrictions would relate to lower levels of reported child SHSe and cotinine. Because we conceptualized residential smoking restrictions as predictive of broader maternal smoking behavior change, we hypothesized that restrictions would relate to fewer maternal cigarettes smoked per day and greater likelihood of intention to quit smoking.

2. METHODS

2.1. Design and Sample

This study focused on cross-sectional, pre-treatment data collected as part of the ongoing clinical trial targeting African American, maternal smokers in medically underserved neighborhoods of Philadelphia, Pennsylvania. Recruitment occurred primarily through Women, Infants, and Children (WIC) centers and pediatric primary care clinics as well as community newspaper, flier, and mass transit advertisements between September 2004 and December 2008. Inclusion criteria required that mothers smoked at least five cigarettes/day and exposed their child to at least two cigarettes/day. Exclusion criteria included psychiatric diagnoses, pregnancy, and inability to speak English. All procedures were approved by Temple University's institutional review board.

2.2. Measures

Data were obtained from the eligibility screening and a 75-minute, in-home baseline interview occurring approximately two weeks after screening. We selected variables consistent with previous empirical literature and the Behavioral Ecological Model [48] to capture a comprehensive explanation of contextual factors and level of residential smoking restrictions on maternal smoking and child SHSe. The assessment strategies used in the current study have been reliable and valid in previous trials with low income smokers [49].

2.2.1. Dependent Variables

Four dependent variables included reported child SHSe, child cotinine, reported maternal cigarettes smoked/day, and intention to quit smoking. Maternal cigarettes/day was derived from summing the average number of cigarettes mom smoked/day inside at home, outside at home, away from home and in the car over the last two weeks. Child SHSe was derived in the same manner across the same smoking locations and by source. Intention to quit in the next 30 days was measured as 1 = yes and 0 = no. Child cotinine, an accurate and frequently used biomarker for SHSe [50], was obtained from urine samples col-

lected using standardized procedures during in-home interviews.

2.2.2. Independent and Controlling Variables

Residential smoking restriction was the hypothesized primary predictor and was assessed using a four-point response scale (1 = total indoor smoking ban to 4 = no indoor restrictions). Restriction was dichotomized (0 = no smoking restrictions, 1 = some to total smoking restrictions) for ease of interpretation and due to the distribution of responses showing that only 10% of participants reported a total smoking ban in their home [51]. Demographic, psychosocial, and smoking factors known to influence maternal smoking were controlling variables.

2.2.2.1. Smoking Factors

Nicotine dependence was measured by the Fagerström Test for Nicotine Dependence (FTND) [52]. Mothers also reported whether their home had a convenient place to smoke outdoors (1 = yes, 0 = no) and if there were additional smokers living at home (0 = mother the only smoker, 1 = additional smokers.) We collected total number of lifetime months mothers' smoked daily and the average hours/day that the child spends indoors.

2.2.2.2. Demographic Variables

Mothers' education was coded as 0 = high school graduate or less, 1 = education beyond high school, including vocational training. Employment was coded as 0 = unemployed, 1 = part- or full-time employment. Household income was coded as 0 = less than $15,000 and 1 = $15,000 or more. Maternal and child age were continuous variables.

2.2.2.3. Psychosocial Variables

Maternal depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) [53]. General social support was measured using the global score of the Interpersonal Support Evaluation List [54]. Support for quitting smoking was assessed via a single interview item (0 = none to 5 = very much). History of current other substance abuse was obtained as 0 = no and 1 = yes.

2.3. Statistical Analyses

Baseline data were double entered to verify accuracy. Logical inspection of study variables for skewed distributions and outliers were performed. Cotinine was log transformed to the tenth power to normalize the skewed distribution. Prior to conducting multiple regression and logistic regression, bivariate associations between the dichotomized home smoking restriction and criterion variables were assessed to determine whether multivariate analyses were appropriate. Additional bivariate associations between criterion and controlling variables determined which variables to include in multivariate analyses (< 0.10). Backwards stepwise method was used to find the best model fit.

3. RESULTS

3.1. Participant Characteristics

Table 1 provides sample characteristics of 307 African American maternal smokers in the study, reflecting a predominantly single, light-to-moderate sample of maternal smokers living below poverty level.

Pearson correlations between dichotomized residential smoking restriction and four criterion variables indicated that restriction had a significant association with reported child SHSe ($r = –0.21$, $p < 0.001$) and maternal cigarettes/day smoked ($r = –0.206$, $p < 0.001$); but not with cotinine ($r = –0.10$, $p = 0.10$) or intention to quit ($r = –0.01$, $p > 0.10$). Because there was not a bivariate association between restriction and either child cotinine or maternal intention to quit smoking, we only conducted multivariate analyses for reported child SHSe and maternal cigarettes/day.

3.2. Multiple Regression Analyses

3.2.1. Reported Child SHSe from All Sources

The multiple regression model for reported child SHSe was significant ($F = 13.55$, $p < 0.001$; $R^2 = 0.34$), but suggested that residential smoking restriction was not associated with reported SHSe when controlling for other factors. Three other factors predicted higher levels of reported child SHSe: more maternal cigarettes smoked/day, shorter daily smoking history, and additional smokers living at home. Not having a convenient place to smoke outside and time spent indoors/day were not significant covariates. (**Table 2**)

3.2.2. Total Maternal Cigarettes/Day Smoked

The multiple regression model for maternal cigarettes/day was significant ($F = 14.16$, $p < 0.001$; $R^2 = 0.32$) but suggested that residential smoking restriction was not associated with maternal smoking when controlling for other factors. Significant covariates included greater nicotine dependence and older age. (**Table 3**)

4. DISCUSSION

This study examined hypothesized influence of residential smoking restrictions on child SHSe and maternal smoking behaviors in a sample of underserved, African

Table 1. Sample characteristics (n = 307).

Variable	Distributional Characteristics		
	Mean	***SD***	**Frequency (n, %)**
Child's Age in Months*	18.9	14.9	
Mother's Age in Years	29.8	7.9	
Home Smoking Restrictions (raw)			
- Total indoor restrictions			28 (9.1%)
- Some area restrictions			151 (49.2%)
- No indoor restrictions			128 (35.7%)
Home Restriction (dichotomous)			
- Some Restriction			95 (30.9%)
- No Restriction			212 (69.1%)
Martial Status			
- Married/living with a partner			56 (18.2%)
- Single			251 (81.8%)
Household Income			
- $15,000 or below			208 (67.8%)
- Above $15,000			99 (32.2%)
Employed			
- Unemployed			100 (32.6%)
			207 (67.4%)
Education Greater than HS degree			
- Yes			67 (21.8%)
- No			240 (78.2%)
Mean # children in home	3.0	1.8	
Number of smokers in child's home			
- 1 smoker			144 (46.9%)
- 2 or more smokers			163 (53.1%)
Number of rooms in the home			
- 0-5 rooms			161 (44.8%)
- > 5 rooms			198 (55.2%)
Nicotine Dependence (FTND)	4.7	1.8	
Mean cigarettes/day smoked	11.7	6.2	
Mean cigarettes /day child is exposed	8.4	8.8	
Child Urine Cotinine (ng/ml) log10	1.23	0.52	
Intention to quit in the next 30 days			
- Yes			88 (28.7%)
- No			219 (71.3%)
Convenient place to smoke outside			
- Yes			342 (95.3%)
- No			16 (4.5%)
- Missing			1 (0.3%)
Support for Quitting Smoking			
- None to Some			102 (33.2 %)
- A lot to Very Much			204 (66.8%)
History or Current Substance Abuse			
- Yes			32 (10.4%)
- No			275 (89.6%)
Depressive Symptoms (CES-D)	18.9	10.4	
General Social Support (ISEL)	36.8	6.5	
Negative Affect (PANAS)	16.8	7.6	

*Dichotomously coded (0 = infants under 1 year; 1 = children of 1-4 years).

Table 2. Maternal report of cigarettes/day child is exposed regressed on selected smoking, social, and demographic characteristics*.

Model	Standardized Coefficients		
	Beta	Std. Error	P
Residential Restriction †	–0.09	0.98	0.10
Cigarettes/day	0.52	0.08	< 0.001
More than 1 smoker at home	0.10	0.88	0.04
Total months smoked	–0.11	0.01	0.03
Education > high school	–0.06	1.05	0.24
Avg Daily Time Baby Indoors	–0.05	0.09	0.33
Social Support	–0.05	0.07	0.35
Substance Abuse	–0.05	1.5	0.37
Child age	0.05	0.03	0.37
Nicotine dependence	0.04	0.28	0.44
Convenient Place to Smoke Outside	–0.04	2.0	0.48

*Dependent variable: Maternal-reported total baby exposure to cigarettes from all sources; †Residential restriction coded as 1 = some to total smoking restrictions, 0 = no restrictions.

Table 3. Maternal cigarettes/day smoked regressed on selected smoking, social, and demographic characteristics*.

Model	Standardized Coefficients		
	Beta	Std. Error	P
Residential Restriction†	–0.072	0.747	0.187
Nicotine Dependence	0.526	0.188	0.000
child age	–0.062	0.024	0.272
Education > high school	–0.046	0.849	0.418
convenient place to smoke outside	–0.034	1.584	0.521
mother age	0.127	0.051	0.035
Income over 15,000	–0.072	0.797	0.210
substance abuse	–0.086	1.119	0.126

*Dependent variable: average number of cigarettes smoked per day; †Residential restriction coded as 1 = some to total smoking restrictions, 0 = no restrictions.

American maternal smokers. Restrictions related to reported SHSe and maternal cigarettes/day in bivariate analyses, but did not relate to cotinine or intention to quit. Restrictions did not predict of either reported SHSe or maternal cigarettes/day in their respective multivariate models. Thus, our results suggest that residential smoking restrictions alone are not sufficient to reduce child SHSe or to promote changes in maternal smoking in this

population, and that additional policies or interventions are needed to enhance such efforts to reduce child SHSe.

4.1. Child SHSe and Residential Smoking Restriction

Our data suggest that residential smoking restrictions may have the potential to influence reported smoking behavior change and SHSe among AA maternal smokers with preschool children (0-4 years old). However, when accounting for broader contextual factors that also influence smoking and SHSe, our data suggest that residential smoking restrictions alone may not be sufficient to affect children's overall SHSe from all sources and in all locations as captured by cotinine (a biomarker of SHSe). More intensive strategies for reducing these children's SHSe may be necessary. For example, our multivariate analyses showed that reported SHSe was influenced by maternal cigarettes smoked/day, consistent with previous research suggesting maternal smoking is the most important predictor of child SHSe [1,33-35]. This model also suggested that children have greater levels of reported SHSe when there are more smokers living in the home. Thus, even if families restrict smoking inside the home, there appears to be the potential for children to be exposed to other sources of SHSe. These sources could include additional smokers living at home, or tertiary levels of exposure (e.g., by contact with smokers' clothes, hair, and surfaces within areas where smoking is permitted [55]). Additional sources of SHSe in many low-income families may also depend on the type of housing conditions both inside and between smokers' housing units, whether the parent is the head-of-household, and whether restrictions are favored by all smokers living in the home—factors that could make enforcement of smoking restrictions more difficult.

Future research should examine the influence of a total indoor smoking ban, something not possible with our baseline dataset given the low proportion of mothers reporting total bans. However, our results suggest that other factors may need to be addressed in addition to promoting smoking restrictions or bans. Further examination of barriers to smoke-free home enforcement could help guide future intervention implementation. Experience with smoking restrictions in public venues suggests that social norms influence enforcement of such policies. Thus, developing interventions that build community and family support for residential smoking restrictions would capitalize on the influence of social norms that oppose SHSe [56]. Local media could also play a role in shaping social contingencies that promote smoke-free homes [57]. Research that can prospectively examine ways to shape anti-residential SHSe social norms will inform future policy and individual-level interventions for smoking behavior change.

4.2. Maternal Smoking and Residential Smoking Restrictions

Our results did not support our hypothesis that residential restrictions would reduce smoking and increase motivation to quit. With only 29% of our sample reporting intention to quit, this result could be a consequence of accrual strategies in our clinical trial designed to include maternal smokers regardless of their present interest in quitting smoking. Our results could also reflect our sample of smoking mothers with young children—a population that demonstrates greater challenges to quitting smoking than the general population of smokers. Perhaps future research could examine whether health professionals, local policies, or family-level contingencies that promote smoke-free homes could be catalysts for smoking cessation in underserved communities [58-63].

4.3. Limitations and Strengths

Our cross-sectional dataset limits the ability to infer causal relations between residential smoking restrictions and maternal smoking and child SHSe. Also, the purposive sample of low income, AA maternal smokers may limit generalizability of study results beyond similar low-income populations. In this study, we did not observe the expected consistency between our self-reported SHSe and cotinine data. Given that only 9% of participants in this study reported total smoking bans, we conclude that this data inconsistency is more likely to be attributable to variability in restriction enforcement rather than over-reporting of said restrictions. Moreover, previous clinical trials have demonstrated the reliability of parent-reported smoking and child SHSe [64]. Future studies should examine the relative influence of enforcement of residential smoking restrictions on child SHSe, a hypothesis that could not be examined in the current study. Despite these limitations, our study offers future directions for research, intervention, and policy.

4.4. Significance

This study provides evidence that residential smoking restrictions alone may not be sufficient to promote significant reductions in child SHSe or change in maternal daily smoking and intention to quit among maternal smokers known to have increased tobacco-related morbidity and mortality risk. Our results further suggests that future programs may need to implement multi-level interventions that promote improved advice about SHSe [58,59] as well as in-home support that assists with the

enforcement of smoking bans and promotes smoking cessation (something that these researchers are proposing to examine).

Theory-based strategies can address sets of idio-graphic factors that undermine smoking behavior change. They also frame sets of factors that can guide the expansion of family- and community-level norms supporting smok-free homes and SHSe-reduction in low income, underserved communities [65]. Globally, there are increasing numbers of smoke-free policies to protect nonsmokers, not only in workplaces and hospitality venues, but also private spaces, such as cars (e.g., Maine [66]) and some communities have instituted policies to prevent smoking inside public housing, such as in Calabasas, CA [67]. However, it is important to consider that such policies will be more effective if coupled by other interventions that can assist families and smokers to achieve residential smoke-free goals. Future research should examine how best to bridge community-supported residential SHSe policy with improved access to smoking cessation intervention. Communities planning smoke-free home interventions may need to blend resources and initiatives for improving the quality and frequency of pediatric providers' assessment and advice for smoking parents and improving access to formal smoking intervention services with their policy efforts in order to maximize the likelihood of achieving intended SHSe reduction goals.

5. ACKNOWLEDGEMENT

This work was supported by the National Cancer Institute at the National Institutes of Health to BC [K07 CA093756 and R01 CA105183].

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