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Household exposure to secondhand smoke is associated with decreased physical and mental health of mothers in the USA

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Abstract

Background—Secondhand smoke is one of the most common toxic environmental exposures to children, and maternal health problems also have substantial negative effects on children. We are unaware of any studies examining the association of living with smokers and maternal health.

Objective—To investigate whether non-smoking mothers who live with smokers have worse physical and mental health than non-smoking mothers who live in homes without smokers.

Methods—Nationally representative data from the 2000–2004 Medical Expenditure Panel Survey were used. The health of non-smoking mothers with children <18 years (n=18,810) was assessed, comparing those living with one or more smokers (n=3,344) to those living in households with no adult smokers (n=14,836). Associations between maternal health, household smoking, and maternal age, race/ethnicity, and marital, educational, poverty and employment status were examined in bivariable and multivariable analyses using SUDAAN software to adjust for the complex sampling design. Scores on the Medical Outcomes Short Form-12 (SF-12) Physical Component Scale (PCS) and Mental Component Scale (MCS) were used to assess maternal health.

Results—79.2% of mothers in the USA are non-smokers and 17.4% of them live with 1 adult smokers: 14.2% with 1 and 3.2% with 2 smokers. Among non-smoking mothers, the mean MCS score is 50.5 and mean PCS is 52.9. The presence of an adult smoker and increasing number of smokers in the home are both negatively associated with MCS and PCS scores in bivariable analyses (p<0.001 for each). Non-smoking mothers with at least one smoker in the household had an 11 % (95% CI=0.80–0.99) lower odds of scoring at or above the mean MCS score and a 19 % (95% CI=0.73–0.90) lower odds of scoring at or above the mean PCS score compared to non-smoking mothers with no smokers in the household. There is an evidence of a dose response relationship with increasing number of smokers in the household for PCS (p<0.001).

Conclusions—These findings demonstrate a previously unrecognized child health risk: living with smokers is independently associated with worse physical and mental health among non-smoking mothers.

Keywords

maternal health; secondhand smoke

INTRODUCTION

There is a voluminous and still growing literature on the effects of secondhand smoke (SHS) on the health of exposed children, adults, and pregnant women. The 2006 US Surgeon General's Report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke* states that "secondhand smoke causes premature death and disease in children and in adults who do not smoke."¹ The report cites many physical health risks associated with exposure to SHS for which there is sufficient evidence to infer a causal relationship. These include Sudden Infant Death Syndrome; low birth weight; childhood respiratory infections; middle ear disease; childhood cough; asthma; lung cancer; and coronary heart disease, among others. The report notes the growing literature showing an association of SHS exposure and child mental health and neurocognitive problems, but concludes that the current data are insufficient to infer a causal relationship between this exposure and child mental health or cognitive functioning.¹ Since that report, more evidence has linked SHS exposure to a number of adverse health consequences, such as lower levels of breast-feeding, poorer academic performance in adolescents, child and family food insecurity, bladder cancer in nonsmoking women, as well as fetal DNA damage and other problems.²⁻⁶

There is a significant separate body of research showing the effects of maternal mental and physical health on child wellbeing. Mother's mental health, particularly maternal depression, has been clearly linked to many childhood problems, including worse child nutrition, poorer growth and development, more diarrheal illnesses, and other childhood problems.⁷⁻²²

The evidence for the association between maternal physical health and child health is less robust and less clear, although there is reason to hypothesize that in the aggregate poorer maternal physical health would be associated with poorer child health and development. Overall, children appear to report experiencing stress from their parent's illness, while there has been little evidence documenting objective symptoms.^{23,24, 25}

A recently published study from Japan demonstrated that exposure to tobacco smoke at work is associated with an increased risk of depression.²⁶ To our knowledge, as well as that of the authors of that paper, their study is the first to link SHS exposure to worse adult mental health. Similarly, we are unaware of any research to date on the association of maternal exposure to *household* SHS and maternal mental and physical health.

In this paper we present the results of analyses of data representative of the US population exploring the independent association of household exposure to SHS and maternal physical and mental health among non-smoking mothers.

METHODS

Data source

Data from the 2000–2004 Medical Expenditure Panel Survey (MEPS), sponsored by the National Center for Health Statistics and the Agency for Healthcare Research and Quality (AHRQ) were utilized. MEPS is an annual survey of the US civilian population, excluding those who are institutionalized, which has been conducted since 1996.^{27, 28} Households participating in MEPS are selected from households that had participated in the National Health Interview Survey during the previous year. In 2000, MEPS began including questions about smoking among all adult members of participating households.²⁹ Therefore we used this data to examine the relationship between household smoking and maternal health in those households with nonsmoking mothers and children less than 18 years of age.

Data for MEPS are collected by interviewers who visit the homes of survey participants. Over the course of two years, the household is visited five times and one adult is interviewed with the assistance of personal interviewing software; the same adult is interviewed throughout the survey process. The Survey includes a Household Component (HC) and an Insurance Component, among others. The HC includes demographic information about socioeconomic status (SES), health information including health problems and use of services, and personal data such as smoking status for members of the household.

Because MEPS oversamples Blacks, Hispanics, and starting in 2006, Asians and low income households, weights were developed for use in the derivation of nationally representative population estimates to support analysis of data collected in sample surveys. All data utilized in this study were weighted and annualized to produce national estimates. More detailed information on MEPS can be found at <http://www.meeps.ahrq.gov>.^{30, 31} Data from the HC and supplemental sections (described below) were used for the determination of household smoking.

Study Variables

Adult Household Smoking—The MEPS includes a section entitled Adult Self Administered Questionnaire, administered to all household members aged 18 years or greater, which participants are instructed to return by mail. One of the questions in this survey is “Do you smoke?” and based on the answers submitted, households were categorized as smoking or nonsmoking as well as by the number of adult smokers in the household. In cases where participants did not respond to this question, a 2-step model was used to impute the missing data.

The first stage of the imputation utilized the two-year structure of MEPS, assigning the smoking status reported in one year to the smoking status in the year not reported. The strategy was validated using the 2003 and 2004 MEPS. For adults participating in the survey in both 2003 and 2004 and who reported their smoking status in each year, 93.5% did not change their smoking status between years. Among the 6.5% who did change, there was near balance between those who quit smoking (3.4%) and those who began (3.0%). The second stage of the procedure imputed values for those adults who did not report their

smoking in either year of participation by applying an algorithm using variables associated with smoking status developed by the Agency for Healthcare Research and Quality.^{32, 33}

Maternal and Family Characteristics—The following maternal and family characteristics were investigated: maternal age, race/ethnicity, marital status, maternal education, employment and poverty status, region, urban/rural residence, and physical activity (Table 1). These data were taken from the MEPS household file as well as the available supplemental sections. Maternal age was categorized as <20, 20–34, and ≥34 years of age. Race/ethnicity was categorized as White (non-Hispanic), Black (non-Hispanic), Hispanic, Asian (non-Hispanic), and Other/Multiple (non-Hispanic), and maternal education was categorized into <12 years, high school (including unfinished college), college graduate and more. Geographic variables included whether the sampled person lived in a Metropolitan Statistical Area (MSA) and region of the country (using the 4 census regions).

Maternal marital status was dichotomized into married vs. not-married (single, divorced, widowed); employment status into employed vs. unemployed and physical activity into “yes” (currently spending half hour or more in moderate to vigorous physical activity at least three times a week) vs. “no”. Poverty level was similarly divided into those below versus at or above 125% of the US poverty level.^{31, 34}

Maternal Physical and Mental Health—Maternal physical and mental health in MEPS were determined by mothers’ responses to the Short Form-12 (SF-12) Questionnaire, which has two components: a Physical Component Scale (PCS) and a Mental Component Scale (MCS). The SF-12 is a reduced version of the original SF-36 and has been shown to be equally effective at assessing respondents’ physical and mental health.^{35, 36} The SF-12 is a well-validated 12 item self report measure of disability, scored from 0–100 with a higher score corresponding with better health with a mean score of 50 and a standard deviation of 10 in the general U.S. population.³⁶ The MCS and PCS scores of respondents are available as part of the MEPS supplementary data.³¹

Sample

A total of 22,915 mothers with children less than 18 years of age were included in the 5 years of data analyzed. From the total sample, 18,180 mothers were non-smokers (79 %) and 4,735 were smokers (21 %). Mothers who smoked were excluded from the analyses.

Analyses focused on the sample of non-smoking mothers (n=18,180) and the presence of adult smokers in their household. Among the sample of non-smoking mothers, 3,344 (18.4 %) lived with at least one smoker. The remaining 14,836 mothers (81.6%) had no adult smokers in their home. Six hundred and ninety eight (3.8%) nonsmoking mothers lived with 2 smokers and 198 (1.1 %) lived with 3 or more smokers (Figure 1).

Analyses

We analyzed the data from non-smoking mothers living with children <18 years (n=18,810), comparing those living with one or more smokers (n=3,344) to those living in households with no adult smokers (n=14,836). Associations between maternal mental/physical health and several variables including household smoking, maternal age, race/ethnicity, marital

status, educational status, poverty and employment status were examined first in bivariable analyses (t-test, one-way ANOVA) and then in multivariable analyses (multiple logistic regression). Scores on the SF-12 were used to assess maternal health. MCS and PCS scores were dichotomized using the mean value for the population of non-smoking mothers: mean and < mean. We modeled the odds of scoring mean MCS or PCS value (1 = mean; 0 < mean). Significance was tested at $\alpha=0.05$. SAS software was used (SAS Institute, Cary, NC) for data management and SUDAAN software for statistical analyses and for complex sampling design adjustment (Research Triangle Institute, Cary NC).^{37, 38}

RESULTS

In the analyzed sample from the years 2000–2004, 79% of all mothers are non-smokers, and 21% smoke. As shown in Figure 1, 18.4% of non-smoking mothers live in households with at least one adult smoker: 13.5% live with 1 adult smoker and 4.9% live with 2 or more smokers (3.8% with 2 smokers, 1.1 % with 3 or more smokers). In 24.4% of households with non-smoking mothers and other adult smokers there are 3 or more children present.

Table 1 shows the characteristics of the sample and the distribution of factors associated with mean MCS and PCS scores in this sample of non-smoking mothers. Among non-smoking mothers, the mean MCS score was 50.46 (SE=0.096) and the mean PCS score was 52.89 (SE= 0.08). In bivariable analyses, nearly all variables explored (maternal age, race/ethnicity, marital status, maternal education, poverty and employment status, residence, physical activity) were significantly associated with MCS and PCS score at a p-value of <0.05. Both the presence of an adult smoker as well as an increasing number of smokers in the household are significantly negatively associated both with MCS and PCS scores ($p<0.001$).

Non-smoking mothers with at least one smoker in the household had an 11 % (95% CI=0.80–0.99) lower odds of scoring at or above the mean MCS score and a 19 % (95% CI=0.73–0.90) lower odds of scoring at or above the mean PCS score compared to non-smoking mothers with no smokers in the household (Table 2). There is an evidence of a dose response relationship with increasing number of smokers in the household for PCS ($p<0.001$) (Table 2).

DISCUSSION

These data are the first we are aware of to show an independent association between living with smokers and the health of mothers. Using information from a large national study, two important findings emerge: first, that mothers who live with any number of smokers have worse mental and physical health than their counterparts who do not live with smokers; and second, that the more smokers a mother lives with, the worse both her physical and mental health are. While it may not be surprising that mothers' physical health would be worse given the extensive literature on adverse physical consequences of SHS exposure^{15, 39–42}, there is a remarkable paucity of literature about the potential consequences of SHS and adult mental health.²⁶

Numerous studies have shown the harmful effects of SHS on those who are exposed, including adults, children, and pregnant women and their fetuses.^{39, 40, 43–52} As early as 1986, the Surgeon General reported that there was sufficient evidence to show that smoking is dangerous not only to smokers but also to those in their environment.⁵³ The 2006 Surgeon General's report lists many physical health consequences for those exposed to SHS as noted above; however, no mention is made of potential deleterious effects on adult mental health. As regards children's mental health and neurocognitive development, it states that the information is still insufficient to infer a causal relationship.¹

There already is a significant literature on the association between active smoking and depression and anxiety, among other mental health problems, in both women and in mothers.^{54, 55, 18, 54–57} However, this study is the first to show an association between exposure to SHS and worse adult mental health in the USA.

The current study specifically addresses the issue of mothers' health because of their profound contribution to the health, development, functioning and quality of life of children. As noted above, there is a great deal of evidence to show that mothers suffering from depression are impaired in their ability to care for their children. While there is considerable uncertainty about maternal physical health and child welfare, there is evidence to suggest that the illness of mothers negatively impacts the health of their offspring.^{7, 10, 14, 58} Moreover, recent research, utilizing the same sample of mothers, children and households, and the same measures of maternal physical and mental health, demonstrates an independent association between both maternal mental and physical health and child mental health.⁵⁹ Also, similar to this study, that study demonstrated that even in the absence of maternal smoking, children's mental health was worse in households with adult smokers and the more smokers present, the worse the child's mental health.^{26, 59}

There are a number of limitations to this study, which used publicly available, previously collected data. First, we are unable to distinguish between the impact of living with smokers as human beings (who, as noted, have higher rates of depression and other problems) versus the impact of SHS exposure as an environmental agent.. Secondly, we are unable to quantify the amount of exposure-there is no information available about how much household smokers smoke or if they smoke in the home. There is also no information about SHS exposure at work or in other settings, which would contribute to the mothers' overall exposure to tobacco smoke. Furthermore, smoking status is only reported for household members over the age of 18; since the rates of teenage smoking remain high, this could be a notable contributor to household SHS.^{13, 60–62}

Smoking status in this study is ascertained via self - report. Since there is considerable public awareness about the effects of SHS on children, participants might be motivated to under-report their smoking status or that of their family members although there is evidence to show that self-report is an accurate way to measure smoking behaviors.^{63, 64} Despite this evidence, self-report of smoking status remains a potential weakness. Access to a biological measurement of nicotine exposure such as serum cotinine or hair nicotine, or household air nicotine levels would be desirable to provide physical evidence of levels of tobacco exposure. This study adjusted for a number of variables that were potential confounders,

including measures of SES. However, it remains possible that other, unmeasured confounders are mediating the relationship between living with smokers and maternal health.

Another limitation of this study is that the MCS and PCS are still self-reported measures of health status despite the fact that they have been validated.

The strengths of this study include its large, nationally representative sample and that maternal health was estimated using a well-validated scale that has proven to be an accurate tool in many studies. Moreover, we were able to adjust for many potential confounders, and after adjustment for them, found statistically significant independent relationship between living with smokers and the mental and physical health of mothers in the United States.

CONCLUSION

SHS has already been shown to have numerous health consequences to exposed children and adults, yet it continues to be a significant problem in the United States. The results of the present study involving a nationally representative US sample demonstrates impaired mental and physical health of non-smoking mothers who live with smokers. The risk is discernible with the presence of a single adult smoker in a household and increases with the number of smokers. These results are of importance, we believe, not only because they are some of the first to show an association between SHS and adult mental health, but also because of their implications for the health and wellbeing of the nation's children.

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Fig. 1.
Percentage of non-smoking mothers in the USA living with 0, 1, 2 or more adult smokers
(n=18,180) Medical Expenditure Panel Survey 2000–2004

Table 1

Factors Associated with Mean Mental Component Scale and Physical Component Scale Score Among Non-Smoking Mothers, Medical Expenditure Panel Surveys 2000–2004, N=18,180, bivariable analyses

Variable	N	MCS ^I (mean)	SE	p-value [†]	PCS ^I (mean)	SE	p-value [†]
Smoker in the household							
Yes	3,344	49.56	0.23		51.97	0.20	
No	14,836	50.65	0.11	<0.001	53.08	0.09	<0.001
Number of smokers in the household							
0	14,836	50.65	0.11		53.08	0.09	
1	2,646	49.65	0.25	<0.001	52.19	0.22	<0.001
2	698	49.45	0.85		50.45	0.78	
Age							
<20 y	141	50.92	1.12		51.91	0.71	
20–34 y	7,515	50.21	0.15	0.07	53.55	0.11	<0.001
35 y	10,515	50.62	0.12		52.49	0.11	
Race/ethnicity							
White (non-Hispanic)	7,917	50.62	0.13		53.39	0.11	
Black (non-Hispanic)	2,878	50.38	0.24		51.92	0.21	
Hispanic	6,353	49.78	0.19	<0.001	52.39	0.16	<0.001
Asian/ PI (non-Hispanic)	814	51.74	0.39		52.12	0.34	
Other/Multiple (non-Hispanic)	218	48.03	0.93		50.28	0.95	
Marital status							
Married	12,778	50.96	0.23	<0.001	53.29	0.09	<0.001
Not married	5,397	48.99	0.11		51.73	0.16	
Maternal education							
<12 y	4,554	48.87	0.23		50.97	0.21	
High school graduate	5,464	50.1	0.17	<0.001	52.51	0.15	<0.001
Some college	6,733	51	0.14		53.41	0.12	

Variable	N	MCS ^I (mean)	SE	p-value [‡]	PCS ^I (mean)	SE	p-value [‡]
College graduate and more	1,338	51.54	0.28		54.48	0.20	
Employment status							
Yes	12,754	50.64	0.11	<0.001	53.26	0.08	<0.001
No	5,393	49.94	0.18		51.77	0.17	
Poverty status							
Poor/Near poor <125 % poverty level	4,688	48.3	0.22	<0.001	50.61	0.20	<0.001
Not poor/Near poor 125 % poverty level	13,492	50.89	0.10		53.34	0.08	
Region							
Northeast	2,651	50.57	0.28		53.30	0.17	
Midwest	3,178	50.84	0.20		53.13	0.12	
South	6,871	50.43	0.16	<0.001	52.63	0.14	0.01
West	5,471	50.08	0.20		52.74	0.15	
Urban/rural residence							
Urban-metropolitan area	14,989	50.51	0.11	0.07	53.03	0.09	<0.001
Rural-non-metropolitan area	3,182	50.22	0.22		52.20	0.19	
Physical activity							
Yes	9,009	50.97	0.12	<0.001	53.77	0.10	<0.001
No	9,086	49.88	0.14		51.90	0.11	

Abbreviations: MCS, Mental Component Scale; PCS, Physical Component Scale; SE, standard error of the mean

^I Medical Outcomes Short Form-12 (SF-12) Physical Component Scale (PCS) and Mental Component Scale (MCS), is a well-validated 12 item self report measure of disability that has been well studied in the general population (mean score of 50 and a standard deviation of 10 in the general U.S. population) and in populations with specific physical (e.g. arthritis, diabetes, MI) and mental health conditions (e.g. depression, anxiety), scored from 0–100 with a higher score corresponding with better health. Mean MCS score=52.89; mean PCS score=50.46 among non-smoking mothers in the U.S. study sample,

[‡] bivariable analysis – T-tests and One-way ANOVA

Table 2

Factors Independently Associated with Mean Mental Component Scale and Physical Component Scale Score Among Non-Smoking Mothers, Medical Expenditure Panel Surveys 2000–2004, N=18,180, Multivariable Analyses

Independent Variables	MCS ¹ Logistic Regression		PCS ² Logistic Regression	
	AOR	95%CI	AOR	95%CI
Smoker in the household				
Yes	0.89	(0.80–0.99)	0.81	(0.73–0.90)
No	*	*	*	*
Number of smokers in the household**				
0	*	*	*	*
1	0.90	(0.80–1.01)	0.82	(0.73–0.92)
2	0.84	(0.68–1.04)	0.75	(0.61–0.93)
Age				
<20 y	2.19	(1.44–3.33)	1.80	(1.18–2.72)
20–34 y	1.08	(0.99–1.18)	1.52	(1.40–1.66)
35 y	*	*	*	*
Race/ethnicity				
White (non-Hispanic)	*	*	*	*
Black (non-Hispanic)	1.16	(1.03–1.32)	0.83	(0.73–0.95)
Hispanic	0.96	(0.85–1.07)	0.94	(0.83–1.06)
Asian/ PI (non-Hispanic)	1.12	(0.91–1.38)	0.69	(0.57–0.84)
Other/Multiple (non-Hispanic)	0.74	(0.52–1.05)	0.58	(0.40–0.85)
Marital status				
Married	*	*	*	*
Not married	0.72	(0.66–0.83)	0.84	(0.77–0.93)
Maternal education				
<12 y	0.82	(0.72–0.93)	0.76	(0.67–0.87)
High school graduate	*	*	*	*

Independent Variables	MCS ¹		PCS ²	
	AOR	95%CI	AOR	95%CI
Some college	1.14	(1.03–1.26)	1.24	(1.12–1.36)
College graduate and more	1.29	(1.09–1.52)	1.44	(1.22–1.68)
Employment status				
Yes	*	*	*	*
No	0.96	(1.88–1.06)	0.82	(0.74–0.90)
Poverty status				
Poor/Near poor <125 % poverty level	0.74	(0.66–0.83)	0.70	(0.63–0.79)
Not poor/Near poor 125 % poverty level	*	*	*	*
Region				
Northeast	*	*	*	*
Midwest	1.03	(0.89–1.19)	0.84	(0.73–0.97)
South	0.97	(0.85–1.12)	0.87	(0.77–0.98)
West	0.90	(0.78–1.05)	0.85	(0.74–0.98)
Urban/rural residence				
Urban-metropolitan area	*	*	*	*
Rural-non-metropolitan area	0.96	(0.87–1.06)	0.87	(0.77–0.97)

¹ dependent variable: mean; mean for MCS

² dependent variable: mean; mean for PCS

* reference values

**

Analyzed in separate logistic regression models adjusting for age, race/ethnicity, education, employment status, urban/rural residence, region, poverty status

Abbreviations: MCS, Mental Component Scale; PCS, Physical Component Scale; SE, standard error of the mean; AOR, adjusted odds ratio; CI, confidence interval