



HHS Public Access

Author manuscript

J Pediatr Nurs. Author manuscript; available in PMC 2016 January 01.

Published in final edited form as:

J Pediatr Nurs. 2015 ; 30(1): 227–235. doi:10.1016/j.pedn.2014.06.004.

Secondhand smoke exposure, parental depressive symptoms and preschool behavioral outcomes

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Abstract

Little is known about the association of secondhand smoke (SHS) exposure and behavioral conditions among preschoolers. A cross-sectional analysis was used to examine billing and pharmacy claims from November 2004 to June 2012 linked to medical encounter-level data for 2,441 children from four pediatric community health clinics. Exposure to SHS was associated with attention deficit-hyperactivity disorder/ADHD and disruptive behavior disorder/DBD after adjusting for potential confounding factors. Assessment of exposure to SHS and parental depressive symptoms in early childhood may increase providers' ability to identify children at higher risk of behavioral issues and provide intervention at the earliest stages.

Keywords

child; preschool; mental health; primary health care; screening; secondhand smoke

INTRODUCTION

The prevalence of behavioral conditions among preschool aged children has been increasing steadily (Egger & Angold, 2006). There also is a nationwide shortage of child psychiatrists and other community mental health providers with expertise in working with young children. Therefore, there is a critical need to examine efficient strategies to support pediatric health care providers who are asked to identify at-risk children as early as possible (Thomas & Holzer, 2006). Shifting the focus towards screening for psychosocial risk factors associated with pediatric behavioral issues may help identify at-risk children such that behavioral issues can be prevented or identified as they are emerging. This is important as pediatric providers can then feasibly manage these issues in the primary care setting. This

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Financial Disclosure for all authors: none

Conflict of Interest for all authors: none

understanding may aid in prioritizing screening and intervention efforts by pediatric healthcare providers and public health officials for at-risk children. SHS exposure can be screened for effectively in primary care settings and is amendable to brief counseling (Anand, Carroll, & Downs, 2012; Bandiera, Richardson, Lee, He, & Merikangas, 2011; Downs, Zhu, Anand, Biondich, & Carroll, 2008; Hamer, Ford, Stamatakis, Dockray, & Batty, 2011; Rosen, Noach, Winickoff, & Hovell, 2012; Twardella, Bolte, Fromme, Wildner, & von Kries, 2010). In a 2007 national survey, 5.5 million children resided in households with a smoker (Singh, Siahpush, & Kogan, 2010). Despite successful US public health efforts aimed at reducing SHS exposure among non-smokers, children of non-Hispanic whites and blacks continue to be at highest risk (Pirkle, Bernert, Caudill, Sosnoff, & Pechacek, 2006; Sexton et al., 2004; Wilson, Kahn, Khoury, & Lanphear, 2005). Additionally, SHS exposure in the prenatal and postnatal periods has been associated with increased rates of childhood behavior problems (Herrmann, King, & Weitzman, 2008).

Despite the growing attention to the science on early brain and child development (Garner & Shonkoff, 2012), relatively little research has focused on secondhand smoke and its association with preschool behavioral outcomes. The majority of studies examining the negative effects of secondhand smoke and behavioral outcomes have relied upon samples of school-age children. One example of this is attention-deficit hyperactivity disorder (ADHD) (Banerjee, Middleton, & Faraone, 2007; Faraone, Sergeant, Gillberg, & Biederman, 2003; Froehlich et al., 2007; Langlely, Rice, van den Bree, & Thapar, 2005; Yoshimasu et al., 2009). However, ADHD is increasingly being diagnosed among preschoolers such that clinical care guidelines have been revised to encourage providers to consider this diagnosis among this age group (Kollins et al., 2006; Wolraich et al., 2011). Moreover, identification rates of other common psychiatric disorders among preschoolers have been increasing as well (Carter et al., 2010; Egger & Angold, 2006; Wilens et al., 2002b). Pediatric providers routinely screen for various psychosocial risk factors during frequent well-child visits in the first five years of life. Yet, no studies were found in our review of the literature that have utilized data collected in community clinics to understand what risk factors are associated with earlier behavioral outcomes.

Prior work **also has** not accounted for important risk factors such as parental mental health conditions. For instance, parental depression has been correlated with poor childhood behavioral outcomes and is being increasingly screened for by pediatric healthcare providers (Earls, 2010; Field, 2011; Murray et al., 2011). Yet, past studies have not always controlled for this important confounder, i.e. depressive symptoms among parents of young children (Bandiera et al., 2011; Hamer et al., 2011; Twardella et al., 2010). Our findings add to existing literature by showing that secondhand smoke is associated with behavioral outcomes as early as preschool age. It also focuses on a community-based sample using data collected in primary care and adjusts for exposure to parental depressive symptoms.

METHODS

Study Design

This is a cross-sectional study of children between the ages of 0 and 6 years seen at 4 community pediatric clinics between November 2004 and June 2012. Data for this study

was derived from a computerized decision support system used in conjunction with our electronic health record. Children were included in the study sample if complete visit level data for exposure to SHS and parental depressive symptoms were available.

Data Sources

We used data collected through the pre-screener form generated by the Child Health Improvement through Computer Automation (CHICA) system, which has been described elsewhere (Anand, Biondich, Liu, Rosenman, & Downs, 2004; Anand et al., 2012). Briefly, CHICA provides clinical decision support for both pediatric preventive care and disease management services (Anand et al., 2004; Anand et al., 2012; Downs et al., 2008). When a parent brings a child to a clinic that uses CHICA, a pre-screener form is generated for the parent to complete in the waiting room. The pre-screener form contains 20 questions based on information contained in the child's health record and the age of the child at the visit as displayed in Figure 1 (Downs, Biondich, Anand, Zore, & Carroll, 2006). Once completed by the parent, the pre-screener form is scanned back into the system and the data is incorporated immediately into the child's health record. CHICA then generates a separate physician worksheet with 6 selected prompts, based on information the parent provided on the pre-screener form and information in the health record. These prompts are designed to call the pediatric provider's attention to specific health risks during the face-to-face encounter as displayed on a sample physician worksheet in Figure 2. At the end of the visit, the physician worksheet is scanned back into CHICA. Data for this study was extracted from the electronic medical record. We linked data from the parent-completed pre-screener form containing information about individual child and family health risks to administrative data of mental health diagnoses and prescriptions data from our statewide clinical network, the Indiana Network for Patient Care, which houses billing data, physician orders, filled prescriptions, and laboratory reports (McDonald et al., 2005).

Measures

SHS exposure—SHS exposure was defined by any positive response to CHICA's pre-screener question asking families whether any household member smoked. Parents of children 0 – 11 years of age **were** asked about SHS exposure if no previous information regarding the child's exposure to SHS existed in CHICA during the last 18 months or if the question had not been asked before. A positive response during any visit resulted in the child being classified as having had SHS exposure. Likewise, if no affirmative responses were captured for any visits, the child was categorized as not having had SHS exposure.

Socio-demographic characteristics—Child gender, race/ethnicity and insurance category were obtained from CHICA's database. Insurance category served as a proxy for socio-economic status.

Parental depressive symptoms—CHICA aids pediatric providers' monitoring of parental depressive symptoms using questions adapted from validated screening instruments as part of routine surveillance of pertinent health risks of the child and family. From 2004 to 2010, the pre-screener form included items from the Patient Health Questionnaire-2 (PHQ-2) measuring parental depressive mood and loss of interest or pleasure in doing things

that previously was perceived as pleasurable (Kroenke, Spitzer, & Williams, 2003). In 2010, the Edinburgh Postnatal Depression Scale (EPDS-3) anxiety subscale items were substituted for the PHQ-2 to improve detection of postpartum depression. The EPDS-3 has been shown to have a high (95%) sensitivity and negative predictive value (98%) and measures parental symptoms of panic, self-blame and anxiety for postpartum depression (K. Kabir, Sheeder, & Kelly, 2008). Even though the use of the PHQ-2 is a valid way to detect parental depression in primary care settings, the items on the pre-screener form were changed to the EPDS-3 items as these were validated specifically for identification of postpartum depression. CHICA performs surveillance of parental mood every 90 days in the first 15 months of life or if there is no previous data on paternal depression in child's record in the electronic health record. If a parent responded affirmatively to any of the three surveillance items, the child was classified as being exposed to parental depressive symptoms; likewise children of parents with no affirmative responses to any of the symptoms at any visit were classified as not being exposed to parental depressive symptoms.

Behavioral Conditions—As we sought to examine the association of preschool children's exposure to SHS with children's behavior, we linked data captured from the pre-screener form to behavioral diagnoses that existed in the child's electronic health record. These behavioral diagnoses were identified using International Classification of Diseases-ninth revision (ICD-9) administrative billing codes for the following conditions: disruptive behavior disorder (DBD) (312.*), attention-deficit hyperactivity disorder (ADHD) (314.*), anxiety (300.*), depression (311), sleep disturbance (307.4), or adjustment disorder (309*).

Psychotropic Treatment—Psychotropic medications of interest included the following classes: stimulant medications, non-stimulants, alpha-2-agonists, sleep agents, atypical antipsychotic drugs, and selective serotonin reuptake inhibitors.

Statistical Analysis

Bivariate analyses of SHS exposure and socio-demographic variables were performed using chi-square test. Multivariable logistic regression models were used to assess the association between SHS exposure and each mental health diagnosis, adjusting for child gender, race/ethnicity, insurance status and parental depressive symptoms. An additional logistic regression model tested the association between SHS exposure and ever having been prescribed a psychotropic drug. All four covariates were selected *a priori*. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were calculated for each model. All analyses were performed using Stata11 (StataCorp, College Station, TX, 2010). This study was approved by our institution's Office of Research Administration-Human Subjects.

RESULTS

A total of 2,441 children were included in the study and their socio-demographics are reported in Table 1. The sample was 52% male, and a large proportion was Black (40.7%) or Hispanic/Latino (45.3%), followed by White (10.5%). The majority of the families in the sample had public insurance (90.2%), followed by self-pay and uninsured (5.9%) and a

minority with private insurance (3.9%). Approximately 27% of children (n=669) were exposed to SHS and 31.5% of children were exposed to parental depressive symptoms.

Race/ethnicity was significantly associated with SHS exposure. A majority of the children whose parents reported SHS exposure were Black (57%), followed by Hispanic/Latino (21%) and White (20%) parents reported the lowest rate of SHS exposure. A majority (89.4%) of families reporting SHS exposure were publically insured. A similar proportion of male and female children lived in households with reported SHS exposure.

The prevalence of behavioral conditions among preschoolers aged 3 to 6 years varied by diagnosis, with ADHD (3.3%) and disruptive behavior disorder (8.6%) being the most common as is shown in Table 1. Among our sample, 1.9% of preschoolers had ever been prescribed psychotropic medication.

Multivariable logistic regression analysis revealed significant associations between SHS and ADHD (AOR 1.9; 95% CI: 1.2–3.1) and DBD (AOR 1.6; 95% CI: 1.1–2.1) after adjusting for child's gender, race/ethnicity, insurance category and parental depressive symptoms. Parental depression was associated with a higher likelihood of a child ever being prescribed a psychotropic medication as shown in Table 2 (AOR 1.9; 95% CI 1.1–3.3). There were no other significant associations between SHS exposure and all other behavioral outcomes examined.

DISCUSSION

In this cross-sectional study of 2,441 children, 27% were exposed to SHS. SHS exposure was significantly associated with a diagnosis of ADHD and DBD among preschoolers, even after adjusting for all other factors. Exposure to parental depressive symptoms was associated with having ever been prescribed a psychotropic medication.

Our study adds to the growing literature showing an association between SHS exposure and behavioral outcomes in early childhood (DiFranza, Aligne, & Weitzman, 2004; Lam, Leung, & Ho, 2001; Mannino, Moorman, Kingsley, Rose, & Repace, 2001; Stoddard & Gray, 1997; Yolton, Dietrich, Auinger, Lanphear, & Hornung, 2005). To our knowledge, ours is the first study to examine the association of SHS exposure and a range of preschool behavioral outcomes in a pediatric primary care setting (Bandiera et al., 2011; Hamer et al., 2011; Twardella et al., 2010). Our study differs from previous work in several significant ways and strengthens previously reported findings. First, while our study focused on preschool-aged children, similar to the cross-sectional study conducted by Twardella et al. (Twardella et al., 2010) the measurement of behavioral outcomes was assessed using different data sources. In that study, behavior problems were assessed using the “Strengths and Difficulties” questionnaire, a parent-reported behavioral screening tool (Twardella et al., 2010) while we used available administrative billing data to classify preschool behavioral outcomes. Given that parents with mood disorders are more likely to have concerns about children's behavior, reliance on a parent-reported screening measure may overestimate the prevalence (Fergusson, Lynskey, & Horwood, 1993) due to reporting bias. We believe our data sources remove this source of bias.

Furthermore, we were able to adjust for the presence of parental depressive symptoms, a potential confounder. This is important not only because mental health conditions can be heritable, but also because individuals with mood disorders are more likely to smoke (Glazier, 2010; Lawrence, Mitrou, & Zubrick, 2009). In addition, caregivers affected by mental illness may experience sub-optimal parent-child interactions and diminished parenting capacity, both of which place their children at higher risk of behavioral conditions (Crawford, Schrock, & Woodruff-Borden, 2011; Keown, 2011). For these reasons, controlling for parental depressive symptoms as a confounder is an important advantage of our study.

There is no known “safe” or acceptable level of SHS exposure. Given the mounting evidence for the negative effects of SHS and the rising prevalence of behavioral conditions among children, our study underscores the continued need for health promotion and intervention at the earliest stages. In 2006, mental illness was the highest healthcare cost among children, surpassing asthma, trauma and infectious disease (Soni, April 2009). Thus far, ADHD among school-aged children is the mental health condition with the greatest evidence of its association with SHS exposure (Braun, Kahn, Froehlich, Auinger, & Lanphear, 2006; Froehlich et al., 2009; Z. Kabir, Connolly, & Alpert, 2011). We found a similar significant association with ADHD and disruptive behaviors among preschool age children.

Our findings underscore the importance of continued smoking cessation counseling efforts. However, overall rates of SHS screening and counseling in both pediatrics and family practice clinics have remained low (Tanski, Klein, Winickoff, Auinger, & Weitzman, 2003; Winickoff et al., 2003; Zapka et al., 1999). Smoking cessation efforts may be strengthened if pediatric providers are able to emphasize to parents the health risks of SHS to children, especially to parents who are interested in quitting (Alwan, Siddiqi, Thomson, & Cameron, 2010; Katz, Muehlenbruch, Brown, Fiore, & Baker, 2002). Brief interventions lasting 3 minutes in primary care can lead to decreases in smoking cessation rates (“A clinical practice guideline for treating tobacco use and dependence: A US Public Health Service report. The Tobacco Use and Dependence Clinical Practice Guideline Panel, Staff, and Consortium Representatives,” 2000). The growing evidence base of the association of SHS exposure and behavioral outcomes may be a motivator for a subset of parents with a strong family history of mental illness. Pediatric providers can discuss these risks with parents and other caregivers and provide smoking cessation advice, perform targeted screening and ongoing surveillance of child’s behavior and functioning for early-onset manifestations of behavioral conditions (Chen, Stanton, Hopper, & Khankari, 2011). Several randomized controlled trials of smoking cessation counseling with parents to protect their children from potential negative health effects have been found to be effective and doable within the scope of primary care practice (Abdullah, Mak, Loke, & Lam, 2005; Curry et al., 2003; Emmons et al., 2001; Rosen et al., 2012).

Some limitations to our study must be considered when interpreting the results. These include the retrospective design. We are not able to account for confounders that may contribute both to parental smoking and preschool behavioral conditions (McDonnell & Glod, 2003; Wilens et al., 2002a). However, we have tried to control for these by adjusting

our analyses for socio-demographic characteristics and parental depressive symptoms. Over the course of the study, the method of capturing parental depressive symptoms changed from the PHQ-2 to the EPDS-3. Scores from the EPDS or the PHQ-9, from which the EPDS-3 and PHQ-2 are derived, were often concordant when using either instrument to screen for parental depression in the clinical care setting (Yawn et al., 2009). In this study, we classified SHS exposure by parent report rather than using a biomarker, such as cotinine. However, parental report has been shown to correlate to biomarkers and is a reliable indicator of exposure (Puig et al., 2008; Yeager & Krosnick, 2010). Moreover, the CHICA pre-screener question is similar to that used in the National Health and Nutrition Examination Survey (NHANES) that used the question, “Does anyone who lives here smoke cigarettes, cigars or pipes anywhere inside this home?” (Braun et al., 2008). Parental response to the SHS surveillance question is subject to social desirability bias; however, the prevalence in our sample is similar to national estimates from the National Health Interview Survey (NHIS) examining parent-reported SHS exposure (Soliman, Pollack, & Warner, 2004). We were unable to control for maternal prenatal smoking history, nor whether any parent had a history of ADHD. While in utero exposure to SHS is a known risk factor for childhood ADHD, the postnatal presence of other smokers in the home, has been shown to be associated with ADHD symptoms in the absence of maternal smoking (Langley, Heron, Smith, & Thapar, 2012). Lastly, we acknowledge that there are inherent challenges to the reliance on ICD-9 codes of behavioral and mental health conditions in children less than 6 years of age (Egger & Emde, 2011); however, published studies have shown these classification systems can be used reliably for mental health disorders among children 2–5 years of age (Briggs-Gowan, Carter, Skuban, & Horwitz, 2001; Lavigne et al., 1998a, 1998b).

As pediatric healthcare providers build therapeutic relationships with families over time, they appreciate the risk and protective factors that may put a particular child at higher or lower need for behavioral concerns. Our study supports the recommendation by the American Academy of Pediatrics that primary care providers continue to pre-screen families for associated psychosocial risk factors, such as exposure to SHS and parental depression, as these risk factors are associated with behavioral issues and psychotropic drug treatment among preschoolers. Moreover, our findings support health promotion efforts that routinely occur during primary care visits that can more accurately aid in identifying families that may benefit from educational efforts to promote optimal parent-child interactions (Regalado & Halfon, 2001). Our study takes a critical first step towards understanding how pre-screening families for modifiable risk factors associated with negative childhood behavioral outcomes may increase providers’ ability to identify children at higher risk of behavioral issues at the earliest stages.

CONCLUSION

Understanding what modifiable risk factors are associated with pediatric behavioral outcomes can help prioritize screening by pediatric healthcare providers so that efforts can be aimed at prevention or as these conditions are emerging. Given the need for primary care providers to perform active surveillance for a host of conditions that can affect childhood behavioral health, multi-faceted efforts to understand how to identify and feasibly intervene

in primary care are needed. Preschoolers' exposure to SHS and parental depressive symptoms are potentially modifiable risk factors that can be screened for in primary care practice.

Acknowledgments

The authors would like to thank the Child Health Informatics Research and Development Lab (CHIRDL) with the Child Health Improvement through Computer Automation (CHICA) system and to Marc Rosenman, MD with IU School of Medicine Department of Pediatrics, Section of Children's Health Services Research; Jane Wang, PhD; and Roberta Ambuehl, BA of the Regenstrief Institute for their assistance with the creation of the database used in the study. The project was supported by grants 1R01HS018453 and R01 HS017939 from the Agency for Healthcare Research and Quality and R01 LM010031 from the National Library of Medicine.

Abbreviations

SHS	Secondhand smoke
CHICA	Child Health Improvement through Computer Automation
PSF	Pre-screener form
AOR	Adjusted Odds Ratio
CI	Confidence Interval
ADHD	Attention deficit-hyperactivity disorder

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1225519072 **CHICA Physician Encounter Form** #99-2

Patient: Patient, Ima Great (F) **MRN:** #99-2 **A Vital Signs:**
DOB: 01/18/13 **Age:** 13 mo **Date:** Mar 7 2014
Doctor: Other **Time:** 4:01PM

Physical Exam: NI Abnl **History / Exam Comments:** Additional notes on back...
General: **CC:** Two ID's Checked
Head: **Informant:** _____
Skin:
Eyes:
Ears:
Nose / Throat:
Teeth / Gums:
Nodes:
Chest / Lungs:
Heart / Pulses:
Abdomen:
Ext. Genitalia:
Back:
Neuro:
Extremities:
Legend: * = Previous o = Needs re-examination

Vital Signs:
 Height: cm (%)
 Weight: kg (%)
 BMI: (%)
 Head Circ: cm (%)
 Temp: F ()
 Pulse:
 RR:
 BP: ()
 Pulse Ox: %
 Hear (L): Hear (R):
 Vision (L):
 Vision (R):

**** ATTENTION **** Ima's parent identified symptoms of anxiety on 03/07/14. Ima has a smoker in the home. This may pose health risk to her. Symptoms of sadness, anhedonia, sleep disturbance or appetite disturbance may indicate depression.

May have depression ----> Referred Discuss Smoking risks
 Counseled & gave handout
 Not depressed Mom not present

INSTRUCTIONS: Check all applicable boxes. COMPLETELY fill space to right of each box to "uncheck" misfilled boxes.

**** ATTENTION **** Ima's parent identified symptoms of anxiety on 03/07/14. Ima has a smoker in the home. This may pose health risk to her. Symptoms of sadness, anhedonia, sleep disturbance or appetite disturbance may indicate depression.

May have depression ----> Referred Discuss Smoking risks
 Counseled & gave handout
 Not depressed Mom not present

Pb level indicated if: 1) exposed to sib/playmate with hi Pb. 2) someone who works with lead. 3) lives in home built before 1950. 4) home built before 1978 recently renovated.

Pre-1950 house Pre-1978 renov. house Parent was interested in info-> Provided contact information
 Lead + contact Contact that works with lead Advise rear facing Provided brochure
 Ordered / Done elsewhere No risk factors Parent not interested in info

The AAP has age-specific recommendations for the prevention of childhood burns and fires. Please review the following, and check those you review:

Working smoke detector Store matches/lighters safety NEVER carry child & hot liquids NEVER play near hot appliances
 Test batteries monthly Adjust water max temp 120F/49C
 Rec no smoking in house-> Smoking = #1 cause of fires Safe place for play while cooking

Assessments and Plan: Medication Education Performed and/or Counseled on Vaccines: Y N N/A
 The medical student acted as a scribe for this note.

Staff: _____ Signature: _____

Figure 2. Sample physician worksheet with reminders to assess exposure to parental depressive symptoms and secondhand smoke

Table 1

Sample characteristics (n=2,441)

Variable	N	%
Socio-demographics		
Male Gender	1270	52
Race/Ethnicity		
White	256	10.5
Black	994	40.7
Hispanic/Latino	1106	45.3
Other	85	3.5
Insurance Type		
Commercial/Private	95	3.9
Medicaid/Public	2186	90.2
Self-Pay/Special Payer	142	5.9
Report of any secondhand smoke exposure	669	27.4
Report of any exposure to parental depressive symptoms	769	31.5
ICD-9 diagnoses between 3 and 6 years of age		
Attention-deficit hyperactivity disorder	80	3.3
Disruptive behavior disorder	209	8.6
Anxiety	17	0.7
Depression	9	0.4
Sleep Problems	7	0.3
Adjustment Disorder	41	1.7
Psychotropic Treatment		
Any Psychotropic Treatment	47	1.9

ICD-9= International Classification of Diseases, Ninth Edition

* Totals vary due to missing data

Table 2

Association between SHS exposure and behavioral conditions among preschoolers*

Characteristic	AOR	95% CI
Attention deficit-hyperactivity disorder	1.9	1.2–3.1
Disruptive behavior disorder	1.6	1.1–2.1
Anxiety	1.5	0.6–4.2
Depression	2.0	0.6–6.8
Sleep Problems	3.4	0.8–14.8
Adjustment Disorder	1.5	0.8–2.8

* Multivariable logistic regression with robust estimates, adjusted for gender, race/ethnicity, insurance type and parental depressive symptoms.

SHS: secondhand smoke; AOR: adjusted odds ratio; CI: confidence interval.

Variables that achieved statistical significance are bolded